A κ-Krein space $H^+_{\kappa.(\tau)} \otimes H^-_{\kappa.(\tau)}$ based mechanical and dynamical quanta energy field model and a related vacuum-, plasma- and Maxwell-Mie κ-quanta scheme

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Dedicated to my son Mario
on the occasion of his 31th birthday on December 2nd, 2022

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Dedicated to my wife Vibhuta
on the occasion of her 62th birthday, August 25, 2023

Abstract

A κ-Krein spaces based unified quanta field theory is provided. From the Mie theory the concept of discrete energy knot elements (modelled as energy quanta of a related mechanical energy Hilbert space) is taken providing an appropriate physical modelling framework based on an underlying given (self-adjoint) mechanical potential energy operator. From the correspondingly defined extended Krein space framework the concept of a (self-adjoint) potential energy operator is applied. It enables the definition of related κ-potential energy norms on all of the κ-Krein spaces built on sets of related κ-quantum number systems.

The proposed two complementary mechanical and dynamical energy field models are accompanied by three groups of two-component energetical mechanical and dynamic quanta pairs. Those mechanical and dynamical quanta pairs are appropriately composed by two fundamental mathematical entities, an electrino and a positrino, governed by appropriately chosen sets of quantum numbers.

The proposed extended „physical world" is about two complementary kinetical & dynamical „energetical worlds", which are both compactly embedded into an overall energetical „physical & mathematical world". The technical construction of those Hilbert space decompositions is purely based on mathematical axioms and theories (e.g., number theory and Krein space theory). Their (potential energy type specific) energy quantum element types (quanta) are appropriately composed by two fundamental mathematical entities/quanta.

The link of the proposed plasma quanta field model to the proposed solution of the Riemann Hypothesis in (BrK) is, when the Krein space based construction of the sum of two hermitian mechanical and dynamic operators of a two-component plasma pair energy field meets the Hilbert-Polya conjecture resp. the Berry-Keating conjecture. The mechanical operator provides an appropriate mathematical model for the (physical-statistical) Montgomery-Odlyzko law (where the action of the Leray-Hopf operator on Gaussian functions meets confluent hpergeometric functions of first kind). The sum of both operators provides an alternative operator to the Berry-Keating "quantized" classical Hamiltonian operator of a particle of mass m that is moving under the influence of a potential $V(x)$.

Content

1. Introduction

a. A little guide through the paper

Guidelines

M. Heidegger
The Age of the World Picture

"modern physics is called mathematical because, in a remarkable way, it makes use of a quite specific mathematics. But it can proceed mathematically in this way only because, in a deeper sense, it is already itself mathematical".

L. Smolin
The Trouble with Physics

Problem 1 (problem of quantum gravity): Combine general relativity and quantum theory into a single theory that can claim to be the complete theory of nature

Problem 2 (foundational problems of quantum mechanics): Resolve the problems in the foundations of quantum mechanics, either by making sense of the theory as it stands or by inventing a new theory that does make sense

Problem 3 (the unification of particles and forces): Determine whether or not the various particles and forces can be unified in a theory that explains them all as manifestations of a single, fundamental entity

Problem 4: Explain how the values of the free constants in the standard model of particle physics are chosen in nature

Problem 5: Explain dark matter and dark energy. Or, if they don't exist, determine how and why gravity is modified on large scales. More generally, explain why the constants of the standard model of cosmology, including the dark energy, have the values they do.

E. Wigner
The Unreasonable Effectiveness of Mathematics in the Natural Sciences

„We now have, in physics, two theories of great power and interest: the theory of quantum phenomena and the theory of relativity. These two theories have their roots in mutually exclusive groups of phenomena. Relativity theory applies to macroscopic bodies, such as stars. The event of coincidence, that is, in ultimate analysis of collision, is the primitive event in the theory of relativity and defines a point in space-time, or at least would define a point if the colliding panicles were infinitely small. Quantum theory has its roots in the microscopic world and, from its point of view, the event of coincidence, or of collision, even if it takes place between particles of no spatial extent, is not primitive and not at all sharply isolated in space-time. The two theories operate with different mathematical concepts - the four dimensional Riemann space and the infinite dimensional Hilbert space, respectively. So far, the two theories could not be united, that is, no mathematical formulation exists to which both of these theories are approximations. All physicists believe that a union of the two theories is inherently possible and that we shall find it. Nevertheless, it is possible also to imagine that no union of the two theories can be found. This example illustrates the two possibilities, of union and of conflict, mentioned before, both of which are conceivable.

In order to obtain an indication as to which alternative to expect ultimately, we can pretend to be a little more ignorant than we are and place ourselves at a lower level of knowledge than we actually possess. If we can find a fusion of our theories on this lower level of intelligence, we can confidently expect that we will find a fusion of our theories also at our real level of intelligence. On the other hand, if we would arrive at mutually contradictory theories at a somewhat lower level of knowledge, the possibility of the permanence of conflicting theories cannot be excluded for ourselves either. The level of knowledge and ingenuity is a continuous variable and it is unlikely that a relatively small variation of this continuous variable changes the attainable picture of the world from inconsistent to consistent. [*This passage was written after a great deal of hesitation. The writer is convinced that it is useful, in epistemological discussions, to abandon the idealization that the level of human intelligence has a singular position on an absolute scale. In some cases it may even be useful to consider the attainment which is possible at the level of the intelligence of some other species. However, the writer also realizes that his thinking along the lines indicated in the text was too brief and not subject to sufficient critical appraisal to be reliable*.]"

R. D. Precht

„The sum of obvious little steps is not seldom a way in the wrong direction", (UnA) p. 212

The scope

Additionally to the theory of quantum phenomena, and the theory of relativity we consider also plasma matter related phenomena, including superfluids and condensates. The rational for this third element is quite simple:

> About 95% of the universe is about the phenomenon „vacuum". The same proportion applies to the emptyness between a proton and an electron. The remaining 5% of universe's vacuum consists roughly of 5% matter, of 25% sophisticated „*dark matter*", and of 70% sophisticated „*dark energy*". Nearly all (about 99%) of the 5% matter in the universe is in "plasma state". A presumed physical concept of „*dark matter*" „explains" the phenomenon of the spiral shapes in the universe. A presumed physical concept of „*dark energy*" explains the phenomenon of the cosmic microwave background. At the same time the scope of theoretical plasma physics is about solid (conductor and semi-conductor) state physics, mechanical thermodynamical and electromagnetic particle vibrations affecting fluid mechanics, elasticity theory, thermodynamics, thermostatistics, the theory of electromagnetism, and quantum theory, (CaF) p. 1.

The considered extended (energy) Hilbert scale concept H_α, $\alpha \in (0,1)$, (where $\alpha = 1/2$ plays a specific role) is also in line with the theory of hypersingular integral equations, playing a key role in aerodynamics, (LiI):

> From a mathematical modelling perspective the standard (energy) Hilbert space H_1 in potential theory equipped with the (Dirichlet integral) inner product $(\nabla u, \nabla v)_{L_2}$ is extended to H_α, $\alpha \in (0,1)$, where $\alpha = 1/2$ plays a specific role. The physical Newton/Coulomb potentials correspond to single layer (potential) integral (inverse) operators to the Laplacian operator, and the exterior Neumann problem admits one and only one generalized solution for $1/2 \leq r < 1$. The corresponding double layer (hyper-singular integral) potential operator of the Neumann problem is the bounded Prandtl operator $\overline{P}: H_r \rightarrow \widehat{H}_{r-1}$ for $0 \leq r \leq 1$, ((LiI) 4.2.

The starting point

Physics at large scale decouples from the physics at a smaller scale, and at each scale, there are different degrees of freedom and different dynamics. The overall principle, the „conservation of energy", is based on the concept a mechanical (kinetical or potential) energy governing case specifically defined mechanical particles.

> The related case specific dynamics (resp. the corresponding case specific „force" phenomena) are mainly governed by the physical Newton/Coulomb potentials. Physically speaking, they represent charges, which are the sources of the considered fields of forces. Mathematically speaking, they are both the same mathematical (inverse) operator to the Laplacian operator, which plays a key role in potential theory and the related Hilbert scale theory, (BrK10). The quantum theory and the general relativity theory operate with different mathematical concepts. The Hilbert space framework of the quantum theory provides a truly geometric mathematical framework, while the field on field framework of the GRT (that focuses on gravity for understanding the universe in regions of both large scale and high mass) provides no geometric mathematical structure at all. Big Bang models are on the basis of general relativity following from a number of greatly simplified physical assumptions of the universe accompanied by ordinary differential equations. Theoretical plasma physics model are classical PDE, basically all based on Boltzmann equations, which is a kinetic theory.

The sections 4 and 5 are related to this part.

The end point

The conceptually new element of the proposed physical modelling framework is an additional „dynamical energy" type to complement the current purely mechanical (kinetical and potential) energy type. There are three different types of energetical quantum elements (called quanta) associated with different types of related (energy) Krein-Hilbert spaces: (1) „mathematical quanta", (2) „physical purely dynamical quanta" pairs, and (3) „physical mechanical-dynamical quanta pairs.

> The related physical modelling framework of interconnected energetical quanta (pair) systems provides an all-encompassing framework
>
> i) for plasma and electromagnetic phenomena accompanied by two-component (variational) interacting particle models
> ii) for atomic, neutral gas, conductor, and fluid phenomena accompanied by one-component (variational or classical) mechanical particle models
> iii) which is in line with the periodic table of chemistry with its underlying three shell atomic model. There are three mechanical atom types ($\pm$-conductors, 0-isolators), and three related dynamical molecule types ($^\pm$organic molecules, ^{0}anorganic molecules).
> iv) which is in line with the conceptions of J. Barbour (e.g., „matter requires an „arrow of time" and „space"), (BaJ1), as well as the aspiration of A. Unzicker's „Mathematical Reality, (UnA2).

The sections 2 and 3, and partly section 4 (remarks), are related to this part.

b. An overview of the modelling framework

Any physical model refers to corresponding direct or indirect observable phenomena in nature. The prerequisite of the proposed physical modelling framework is about a given orthogonal set of eigen-pairs (λ_n, φ_n) of a linear self-adjoint & positive definite operator A, where A^{-1} is compact. The physical model problem for such an operator A is the Friedrichs extension of the Laplacian operator $A := \overline{-\Delta}^{\|\ \|_1}$ with domain $D(A) = H_1$. In this model case, the bilinear form $a(u,v) := (Au, v)$ defines an inner (kinetic energy) product in $D(A) = H_1$ and the operator equation $-\Delta u = f$ is equivalent to the weak (variational) representation in the form, (BrK10),

$$(u,v)_1 = (f,v), \forall v \in H_1.$$

This modelling prerequisite is the standard model problem for all related (linear or non-linear) integral or differential operator problems in potential theory, (BrK10). It enables the definition of Hilbert scales $\{H_\alpha | \alpha \in R\}$, which are spanned by the finite norms

$$\|x\|_\alpha^2 = \sum_1^\infty \lambda_n^\alpha x_n^2 < \infty, \ x_n := (x, \varphi_n)$$

accompanied by the inner product $(x,y)_\alpha = \sum_1^\infty \lambda_n^\alpha x_n y_n$. In case of $\alpha = 0$ this Hilbert space corresponds to the standard statistical Hilbert space $H_0 = L_2$. For $\alpha < 0$ the Fourier coefficients x_n contribute to the α-norm with a polynomial decay. The extended Hilbert space $H_{(\tau)}$ is defined by the inner product resp. norm

$$(x,y)_{(\tau)} = \sum_1^\infty e^{-\sqrt{\lambda_i}\tau} x_n y_n, \ \ \|x\|_{(\tau)}^2 = (x,x)_{(\tau)}.$$

The (τ)-norm is weaker than any α-norm, i.e., $\|x\|_{(\tau)}^2 \leq c\|x\|_\alpha^2$ for any α-norm with $c = c(\alpha, \tau)$ depending only on α and τ.

The conceptually new element of the proposed physical modelling framework is an additional „dynamic energy" type to complement the current purely mechanical (kinetical and potential) energy type. The related physical modelling framework of interconnected energetical quanta systems supports two areas of physical phenomena:

(1) plasma and electromagnetic phenomena accompanied by two-component (variational) interacting particle models in the form (e, p), $(\underline{e}, \underline{m})$

(2) atomic, neutral gas, conductor, and fluid phenomena accompanied by one-component (variational or classical) mechanical particle models built on $2\underline{m}$, $\underline{em}$, $2\underline{e}$ mechanical particle types.

The one-component nuclide case (2), is governed by the sum of two hermitian operators, an one-component mechanical „matter" energy operator and a two-component dynamical „vacuum" energy operator. This purely physical-mechanical modelling case is accompanied by all mechanical energy related notions. One of its characteristics in contrast to case (1), are the required concepts of a time arrow and entropy as a consequence of the imbalance (potential difference) between the physical-mechanical and mathematical-dynamical energetical „worlds". The proposed related mathematical microscope analysis tool is provided by Calderón's wavelets.

The two-component ((e, p) resp. $(\underline{e}, \underline{m})$ quanta pair based) plasma and electromagnetic cases (1), are also governed by the sum of two hermitian operators, a two-component dynamical „plasma" resp. „electromagnetic" energy operator and their corresponding dynamical two-component (((p, e) resp. $(\underline{m}, \underline{e})$ „anti-quanta" pair based) dynamical „plasma" resp. „electromagnetic" energy operators. The invariances of those two physical-dynamical systems are governed by the complex Lorentz group.

The dynamics of the proposed physical modelling framework is governed by three interconnected dynamical field types (vacuum, plasma, electromagnetism) accompanied by their related dynamical quanta pair types. Those quanta pairs are built on appropriate compositions of two mathematical baseline quanta, the electrino ϵ and the positrino π. The corresponding construction κ-quanta scheme are provided in the mathematical model section below. The building principle is based on appropriately defined sets of quanta numbers derived from the two fundamentally different sets of quantum number for electrinos and positrons. Those two sets of quantum numbers are based on the fundamentally different (Shnirel'man density) properties of the sets of positive odd resp. even integers. The composition $\nu = \epsilon\pi$ of an electrino and a positrino we call a neutrino.

> **Remark**: *The two complementary mechanical and dynamical energy "realities" fit to M. Planck's distinction between physical-statistical type of laws and mathematical-dynamical type of laws, (PlM). This conceptional design approach is also in line with E. Schrödinger's distinction between „order from disorder" and „order from order" mechanisms governing regular courses of events in physics and biology, (ScE).*

In the proposed mathematical κ-Krein space based dynamic quanta energy field models the related (self-adjoint) potential operator is an intrinsic part of the given framework and not a physical phenomenon specific to be defined „potential function", like the Coulomb/Newton or the Schrödinger potential functions.

The kinetical energy field system is defined by the „energy knots" of the a priori given physical phenomenon specific kinetic energy operator (as described by its orthogonal set of eigen-pairs (λ_n, φ_n)). Those energy knots may be interpreted as the mass of the corresponding mechanical quantum element.

We distinguish between three different types of energetical quantum elements associated with different types of related (energy) Hilbert spaces: „mathematical quanta", (physical-) dynamical quanta, and (physical-) mechanical quanta.

In the proposed physical framework the total energy of a considered mechanical system is accompanied by a Hamiltonian (selfadjoint) operator H expressed as the sum of a mechanical and a dynamical potential energy operator accompanied by a related Hilbert space decomposition in the form $E_{tot} \coloneqq E_{mech} \otimes E_{dyn}$. The (discrete) energy knots structure of the E_{mech}-related kinetical operator (accompanied by the total kinetical energy of the considered physical quantum system) enables the definition of related dynamic (self-adjoint) potential operators defined in correspondingly defined dynamical energy Hilbert spaces. The corresponding types of physical statistical and dynamical laws are based on related operator equations defined in a calculus of variations framework.

The simplest „dynamical energy operator" in an one-component physical system is accompanied by the domain $H_{1/2}$ equipped with a norm in the form

$$\|x\|_{1/2}^2 = \int_0^\infty \|x\|_{1.(\tau)}^2 d\tau = \sum_{n=1}^\infty \sqrt{\lambda_n} x_n^2 \ .$$

Therefore, the simplest $E_{tot} \coloneqq E_{mech} \otimes E_{dyn}$ representation is given by $H_{1/2} = H_1 \otimes H_1^\perp$, where the inner product of the Hilbert space H_1 is given by the Dirichlet integral in the form $D(u,v) = (\nabla u, \nabla v) = (u,v)_1$ with $\nabla : H_1 \to H_0$.

Note: In (BrK6) an alternative Schrödinger operator is proposed; it is the Calderón-Zygmund integrodifferential operator with symbol $|\nu|$ and domain $H_1^\perp$, i.e., $i\nabla R : H_1^\perp \to H_0^\perp$; here R denotes the Riesz transform operator, which commutes with translations, dilations, rotations, and anticommutes with reflections, (EsG) p. 44). The related Calderón (mathematical microscope) wavelets provides the corresponding counterparts of the Fourier waves. Physically speaking, the energetical quanta of the sub-space $H_1^\perp$ of $H_{1/2}$ become an alternative (energy space) quanta model replacing physical case specific potential functions, which only govern potential differences of two physical particles in space over a certain distance.

Note: In (BrK9) the extended energy Hilbert space $H_{1/2}$ is applied to solve the 3D-NSE millennium problem of the Clay Mathematics Institute. It turned out that based on a variational representation of the 3D NSE in a $H_{-1/2}$ Hilbert space framework (interpreted as a fluid element test space) the 3D NSE enjoy global solutions. Its a consequence of the well-known Sobolevskii-estimates for the 3D case. Those estimates fail in case of a $H_0 = L_2$ (statistical) test space. The standard analysis technique results into the a priori estimate

$$\|u(t)\|_{-1/2} \le \|u(0)\|_{-1/2} + \int_0^t \|u\|_1^2(s)ds \le c\{\|u_0\|_{-1/2} + \|u_0\|_0^2\},$$

which ensures global boundedness of the 3D-NSE-solution provided that $u_0 \in H_0$. The pressure term p of the solution pair (u, p) of the NSE are related by the Riesz transform operator by the formula $p = \sum_{j,k=1}^3 R_j R_k (u_j u_k)$, where $u \otimes u = (u_j u_k)$ is a $3x3$ matrix. It enables a representation of the sum of the non-linear NSE term and the negativ pressure in the form $P\nabla \cdot (u \otimes u)$, where P denotes the Helmholtz-Weyl projection operator and $\nabla \cdot$ represents the column vector with each component being the divergence of the row vectors of the matrix $u \otimes u$, (CuS).

Note: The decomposition of the quantum element space $H_{-1/2} = H_0 \otimes H_0^\perp$ resp. its related quantum element energy space decomposition $H_{1/2} = H_1 \otimes H_1^\perp = H_{-1/2}^*$ is very much related to the Calderón wavelet tool. In contrast to the one-parameter depending Fourier wave the Calderón wavelet depends from two parameters. It may be interpreted as a mathematical microscope analysing Fourier wave behavior beyong their statistical L_2 domain:

> (HoM) 1.2: „The idea of wavelet analysis is to look at the details are added if one goes from scale a to scale $a - da$ with $da > 0$ but infinitesimal small. … Therefore, the wavelet transform allows us to unfold a function over the one-dimensional space R into a function over the two-dimensional half-plane H of positions and details (where is which details generated?). … Therefore, the parameter space H of the wavelet analysis may also be called the position-scale half-plane since if g localized around zero with width Δ then $g_{b,a}$ is localized around the position b with width $a\Delta$. The wavelet transform itself may now be interpreted as a mathematical microscope where we identify
>
> $b \leftrightarrow$ position; $(a\Delta)^{-1} \leftrightarrow$ enlargement; $g \leftrightarrow$ optics. ".

Note: By design a H_α Hilbert space provides the appropriate domain framework for strong elliptic resp. strong parabolic partial differential operators with respect to the norms $\|u\|_\alpha^2$ resp. $\int_0^T \|u\|_\alpha^2(t)dt$. In general this is not valid for hyperbolic partial differential equations (a counterexample is provided in (BrK1)). However, the extended Hilbert space $H_{(\tau)}$ enables the appropriate domain framework defining strong hyperbolic differential operators, (BrK1). This puts the spot on the Courant conjecture, which is about undistorted spherical waves existing only in case of two or four variables, (CoR) p. 763.

The proposed unified field theory is operating on the following common mathematical concepts:

- number theory based mechanical & dynamic quanta number scheme

- two two-component (a priori time-independent plasma and electromagnetic) Maxwell-Mie equation systems, where the Coulomb and Lorentz potential forces are replaced by (self-adjoint) potential energy operators, and where the sum of the line and (only first order approximation) displacement current is replaced by a single two component (electroton-magneton) convection current

- energy method and related quadratic & complementary extremal problem solutions enabled by a compactly embedded mechanical (variational) Hilbert space H_1 all into dynamic ($H_{(\tau)}$-type) Hilbert spaces

- strong elliptic (Laplace-) resp. hyperbolic (D'Alembert-) type operators with H_α-type resp. $H_{(\tau)}$-type domains, where the restriction to the mechanical H_α-type Hilbert space framework is supported by the concept of (maximal-) dissipative operators.

  Remark: The new „dynamic energy" concept supports related „spiral movement models", e.g.,

  - Ehrenhaft's „screw movements"/„photophoresis" phenomenon, (AlO) p. 222
  - Schauberger and Dee's implosion principle, (LaS) S. 226, (DeK) p. 98
  - spiral movements of stars in a galaxy governed by spiral downsity waves, (ShF) p. 402.

2. The physical modelling framework

a. Three two-component dynamical field types and their related dynamical quanta pair types

The definition of the quantum numbers κ_n of the mathematical vacuum quanta pair (ϵ, π) are based on the different mathematical Snirel'man densities of odd and even integers. The plasma and electromagnetic quanta pairs are appropriately composed by those two fundamental types of quantum elements (next section).

Dynamic quanta pair field types	Dynamical quanta pair	Dynamical anti-quanta pair
vacuum energy field	(electrino,positrino) (ϵ, π)	(positrino, electrino) (π, ϵ)
plasma energy field	(electron,positron) $(e = \epsilon\epsilon, p = \pi\pi)$	(positron ,electron) $(p = \pi\pi, e = \epsilon\epsilon)$
electromagnetism energy field	(electroton, magneton) $(\underline{e} = \epsilon\epsilon\pi, \underline{m} = \pi\pi\epsilon)$	(magneton ,electroton) $(\underline{m} = \pi\pi\epsilon, \underline{e} = \epsilon\epsilon\pi)$

Note: The interconnections regarding the hot, medium, cold plasma and Landau damping phenomena may be interpreted in the context of the two possible changes: (1) a plasma quanta pair may be change to two neutrinos $\nu = \epsilon\pi$, which may be connect to a neutron $\underline{n} = \nu\nu$, (2) an electromagnetic quanta pair may be built by two plasma quanta pairs by emitting a neutrino ν.

b. Three one-component (atomic) mechanical and dynamical system types

The two components of the electromagnetism field, the electroton ($\underline{e} = \epsilon\epsilon\pi$) and the magneton ($\underline{m} = \pi\pi\epsilon$), provide the baseline quanta for an „aggregated" one-component electromagnetical atomic mechanical and dynamical system. The three possible combinations of the electroton $\underline{e}$ and the magneton $\underline{m}$ result into three types of atomic mechanical systems, the positronium N^{+} [(*)], the electronium N^{-}, and the neutronium N^{0}. Their related dynamical anti-quanta types according to the κ-quanta scheme may be physically interpreted as magnetic conductor, electric conductor, or isolator property of the considered mechanical system.

The atomic mechanical system types

Mechanical quantum types	Dynamical anti-quantum types		Electro-magnetical property	Atomic nucleus types	Possible mechanical quanta decays [(***)]
positronium [(*)] $N^{+}: 2\underline{m}$	electron $e = \epsilon\epsilon$	$N^{+} + e = 2\underline{n}$	positive	atomic magnetic conductor	$N^{+} \rightarrow p + \underline{n}$ [(**)] $N^{+} \rightarrow 2p + \underline{e}$
electronium $N^{-}: 2\underline{e}$	positron $p = \pi\pi$	$N^{-} + p = 2\underline{n}$	negative	atomic electric conductor	$N^{-} \rightarrow \underline{e} + \underline{n}$ $N^{-} \rightarrow 2\underline{e} + p$
neutronium $N^{0}: \underline{e}\underline{m}$	neutrino $\nu = \epsilon\pi$	$N^{0} + \nu = 2\underline{n}$	neutral	atomic isolator	$N^{o} \rightarrow \nu + \underline{n}$ $N^{o} \rightarrow p + \underline{e} + \nu$

[(*)] notion is proposed in (UnA2) p. 96; [(**)] $\underline{n} = \nu\nu$ is called „neutron/photon"; [(***)] accompanied by notions like „time arrow",„entropy"

The atomic dynamical system types

The three electromagnetical types of atomic mechanical systems, the positronium N^{+}, the electronium N^{-}, and the neutronium N^{0} allow three types of combinations accompanied by corresponding three different types of affected plasma and vacuum quanta.

Atomic dynamical quanta	Atomic dynamical anti-quanta	Electromagnetic dynamical quanta component		Plasma dynamical quanta component		Vacuum dynamical quanta component
$N^{+} + N^{0} \cong 2\underline{n} + p + \nu \cong 3\underline{n}$	$\underline{e} + \nu$	$2\underline{n}$	+	p	+	ν
$N^{-} + N^{0} \cong 2\underline{n} + \underline{e} + \nu \cong 3\underline{n}$	$p + \nu$	$2\underline{n}$	+	$\underline{e}$	+	ν
$N^{+} + N^{-} \cong 2\underline{n} + \nu + \nu \cong 3\underline{n}$	$\underline{e} + p \cong \underline{n}$	$2\underline{n}$	+	ν	+	ν

Note: The three types of atomic dynamical quanta are in line with the periodic table of chemistry with its underlying three shell atomic model. There are three mechanical atom types ($\pm$-conductors, 0-isolators), and three related dynamical molecule types ($^{\pm}$organic molecules, ^{0}anorganic molecules).

3. The mathematical model

a. The κ-Krein space framework $H_{\kappa.(\tau)}^{+} \otimes H_{\kappa.(\tau)}^{-}$

For the notations and further mathematical details we refer to (BrK1).

Let (λ_n, φ_n) be the orthogonal set of eigen-pairs of a linear self-adjoint & positive definite operator A, with A^{-1} compact. The Hilbert spaces $\{H_\alpha | \alpha \in R\}$ are spanned by the finite norms

$$\|x\|_\alpha^2 = \sum_1^\infty \lambda_n^\alpha x_n^2 < \infty \,, \, x_n := (x, \varphi_n)$$

accompanied by the inner product $(x, y)_\alpha = \sum_1^\infty \lambda_n^\alpha x_n y_n$.

In case of $\alpha = 0$ we skip the subscript. The physical model problem for the operator A is the Friedrichs extension of the Laplacian operator $A := \overline{-\Delta}^{\|} {}^{\|_1}$ with domain $D(A) = H_1$. Then, the bilinear form $a(u, v) := (Au, v)$ defines an inner (kinetic energy) product in $D(A) = H_1$ and the operator equation $-\Delta u = f$ is equivalent to the weak (variational) representation in the form, (BrK),

$$(u, v)_1 = (f, v), \forall v \in H_1.$$

For $\alpha < 0$ the Fourier coefficients x_n contribute to the α-norm with a polynomial decay. The extended Hilbert space $H_{(\tau)}$ is defined by the inner product resp. norm

$$(x, y)_{(\tau)} = \sum_1^\infty e^{-\sqrt{\lambda_i}\tau} x_n y_n, \quad \|x\|_{(\tau)}^2 = (x, x)_{(\tau)}.$$

The (τ)-norm is weaker than any α-norm, i.e., $\|x\|_{(\tau)}^2 \leq c\|x\|_\alpha^2$ for any α-norm with $c = c(\alpha, \tau)$ depending only on α and τ.

Let $\Phi_n := \varphi_n^H$ denote the Hilbert transform of φ_n with $(\varphi_n, \Phi_n) = 0$, [*], (BrK1). Then, the system $\left\{\psi_{n.\tau}^{(1)}, \psi_{n.\tau}^{(2)}\right\}$ with

$$\psi_{n.\tau}^{(1)} := \varphi_n - i\Phi_n e^{-\frac{1}{2}\sqrt{\lambda_n}\tau}, \quad \psi_{n.\tau}^{(2)} := \varphi_n + i\Phi_n e^{-\frac{1}{2}\sqrt{\lambda_n}\tau}$$

defines an orthogonal system of the Hilbert space composition $H_0 \otimes H_{(\tau)}$.

The conceptual challenge in quantum theory is about the construction of appropriate one-quantum particle systems governed by a Hamiltonian operator H expressed as the sum of a kinetic and a potential energy operator in the form $H_{mech} = H_{mech-kin} + H_{mech-pot}$.

The conceptual design of the proposed integrated mathematical model is based on a Hermitian operator expressed as the sum of two hermitian mechanical and dynamic operators. The domain of the mechanical energy operator is accompanied by the (weak) standard domain H_1. The domain of the dynamic energy operator is accompanied by domains like $H_{1/2}$ and $H_{1/2.\kappa}$ equipped with the norms like

$$\|x\|_{1/2}^2 = \int_0^\infty \|x\|_{1.(\tau)}^2 d\tau = \sum_{n=1}^\infty \sqrt{\lambda_n} x_n^2$$

$$\||x\||_{1/2.\kappa}^2 = \sum_{n=1}^\infty \sqrt{\lambda_n} x_n^2 \int_0^\infty tanh^2(\kappa_n\tau) e^{-\sqrt{\lambda_n}\tau} d\tau \,, \kappa_n \neq 0.$$

The related sequences

$$\kappa_{\tau.n}^+ := \frac{1}{2} \frac{e^{\kappa_n\tau}}{\cosh(\kappa_n\tau)} \,, \kappa_n^- := \frac{1}{2} \frac{e^{-\kappa_n\tau}}{\cosh(\kappa_n\tau)} \text{ with } \kappa_n \in R$$

define a Krein space decomposition of the Hilbert space $H_{(\tau)}$ in the form $H_{(\tau)} = H_{\kappa.(\tau)}^+ \otimes H_{\kappa.(\tau)}^-$.

[*] for space dimensions greater than one the counterpart of the Hilbert transform operator is the Riesz transform operator;
for a correspondingly defined alternative Schrödinger (i.e., the Calderón-Zygmund integrodifferential, (EsG) p. 44)) momentum operator we refer (BrK5);
for related well-defined hybrid/mixed Ritz-Galerkin approximations we refer to (NiJ2).

The Hilbert space $H_{(\tau)}$ and the Krein space $H^+_{\kappa.(\tau)} \otimes H^-_{\kappa.(\tau)}$ are accompanied by two related inner products on all of the Hilbert space $H_{(\tau)}$ in the form [*]

$$(x,y)_{(\tau)} = \sum_{n=1}^{\infty} e^{-\sqrt{\lambda_n}\tau} x_n y_n$$

$$((x,y))_{\kappa.(\tau)} = \sum_{n=1}^{\infty} tanh^2(\kappa_n \tau) x_n y_n e^{-\sqrt{\lambda_n}\tau} .$$

For $x = x_1 + x_{1/2.\kappa} \in H_1 \otimes H_{1/2.\kappa}$ and

$$(((x,y)))_{1/2.\kappa} := (x_1, y_1)_1 + ((x_{1/2.\kappa}, y_{1/2.\kappa}))_{1/2.\kappa}$$

the weak (variational) representation of a Hermitian (energy) operator equation is given by

$$u \in H_1 \otimes H_{1/2.\kappa}: \quad (((u,v)))_{1/2.\kappa} = (f,v), \forall v \in H_1 \otimes H_{1/2.\kappa}.$$

The Hilbert-Krein spaces are associated with Sobolev spaces. The underlying domains are associated with the complex Lorentz group, which is associated with $SL(2,C) \otimes SL(2,C) \cong SU(2) \otimes SU(2) \cong S^3 \otimes S^3$. The variational representation enables approximation methods in Hilbert scales (compactly embeddedness of $H_2 \subset H_1 \subset H_{1/2}$) for underlying (standard) statistical relevant kinetic and potential function solutions.

The Krein space is also equipped with the indefinite inner products resp. metric [*]

$$[x,y]_{\kappa.(\tau)} := (x^+_{\kappa.(\tau)}, y^+_{\kappa.(\tau)}) - (x^-_{\kappa(\tau)}, y^-_{\kappa.(\tau)}) = \sum_{n=1}^{\infty} tanh(\kappa_n \tau) e^{-\sqrt{\lambda_n}\tau} x_n y_n$$

with

$$(x^+_{\kappa.(\tau)}, y^+_{\kappa.(\tau)}) := \sum_{n=1}^{\infty} (\kappa^+_{\tau.n})^2 e^{-\sqrt{\lambda_n}\tau} x_n y_n \ , \ (x^-_{\kappa(\tau)}, y^-_{\kappa.(\tau)}) := \sum_{n=1}^{\infty} (\kappa^-_{\tau.n})^2 e^{-\sqrt{\lambda_n}\tau} x_n y_n .$$

The indefinite norm $[x,x]_{\kappa.(\tau)}$ may be interpreted as a potential (functional), (VaM) p. 90,

$$\varphi_{\kappa.\tau}(x) := [x,x]_{\kappa.(\tau)} = \left\|x^+_{\kappa.(\tau)}\right\|^2 - \left\|x^-_{\kappa(\tau)}\right\|^2 = \sum_{n=1}^{\infty} tanh(\kappa_n \tau) e^{-\sqrt{\lambda_n}\tau} x_n^2 .$$

The self-adjoint operator

$$W_{\kappa.\tau}x := x^+_{\kappa.(\tau)} - x^-_{\kappa.(\tau)} = \sum_{n=1}^{\infty} tanh(\kappa_n \tau) e^{-\frac{1}{2}\sqrt{\lambda_n}\tau} x_n \Phi_n$$

may be interpreted as the quantum potential operator of the considered κ-quantum potential energy systems.

The definition of the potential operator enables a treatment of the results of its action as the „mirror reflection" of the space $H_{(\tau)}$ in the subspace $H^+_{\kappa.(\tau)}$. The sub-space $H^+_{\kappa.(\tau)}$ is an eigen-subspace of the operator $W_{\kappa.\tau}$ corresponding to the eigenvalue $\lambda = 1$. The sub-space $H^-_{\kappa.(\tau)}$ is an eigen-subspace of the operator $W_{\kappa.\tau}$ corresponding to the eigenvalue $\lambda = -1$. The whole spectrum of $W_{\kappa.\tau}$ lies on the join of the points $\lambda = \pm 1$.

From the equivalent formulas

$$(x,y)_{(\tau)} = [x^+_{\kappa.(\tau)}, y^+_{\kappa.(\tau)}] - [x^-_{\kappa.(\tau)}, y^-_{\kappa.(\tau)}]$$

$$[x,y]_{\kappa.(\tau)} := (x^+_{\kappa.(\tau)}, y^+_{\kappa.(\tau)}) - (x^-_{\kappa(\tau)}, y^-_{\kappa.(\tau)})$$

it follows the characterization of „positive", „negative", and „neutral" vectors $x \in H_{(\tau)}$ by the relations

$$\left\|x^+_{\kappa.(\tau)}\right\| > \left\|x^-_{\kappa(\tau)}\right\| \ , \ \left\|x^+_{\kappa.(\tau)}\right\| < \left\|x^-_{\kappa.(\tau)}\right\| \ , \ \left\|x^+_{\kappa.(\tau)}\right\| > \left\|x^-_{\kappa(\tau)}\right\| .$$

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[*] The relation to the proposed potential energy norms is given by the equality $\|x\|^2_{1/2} = \int_0^{\infty} \|x\|^2_{1.(\tau)} d\tau = \sum_{n=1}^{\infty} \sqrt{\lambda_n} x_n^2$.

Putting $\quad x_{(\tau)} := \sum_{n=1}^{\infty} e^{-\frac{1}{2}\sqrt{\lambda_n}\tau} x_n \Phi_n \in H_{(\tau)}$, $x^+_{\kappa.(\tau)} := \sum_{n=1}^{\infty} \kappa^+_{\tau.n} e^{-\frac{1}{2}\sqrt{\lambda_n}\tau} x_n \Phi_n \in H^+_{\kappa.(\tau)}$, $x^-_{\kappa.(\tau)} := \sum_{n=1}^{\infty} \kappa^-_{\tau.n} e^{-\frac{1}{2}\sqrt{\lambda_n}\tau} x_n \Phi_n \in H^-_{\kappa.(\tau)}$

it follows $\quad \kappa^+_{\tau.n} + \kappa^-_{\tau.n} = 1 \quad , \quad \kappa^+_{\tau.n} - \kappa^-_{\tau.n} = tanh(\kappa_n \tau)$, $(\kappa^+_{\tau.n})^2 - (\kappa^-_{\tau.n})^2 = \frac{sinh(2\kappa_n \tau)}{cosh^2(\kappa_n \tau)} = tanh(\kappa_n \tau)$

$$[x,y]_{\kappa.(\tau)} := (x^+_{\kappa.(\tau)}, y^+_{\kappa.(\tau)}) - (x^-_{\kappa(\tau)}, y^-_{\kappa.(\tau)}) = \frac{1}{2}\sum_{n=1}^{\infty} \frac{sinh(2\kappa_n \tau)}{cosh^2(\kappa_n \tau)} e^{-\sqrt{\lambda_n}\tau} x_n y_n = \sum_{n=1}^{\infty} tanh(\kappa_n \tau) e^{-\sqrt{\lambda_n}\tau} x_n y_n .$$

The potential $\varphi_{\kappa.\tau}(x)$ in combination with the functional $\big((x)\big) := \sqrt{\varphi_{\kappa.\tau}(x)}$ generates hyperboloids H_c, hyperbolic regions V_c, and conical regions V_0 in the form

$$H_c := \big\{x \in H_{(\tau)} \,\big|\, \varphi_{\kappa.\tau}(x) = c > 0\big\}, \ V_c := \big\{x \in H_{(\tau)} \,\big|\, \big((x)\big) \geq c > 0\big\}, \ V_0 := \big\{x \in H_{(\tau)} \,\big|\, \big((x)\big) \geq 0\big\}.$$

Evidently V_c is a subspace of V_0. The boundary K of the conical region is defined by the condition $\big((x)\big) = 0$. It is an asymptotic conical manifold for the hyperboloid $\big((x)\big) = c > 0$ [*].

The counterparts of the W-norms $\||x\||^2_{\kappa.(\tau)} := [W_{\kappa.\tau}x, x]_{\kappa.(\tau)}$ with respect to the H_α Hilbert space norms $\|x\|^2_\alpha = \sum_1^\infty \lambda_n^\alpha x_n^2 < \infty$ are given by the norms

$$\||x\||^2_{\alpha.\kappa} := \sum_{n=1}^\infty \tanh^2(\kappa_n \tau)\, \lambda_n^\alpha x_n^2 \,.$$

Let $L := H_{\alpha.\kappa} \subset H_{(\tau)} = H^+_{\kappa.(\tau)} \otimes H^-_{\kappa.(\tau)}$ and $P^\pm$ be the canonical projectors. Then the set of vectors of L can be represented in the form

$$L := H_{\alpha.\kappa} := \{x^+_{\alpha.\kappa} + K^+ x^+_{\alpha.\kappa}\}_{x^+ \in H^+_{\kappa.\alpha}}$$

giving the general form of all $H^+_{\kappa.\alpha} \subset H^+_{\kappa.(\tau)}$ of the Krein space $H = H^+_{\kappa.(\tau)} \otimes H^-_{\kappa.(\tau)}$. The bounded linear operator

$$K^+ = K^+_{\kappa.(\tau)} := P^-(P^+|H_{\alpha.\kappa})^{-1} : \ P^+|H_{\alpha.\kappa} \to H^-_{\kappa.(\tau)}$$

is called the angular operator for $H_{\alpha.\kappa}$ with respect to $H^+_{\kappa.(\tau)}$ [**]. The inclusion $H^+_{\kappa.\alpha} \subset H^+_{\kappa.(\tau)}$ is accompanied by related inclusions $H^-_{\kappa.\alpha} \subset H^-_{\kappa.(\tau)}$. The related Krein space concept is called alternating (maximal) pairs and alternating extensions, [***]. This concept can be applied in the context of dissipative operators in Hilbert spaces, (BoJ) p. 116.

We note that the wave operator accompanied by Hilbert space $H_{(\tau)}$ like domains becomes a strong hyperbolic operator.

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[*] (VaM) p. 91: „*If x is an exterior point of the conical region V_0, then those points of the ray tx, $t \in [0, \infty)$ for which $t \geq c/a$ belong to the hyperbolic region V_c, and those for which $0 \leq t < c/a$ do not belong to V_c. If x is not an element of V_0, then the ray tx, $t \in [0, \infty)$ does not have any point in common with V_c. Thus, every interior ray of the conical region V_0 intersects the hyperbolid $\big((x)\big) = c > 0$ in a single point.*

We denote by K the boundary of the conical region V_0. The manifold K is defined by the condition $\big((x)\big) = 0$. If we look at the unit sphere S^1 ($\|x\|^2 = 1$), then those points of S^1 for which $\|x^+_{\kappa.(\tau)}\| = \|x^-_{\kappa.(\tau)}\|$ belong to K, and those points of S^1 for which $\|x^+_{\kappa.(\tau)}\| > \|x^-_{\kappa.(\tau)}\|$ intersect the hyperboloid $\big((x)\big) = c > 0$ at the point whose distance from θ is given by $t = c(\|x^+_{\kappa.(\tau)}\|^2 - \|x^-_{\kappa.(\tau)}\|^2)^{-1/2}$.

From this it is seen that $t \to \infty$ if $\|x^+_{\kappa.(\tau)}\|^2 - \|x^-_{\kappa.(\tau)}\|^2 \to 0$, i.e. the manifold K is an asymptotic conical manifold for the hyperboloid $\big((x)\big) = c > 0$."

[**] The subspace $L \subset H_{(\tau)} = H^+_{\kappa.(\tau)} \otimes H^-_{\kappa.(\tau)}$ is positive if and only if the angular operator K^+ of L with respect to $H^+_{\kappa.(\tau)}$ exists and satisfies the condition

$$\||K^+_{\kappa.(\tau)} x^+_{\kappa.(\tau)}\||^2_{\kappa.(\tau)} \leq \||x^+_{\kappa.(\tau)}\||^2_{\kappa.(\tau)}, \ x^+_{\kappa.(\tau)} \in D(K^+_{\kappa.(\tau)}).$$

In particular, positive definite subspaces are characterized by the property

$$\||K^+_{\kappa.(\tau)} x^+_{\kappa.(\tau)}\||^2_{\kappa.(\tau)} < \||x^+_{\kappa.(\tau)}\||^2_{\kappa.(\tau)}, \ x^+_{\kappa.(\tau)} \in D(K^+_{\kappa.(\tau)}), \ x^+_{\kappa.(\tau)} \neq 0,$$

and neutral subspaces by

$$\||K^+_{\kappa.(\tau)} x^+_{\kappa.(\tau)}\||^2_{\kappa.(\tau)} = \||x^+_{\kappa.(\tau)}\||^2_{\kappa.(\tau)}, \ x^+_{\kappa.(\tau)} \in D(K^+_{\kappa.(\tau)}).$$

[***] The concept of alternating pairs can be applied to prove the existence of maximal dissipative operators $T_1^{(0)}, T_2^{(0)}$ of dissipative operators T_1, T_2 with dense domains $D(L_1), D(L_2)$ in H_0 (i.e., dissipative operators having no dissipative proper extension) satsifying

$$[T_1 x_1, x_1] + [x_1, T_1 x_1] \leq 0, \ x_1 \in D(T_1)$$

$$[T_2 x_2, x_2] + [x_2, T_2 x_2] \leq 0, \ x_2 \in D(T_2).$$

b. The integrated vacuum, plasma, and Maxwell-Mie κ-quanta scheme

The Krein space based vaccum, plasma, and Maxwell-Mie κ-quantum potential systems are defined by related appropriately defined sets of quantum numbers κ_n according to the following table:

Model case	EP	Anti-EP	QN quantum numbers	QN quantum numbers	QN quantum numbers
	$q^+ \in H^+_{\kappa.(\tau)}$	$q^- \in H^-_{\kappa.(\tau)}$	q_n^+	q_n^-	$\boldsymbol{\kappa_n} := q_n^+ - q_n^-$
Vacuum particle Electrino ϵ	ϵ	$\epsilon \otimes \pi \otimes \pi$	$n_\epsilon := \dfrac{n-1/2}{4n-1}$	$\dfrac{3n-1/2}{4n-1}$	$\kappa_\epsilon = -\dfrac{2n}{4n-1}$
Vacuum particle Positrino π	π	$\pi \otimes \epsilon \otimes \epsilon$	$n_\pi := \dfrac{n}{4n-1}$	$\dfrac{3n-1}{4n-1}$	$\kappa_\pi = -\dfrac{2n-1}{4n-1}$
Vacuum particle Neutrino ν	$\nu := \epsilon \otimes \pi$	$\nu = \epsilon \otimes \pi$	$n_\nu = \dfrac{1}{2}$	$\dfrac{2n-1/2}{4n-1} = \dfrac{1}{2}$	$\kappa_\nu = 0$
Plasma particle Neutron $\underline{n}$	$\underline{n} := \nu \otimes \nu$	—	$n_{\underline{n}} = \dfrac{4n-1}{4n-1} = 1$	0	$\kappa_{\underline{n}} = 1$
Plasma particle Electron e	$e := \epsilon \otimes \epsilon$	$p := \pi \otimes \pi$	$n_e = \dfrac{2n-1}{4n-1}$	$n_p = \dfrac{2n}{4n-1}$	$\kappa_e = -\dfrac{1}{4n-1}$
Plasma particle Positron p	$p := \pi \otimes \pi$	$e := \epsilon \otimes \epsilon$	$n_p = \dfrac{2n}{4n-1}$	$n_e = \dfrac{2n-1}{4n-1}$	$\kappa_p = \dfrac{1}{4n-1}$
Maxwell-Mie particle Electroton $\underline{e}$	$\underline{e} := e \otimes \pi$ $\underline{e} = \epsilon \otimes \epsilon \otimes \pi$	π	$n_{\underline{e}} = \dfrac{3n-1}{4n-1}$	$\dfrac{n}{4n-1}$	$\kappa_{\underline{e}} = \dfrac{2n-1}{4n-1}$
Maxwell-Mie particle Magneton $\underline{m}$	$\underline{m} := p \otimes \epsilon$ $\underline{m} = \pi \otimes \pi \otimes \epsilon$	ϵ	$\underline{m} = \dfrac{3n-1/2}{4n-1}$	$\dfrac{n-1/2}{4n-1}$	$\kappa_{\underline{m}} = \dfrac{2n}{4n-1}$

Remark: The building processes from the underlying two fundamental „vacuum field" dynamic quanta (electrino, positrino) happen randomly. The related conditional probabilities are governed by the different Schnirelmann densities of the sets of odd („1/2") and even („zero") integers.

Remark: The experimental observations of the spectra of atoms and their decomposition into magnetic and electric fields showed a decomposition of spectral lines or of electron beams into an even number of components, while the angular momentum multiplets were only composed by an odd number of multiplets with the numbers $2l + 1$, (RoH) p. 217.

Remark: The ranges of the considered sets of quantum number systems are $\kappa_\epsilon \in [-2/3, -1/2[$, $\kappa_\pi \in]-1/2, -1/3]$, $\kappa_e \in [-1/3, -1/4[$, $\kappa_p \in]1/4, 1/3]$, $\kappa_{\underline{e}} \in [1/3, 1/2[$, $\kappa_{\underline{m}} \in]1/2, 2/3]$. Beside the (neutrino-neutron) vacuum-Mie quanta pair, the physical-statistical laws relevant quanta are given by the (electron-positron) plasma-Mie quanta pair, and the (electroton-magneton) Maxwell-Mie quanta.

Remark: In the case, where the positive part of the spectrum of $W_{\kappa.\tau}$ lies in an interval $[m, b]$, where $m > 0$, then the inequality

$$\|W_{\kappa.\tau} x\|_{(\tau)} \geq \frac{m}{\sqrt{2}} \sqrt{\varphi_{\kappa.\tau}^2(x) + \|x\|_{(\tau)}^2} \geq \frac{m}{\sqrt{2}} \sqrt{c^2 + \|x\|_{(\tau)}^2}$$

holds for every x in the hyperbolic region V_c defined by $\sqrt{\varphi_{\kappa.\tau}(x)} \geq c > 0$, as well as in the conical region V_0, i.e., when $c = 0$, (VaM) p. 92.

c.   The scope of applications

There are two kinds of proposed physical phenomena areas:

(3) Plasma and electromagnetic phenomena areas accompanied by two-component (variational) mechanical interacting particle models: (e, p), $(e, \underline{m})$ mechanical particle pairs

(4) Atomic, neutral gas, conductor, and fluid phenomena areas accompanied by one-component (variational or classical) mechanical particle models: $2\underline{m}$, $\underline{em}$, $2\underline{e}$ mechanical particle types.

Because of $e + p \;\leftrightarrow\; \underline{n}$ we have

$$2\underline{m} \;\leftrightarrow\; p + \underline{n} \;\leftrightarrow\; 2p + e \;\;;\;\; 2\underline{m} + \epsilon \;\leftrightarrow\; \underline{e} + p + \nu$$
$$2\underline{e} \;\leftrightarrow\; e + \underline{n} \;\leftrightarrow\; 2e + p \;\;;\;\; 2\underline{e} + \pi \;\leftrightarrow\; \underline{m} + e + \nu$$
$$\underline{me} \;\leftrightarrow\; \nu + \underline{n} \;\leftrightarrow\; p + e + \nu.$$

This means, that

-   in the two-magneton case, two protons (which may be called a „positronium", (UnA2) p. 96) are kept together by the „cohesive pressure" of an electron, (WeH1) p. 206 ff.; it may become the new model for the hydrogen nucleus

-   two electrons are kept together by the „cohesive pressure" of a neutron, i.e., the two-electroton case (which may be called an „electricon") would be in line with the $spin(1/2)$ hypothesis, while n of such entities may be interpreted as n-valent ions

-   a magneton-electroton composition is unstable as such a composition is built by a proton and an electron with a borrowed neutrino from the vacuum; ($\underline{me} + \nu \;\leftrightarrow 2e + 2p \;\leftrightarrow\; 2\underline{n}$; $\underline{me} + \pi \;\leftrightarrow\; 2p + e + \epsilon$; $\underline{me} + \epsilon \;\leftrightarrow\; p + 2e + \pi$).

The mechanical and dynamic laws are accompanied by bilinear forms $a(\cdot,\cdot): E_{mech} \times E_{dyn} \;\rightarrow\; R$, governing mechanical „matter quanta" pairs and their related „dynamic quanta" pairs for the following three physical dynamic worlds:

Two mechanical component case	Plasma „matter" potentials	$(p, e) \times (e, p)$
Two mechanical component case	Electricity/Magenticity „matter" potentials	$(2\underline{e}, 2\underline{m}) \times (p, e)$
One mechanical component case	Atomic nucleus „matter" potential	$(2\underline{m}) \times (e)$
One mechanical component case	Electricity „matter" potential	$(2\underline{e}) \times (p)$

We note that the gradient of (e.g. electromagnetic or plasma) potentials

-   physically speaking, may be interpretated as (e.g., electromagnetic or plasma) forces acting on corresponding potential function solutions of corresponding underlying physical law equations

-   mathematically speaking in the considered Krein space framework, defines a (hermitian) potential operator on all of the underlying energy Hilbert space

-   physically-mathematically speaking, the energetical mechanical and dynamic pairs enable mechanical spiral movements in line with Ehrenhaft's „screw movements" of the observed „photophoresis" phenomenon, (AlO) p. 222, Schauberger and Dee's implosion principle, (LaS) S. 226, (DeK) p. 98, and the interactions of stars in a galaxy governed by spiral downsity waves, (ShF) p. 402

-   mathematically speaking, the spiral movements are governed by vortex potentials resp. vortex forces in the form „Force=grad(Pressure)=grad(Potential)", where a (local point charge) vortex force $\vec{\Phi}_0 . \delta(x, y) \in H_{-\frac{n}{2}-\varepsilon}$ with $|rot(u)| = 0$ for $(x, y) \neq (0,0)$ is replaced by potential operators in the form $W[u] := \frac{1}{2} grad(potential)[u]$.

d. Examples

„Cold", „medium", and „hot" plasma

Putting $N^+ := (\underline{m}, \epsilon)$ and $N^- := (\underline{e}, \pi)$ the three cases of „plasma matter" potentials (cold, „medium", hot) are modelled by the following two-component-particle scheme:

Ionization of …	Ionization" percentage	two-component mechanical quanta pair	Two-component dynamical quanta pair
$(N^+, N^-), (N^-, N^+)$	0% (cold plasma)	$(\underline{m}, \underline{e})$	(ϵ, π)
$(N^+, N^-), (N^-, N^+)$	100% (hot plasma)		(e, p)
„medium"	$\alpha \cdot \#cold + \beta \cdot \#hot$	$\alpha \cdot \#(\underline{m}, \underline{e})$	$\beta \cdot \#(e, p)$

F. Ehrenhaft's discovery of electric *and magnetic* ions

F. Ehrenhaft introduced the notion *„magnetized ions"* already in his communication in the Physical Review, titled *„Diffusion, Brownian Movement, Loschmidt-Avogadros Number and Light"*, April 29, 1940. Related to this topic A. Einstein wroted to him at July 26, 1040:

> (BrJ) S. 88: „ ich muss gestehen, dass ich aus theoretischen Gründen fest davon überzeugt bin, dass es keine freien magnetischen Pole geben kann. Der Grund dafür ist der, dass das Vierer-Potential eine unmittelbare physikalische Bedeutung zu haben scheint und dieses wegen des Stokes'schen Satzes freie magnetische Pole ausschließt …"

In simple words, Einstein's position was, if „magnetized ions" are accepted as physical realities, the Maxwell equations governed by the Stokes' theorem would need to be revised. Therefore, he rejected the „photophoresis" interpretation of Ehrenhaft's discovery.

At the same time, (1) he complained the restricted scope of the Maxwell equations concerning missing laws governing electromagnetic currents and charges, (EiA4) p. 28, and, (2) in the dispute with W. Ritz, he insisted that the irreversibility of radiation processes is exclusively due to reasons of probability (modelled by a specific related mathematical integral representation), even if the mathematical modelling framework would allow multiple other forms of representations, (RiW).

The proposed model is in line with F. Ehrenhaft's discovery of electric *and magnetic* ions, ((EhF), (EhF1), (LeE), and provides an appropriate modelling framework for the Landau damping phenomenon, supporting several forgotten insights:

> *The nature from a phenomenological perspective (E. Husserl, (ZaD), (ZaD1), R. Avenarius (AvR)), the nature from a natural philosophical perspective (V. Schauberger, (BaA), (AlO), (ScJ), (RaC)), accompanied by two kinds of energies, implosion and explosion energies, related to „implosion technology", (LaS), (ScJ), „an implosion theory of universe creation", (DeK), and an alternative view on the vacuum, DaJ).*

The Landau damping phenomenon

The Landau damping phenomenon is accompanied by two different force types depending from the considered mathematical model. Technically speaking, there is a linear and a non-linear Landau damping theory assuming untrapped resp. trapped plasma particles. In simple words, the linear and nonlinear Landau damping models predict Landau damping from different (Coulomb resp. ponderomotive force governed) physical effects.

The proposed two-component plasma quanta mechanical mass/energy entities are in line with the physical modelling requirement of a two-component (not neutral, with opposite charges) interacting gas particles, and where the related two potentials are governed by related two potential operators defined by the corresponding potential differences.

4. Additional notes

Note (mathematics): Mathematics is a describing science providing a common language framework for natural sciences (including neurobiology & microbiology), and may be also for „meta physics", (philosophy).

Note (mathematics and physics): Most laws of physics are derived by a statistical mechanisms (thermo-statistics accompanied by the concept of entropy), which E. Schrödinger called „order-from-(atomic) disorder" mechanism. As a consequence, the physics (with the claim to be the foundation of chemistry) is not able to provide any fundamental law derived by an „order-from-order" mechanism as common „law" with chemistry and biology.

Note (physics and chemistry): The current understanding of the relationship of physics and chemistry may be briefly sketched by H. Weyl's statement that

> „the valence bonds are an abbreviated symbol for the actual quantum-physical forces acting between the atoms,
> which themselves are complex dynamical system", (WeH) p. 266.

Note (dead and living matter): The contrast of dead and living matter may be briefly sketched by H. Weyl's statement that

> „One of the profoundest enigmas of nature is the contrast of dead and living matter. …. Incidentally, the gap
> between organic and inorganic matter has been bridged to a certain extent by the discovery of virusses. Virusses are
> submicroscopic entities that behave like dead inert matter unless placed in certain living cells. …. Many virusses have
> the structure typical of inorganic matter; they are crystals", (WeH) p. 276.

Remark (mathematics and consciousness): The electrinos and the positrinos may be interpreted as binary quanta information carriers enabling a link to information and consciousness theory. With the proposed conception of non-mechanical binary quanta information carriers the synapses (neuronal net) model is no longer restricted to mechanical signals with velocities limited by the speed of light, enabling other kinds of potential differences between biological synapses governed by dynamical energy quanta.

Remark (mathematics and philosophy): There is an analogy to Leibniz's conception of (otherworldly) monades and their role defining a preestablished (mechanical) harmony.

> „The classical philosopher of a dynamic world presentation is Leibniz. … For him the real of movement does not lie in
> a pure change of the location, but in a moving force „La substance est un etre capable d'action – une force primitive –
> overspatial, immaterial. … The last element is the dynamic point, from which the force erupts as an otherworldly
> power, an indecomposable strechless unit: the monade", (WeH2) p. 51

> „And so we can conclusively state the relationship of the least action principle to Kant's Critique of Judgement in the
> following form: the principle of least action in its most modern generalization is a maxim of the reflective
> judgement", (KnA) p. 55.

The „binary quanta" interpretation also puts the spot on related „mind & matter" resp. „mind & cosmos" topics, e.g., the „philosophy of time", (CaC), especially regarding the „problem of time" with respect to the differentiation between the notions „physical time" (A. Einstein's view accompanied by multiple other physicists' views) vs. „duration" (Bergson's view), and related philosophical views of the world, e.g., from E. Husserl and M. Heidegger, (CaJ1).

Remark (characteristic quanta type phenomena): The characteristic phenomenon of the plasma quanta pair model is the Landau damping. The characteristic phenomenon of the electromagnetic quanta pair model is the Ehrenhaft photophoresis. The characteristic phenomenon of the electromagnetic atomic quanta model is the Einstein photoelectricity. Its related characteristic phenomenon of the organic atomic quanta model is the chemical photosynthesis. Within the proposed physical modelling framework those phenomena are governed by the least action principle between the affected (dynamical-dynamical resp. mechanical-dynamical) quanta pair potentials, where the latter ones are accompanied by the concepts of „time arrow" and „entropy".

Remark (mechanical & dynamical energy types): By mathematical design based on appropriate properties provided by a Krein-Hilbert space framework there are positive, increasing potential differences between the three dynamic field types starting from the vacuum energy field up to the

electromagnetism energy field. The combined energetical system enables the description of physical quanta type specific laws governed by the principle of conservation of total energy, defined by the sum of two „complementary" mechanical & dynamical energies of the related considered physical system.

Note: The probably most fundamental principles of physics are the conservation principles of energy, linear momentum, angular momentum, and electric charge, (NeD).

Remark: The probably most fundamental mathematical theorem in physics is E. Noether's theorem. It effects a huge class of conservation laws governing symmetries of space, time, and „internal" variables. Noether's theorem relates conservation to invariance, and thus to symmetry. This theorem provides the mathematical foundation of the whole quantum mechanics. However, the conservation of electric charge emerges from a more abstract symmetry called „gauge invariance".

Note: (renormalization group equation and symmetry break down): The behavior of a physical system depends on a scale (of energies, distances, momenta, etc.) at which the behavior is studied. The change of behavior when the scale is changed, is described by the renormalization group equation. In quantum field theory, the dependence of the behavior on the scale is often expressed mathematically by the fact that in order to regularize (i.e., render finite) Feynman diagram integrals one must introduce auxiliary scales, cutoffs, etc. The effect of these choices on the physics is encoded into the renormalization group equation. The "case" if there is no related (G-invariant) renormalization realisation (example ground state energy) is called "symmetry break down", (DeP1) p. 1119 ff..

Note (Higgs P. W., Spontaneous Symmetry Breakdown without Massless Bosons):

Abstract: We examine a simple relativistic theory of two scalar fields, first discussed by Goldstone, in which as a result of spontaneous breakdown of $U(1)$ symmetry one of the scalar bosons is massless, in conformity with the Goldstone theorem. When the symmetry group of the Lagrangian is extended from global to local $U(1)$ transformations by the introduction of coupling with a vector gauge Geld, the Goldstone boson becomes the longitudinal state of a massive vector boson whose transverse states are the quanta of the transverse gauge field. A perturbative treatment of the model is developed in which the major features of these phenomena are present in zero order. Transition amplitudes for decay and scattering processes are evaluated in lowest order, and it is shown that they may be obtained more directly from an equivalent Lagrangian in which the original symmetry is no longer manifest. When the system is coupled to other systems in a $U(1)$ invariant Lagrangian, the other systems display an induced symmetry breakdown, associated with a partially conserved current which interacts with itself via the massive vector boson.

Note: The conservation principles of energy, linear momentum, angular momentum, and electric charge are amoung the most fundamental principles of physics. … „Conservation" as in „conservation of energy" is not the same as „invariant". They are related, …, but they are not synonymous. The momentum or energy of a system of particles may be conserved but not necessarily invariant, (NeD) pp. 1, 4.

Remark: The mathematical notion for the invariant quantities in the conservation laws of mechanics and electrodynamics is called „functional". In mathematics, „functionals" are a central concept in Hilbert space theory playing a key role in variational methods for the study of nonlinear (potential) operators, (ChJ), (VaM). At the same time, the L_2- Hilbert space is a well established mathematical framework for thermostatistics and quantum mechanics.

Note: (zero point energy and symmetry break down): Physics is scale dependent and decoupling. The down (complexity) causality thinking results into a degrease of the number of scales, while the number of «nature constants» increases. The effect of the required auxiliary scales, cutoffs, etc. on the physics is encoded into the renormalization group equation. The "case" if there is no related (G-invariant) renormalization realisation (example ground state energy) is called "symmetry break down", (DeP1) p. 1119 ff.

Remark (zero point energy): The mathematical-dynamical „energy" field may be interpreted as „zero point energy".

Note (Newtonian theory, (PeR4) p. 431): The quantities Newtonian energy, momentum, and angular momentum have a well-defined meaning in Newtonian theory. Their vital importance is that they are conserved – for a system not acted upon by external forces – in the sense that the total energy, momentum, and angular momentum are constant in time. The energy of a system may be considered to be composed of two parts, namely the kinetic energy (i.e. the energy of motion) and the potential energy (the energy stored in

the forces between particles). The kinetic energy of a (structureless) particle, in the Newtonian theory, is given by the expression $E_{kin} = \frac{1}{2}mv^2$, where m i s the mass of the particle and v is the speed. To obtain the entire kinetic energy, we simply add the kinetic energies of all the individual particles (… we may refer to their energy as heat energy). To obtain the total potential energy, we need to know something of the detailed nature of all the forces involved. Neither the total kinetic energy nor the total potential energy need be individually conserved, but the total is.

The momentum $\boldsymbol{p}$ of a particle is a vector quantity, given by the expression $\boldsymbol{p} = m\boldsymbol{v}$, where $\boldsymbol{v}$ is the vector describing the velocity. To get the entire momentum, one takes the vector sum of all individual momenta. This total quantity is also conserved in time.

For the Newtonian theory it holds the Galilean relativity. How do our conservation laws manage to survive when neither the energy nor the momentum is left unchanged as we move from one inertial frame to another? … It turns out that conservation of energy and momentum in the first frame goes over to conservation of energy and momentum in the second frame provided we take into account that mass is also conserved.

In Newtonian mechanics there are also other conserved quantities

- The angular momentum
- For a single particle $N = t\vec{p} - m\vec{x}$.

Note (Newtonian dynamics): The Newtonian dynamics is governed by the ravitational (Newton) potential at a „point" in space equipped with a mass m. The reference point, where the potential is zero, is by convention infinitely far away from any mass, resulting in a negative potential at any finite distance. The field of gravity potentials is called the gravitational field. If the field is nearly independent of position the gravitational accelleration g (the standard gravity on the surface of the earth) can be considered constant. In that case, the difference in potential energy from one height to another is, to a good approximation, linear to the difference in height: $\Delta U \approx mg\Delta h$.

Note (Einstein's formula $E = mc^2$): According to Einstein's formula $E = mc^2$ mass and energy are two sides of the same coin; in simple words, there is no mass creation out of energy and the other way around, there is only mass into energy conversion and vice versa; consequently, the distinction between bright matter/energy and dark matter/energy is either nonsense or defines a new kind of energy, which is different from the current two physical-mechanical energy concepts as defined by Leibniz ($E_{kin} = \frac{1}{2}mv^2$ of a moving point in space) and Newton ($\Delta E_{pot} \approx mg\Delta h$; the difference in potential energy from one height to another of two points in space accompanied by the gravitational (Newton) potential at a „point" in space equipped with a mass m).

Note: (relativistic energy, momentum, and angular momentum, (PeR4) p. 434): Similar as space and time become united in relativity to become the single entity „spacetime", the momentum and energy become unitied. There is the energy-momentum 4-vector, whose spatial components are $(p^1, p^2, p^3) = c^2\vec{p}$, and whose time-component p^0 measures not only the total energy but also, equivalently, the total mass m of the system according to $p^0 = E = mc^2$, qhich incorporates Einstein's famous mass-energy relation.

Note (relativity and quantum theory): Relativity theory applies to macroscopic bodies, such as stars. Quantum theory has its roots in the microscopic world. The two theories operate with different mathematical concepts - the four dimensional Riemann space and the infinite dimensional Hilbert space, respectively. Therefore, from a mathematical perspective the two theories could not be united, that is, there exists no mathematical formulation to which both of these theories are approximations, while „*all physicists believe that a union of the two theories is inherently possible and that they shall find it*", (WiE).

Note (Einstein's field equations and the Einstein-Hilbert action functional): The GRT is the probably most prominent example of a theory, which can derived from two conceptually different design processes; it can be expressed in two different ways: Einstein's field equations and the Einstein-Hilbert action functional.

Note (SRT and GRT): The special relativity theory is about the gravitational dynamics in the universe, where each of the affected single „elementary particle" type is modelled as an element of the Minkowski space-time continuum; mathematically speaking, this is a Banach space equipped with an indefinite inner product. The

general relativity theory is about the gravitational dynamics in the universe, where each of the affected single „elementary particle" type is modelled as an element of a four-dimensional Riemannian (space-time) *manifold* continuum; therefore, the GRT is a *field on field* theory.

> General relativity is the discovery that spacetime and the gravitational field are the same entity. What we call „spacetime" is itself a physical object, in many respects similar to the electromagnetic field. We can say that GR is the discovery that there is no spacetime at all. What Newton called „space", and Minkowski called „spacetime", is unmasked: it is nothing but a dynamic object – the gravitational field – in a regime in which we neglect its dynamics. …., the universe is not made up of fields on spacetime; it is made up of fields on fields, (RoC).

Physically speaking, the Riemannian *manifold* continuum governs the gravitational movements of all affected mechanical matter/energies in the universe (replacing the Newton potential), while at the same time, those movements influence the curvature („geometry") of the Riemannian manifold. In simple words, physical-mechanical effects (actors on the stage) influence the mathematical framework (the geometry of the stage), while at the same time, the (stage) framework determines the actions of the actors. Needless to say, that in such an actor-stage dynamical world there is no room and opportunity for naturalists to observe the show on stage.

> A purely „geometrodynamics" proclaims a *law without law at the basis of physics*, where it is possible to derive the dynamical equations for matter and fields from the extremely simple but central identity of algebraic topology: the principle that the *boundary of the boundary of a manifold* is zero, (CiL) p. 49.

Note: The prize being paid for a physical "purely geometrodynamics" interpretation is, (TrH1),

- giving up the fundamental principle of nature, the least action principle
- requiring so-called Einstein spaces
    o gravitation models without sources
    o not identical with SRT-Minkowski space equipped with an indefinite inner product.

Note: Each Hilbert space is a Banach space; each Banach space is a metric space; each metric space is a topological space. However, only the Hilbert space has a geometric structure enabled by the inner product.

Note („Einstein's lost key, „a variable speed of light", (UnA1)): This idea is in line with thoughts and models from Schrödinger, Mach, Dicke, Sciama. Dicke's related theory is in agreement with all known four classical tests of the GRT (light defection, gravitational shift, radar echo delay, perihelion advance of the planet Mercury); although this theory means a huge simplification compared to the GRT, it's the GRT-manifolds-on-manifolds theory were all cosmology theories are refering to.

Note (the four classical tests of the GRT): In (DeH) the four classical tests of the GRT, (1) light defection, (2) gravitational redshift, (3) radar echo delay, (4) the perihelion advance of the planet Mercury, are explained all with variable speed of light, the essential concept of Dicke's theory and Einstein's formula about the „effect of gravitational field" on clocks.

> Einstein's formula says the speed of light near the sun c differs from „normal" speed c_0 only minutely, by a factor litte smaller than 1 that contains both the gravitational potential $\Phi = -\frac{GM}{r}$ (M mass of the sun, r distance from the sun) and the speed of light, c= $c_0(1 + \frac{\Phi}{c^2})$, (UnA1) pp. 77, 142.

Note (symmetry and permanent elementary particles): According to the "Big-Bang Theory" in the early universe pressures and temperature prevented the permanent establishment of elementary particles. None of the invented elementary particles of the SMEP were able to form stable objects until the universe had cooled beyond the so-called „supergravity phase". „Symmetry" is thought of as an overall governing concept already existing during the chaos and flux of the early universe, before and during virtual particles are created and destroyed until today. This „symmetry" concept is accompanied by the concept of a „time symmetric, mirror-like quality to every interaction in the early universe". Physical conservation laws governed by this „symmetry principle" limit the possible interactions between particles. Imaginary processes that violate conservation laws are forbidden. So the „existence of symmetry" provides the source of order to the early universe. Technically speaking, the „symmetry" „modelling assumption" of whatever is required to explain E. Schrödinger's order-from-order mechanisms governing regular courses of events in natural sciences. The proposed physical modelling framework is purely based on a mathematical fundamental building block, which is governed by an only „nearly symmetry principle", as the Snirel'man density of odd and even integers is fundamentally different.

Note: The Maxwell (field) theory of electrodynamics plays an important role in quantum theory, as well as in the relativity theory. The Maxwell fields can carry energy from one place to another. It describes the electricity dynamics of an a priori existing charged elementary particle (called electron) in an idealized semiconductor world governed by an electric and a magnetic field. The induced electric (current) force is modelled by the sum of an electrical conductor line current and a so-called displacement current. The latter one is a cross-section line reduced 1st order approximation of a virtual electrical insulator field shriveled up to an „insulator line current" accompanied by the notions of „time" and „distance".

Note: Half of the four Maxwell equations,

$$div(\vec{B}) = 0 \,, rot(\vec{E}) + \frac{\partial}{\partial t}\vec{B} = 0 \,,$$

are „just" a mathematical consequence of the definition of the magnetic field $\vec{B}$. They are derived via a differentiating process, applying the div- resp. the rot-operator to the definition of the magnetic field $\vec{B} := rot\vec{A}$, whereby $\vec{A}$ denotes an arbitrary (differentiable) vector field. In other words, there are no magnetic charges foreseen telling the fields, how to vary, (SuL).

The other half of the Maxwell equations,

$$div(\vec{E}) = \rho, rot(\vec{B}) - \frac{\partial}{\partial t}\vec{E} = \vec{j} \,,$$

are the consequences of a more specifically defined vector field $\vec{A}$. In this case there is an underlying scalar field of $\vec{A}$ regarding the time variable, reflecting the space-time geometry structure. It enables the definition of an electric field $\vec{E}$ given by, (SuL)

$$\vec{E} := -\frac{\partial \vec{A}}{\partial t} - grad(A_0).$$

In other words, only electric charges tell the electro-magnetic fields, how to vary. Reversely, there is only the Lorentz force

$$\vec{F} = e(\vec{v} \times \vec{B}),$$

where „the magnetic field tells the electrons, how to move". From a physical modelling perspective, this „imbalance" challenge has been overcome by the concept of „displacement current".

Note: The Maxwell equations unify the behaviour of electric fields, magnetic fields, and even the light; they are the first of the relativistic field equations, (PeR4) p. 441. The vanishing divergence of the charge-current vector provides the equation of conservation of electric charge in spacetime. The reason that it is referred to as a „conservation equation" comes from the mathematical theorem of exterior calculus accompanied by an integration over a closed 3-surface Q in a Minkowski space, (PeR4) p. 446.

Note (the energy tensor of the electromagnetic fields): The energy tensor of the electromagnetic fields is only known outside of the electrons.

Note: Maxwell's equations determine the electromagnetic field, when the distribution of electric charges and currents is known. However, the laws which govern the currents and charges are not known:

> „We do know, indeed, that electricity consists of elementary particles (electrons, positive nuclei), but from a theoretical point of view we cannot comprehend this. We do not know the energy factors which determine the distribution of electricity in particles of definite size and charge, and all attempts to complete the theory in this direction have failed. If then we can build upon Maxwell's equations at all, the energy tensor of the electromagnetic field is known only outside the charged particles. In these regions, outside of charged particles, the only regions in which we can believe that we have the complete expression for the energy tensor, we have $\frac{\partial T_{ij}}{\partial x_j} = 0$." (EiA4).

Note (F. Ehrenhaft's photophoresis): Classical theoretical physics does not known about magnetism, (RoH). F. Ehrenhaft's discovery of the „photophoresis" phenomenon discovery is still neglected, (EhF) p. 243.

> Ehrenhaft's „photophoresis" is about light inducing not only electric but also magnetic charges (poles) upon the particles if they are illuminated by concentrated light preponderantly shorter wave lengths.

The proposed electromagnetic dynamical quanta field pair provides an appropriate model for F. Ehrenhaft's discovery.

Note: The experimental observations of the spectra of atoms and their decomposition into magnetic and electric fields showed a decomposition of spectral lines or of electron beams into an even number of components, while the angular momentum multiplets were only composed by an odd number of multiplets with the numbers $2l + 1$, (RoH) p. 217.

Note (quantum electrodynamics, or the theory of the Lamb shift): Whereas Newton's theory of gravitation still had obvious connections with experience, experience entered the formulation of matrix mechanics only in the refined or sublimated form of Heisenberg's prescriptions. The quantum theory of the Lamb shift, as conceived by Bethe and established by Schwinger, is a purely mathematical theory and the only direct contribution of experiment was to show the existence of a measurable effect. The agreement with calculation is better than one part in a thousand, (WiE).

Note (gauge bosons; field quanta): Gauge bosons arise spontaneously without external influence and you can freely select certain parameters locally without anything changing of the related interaction.

Note: In the Maxwell theory and the related SMEP the spin of an elementary particle is its eigen-rotation with exactly two rotation axles, one parallel and one anti-parallel axis to a magnetic field. This is the 2×2 complex number scheme $SL(2, C) \cong SU(2)$, where every „normal" rotation is contained twice. Consequently, an electron has a charge only half of the Planck's quantum of action. It is applied in describing the transformation properties of spinors.

Note: In SMEP the group $SU(2) \cong SL(2, C)$ describes the weak force interaction with 3 bosons W^+, W^-, Z. It describes the „how" of the β-decay process. This is the (about 15 minutes) decay of a neutron into a proton, an electron, and an antineutrino. Unfortunately, this (weak interaction process) theory does not say anything about the „why" accompanied by related physical laws.

Note: A mathematical curiousity in the electroweak theory:

> „In the standard model the weak and the electromagnetic interactions are unified in what is called electroweak theory, where there is a special symmetry related to W^+, W^-, Z^0, and the photon γ, according to the groups $SU(2) \times U(1)$ or, more correctly, U(2). The group might be expressed as $SU(2) \times U(1)/Z_2$, where the $'/Z_2'$ means „factor out by a Z_2 subgroup". However, there is more than one such subgroup, so this notation is not fully explicit. The notation $'U(2)'$ automatically picks out the correct one. (I am grateful to Florence Tsou for this observation.) It seems that the reason that the electroweak symmetry group is not conventionally referred to as $'U(2)'$ is that this does not easily extend to the symmetry of the full standard model, which also incorporates the strong symmetry group SU(3), the full group being a version $SU(3) \times SU(2) \times U(1)/Z_6$", (PeR4) p. 641, 654.

Note (β-decay): Nobody knows to this day, why this process occurs and takes only 15 minutes. The „how-process" described by the symmetry group $SU(2)$ is based on the idea that there is a physical substance called nucleon with two states, called „neutron" and „proton" (the two „spin-states" of a nucleon), and where the root cause of their „folding over/flipping" is called „weak interaction" (which is not a „force" in a true sense of this word), (UnA3) p. 189.

Remark: In the proposed framework Maxwell's „line current" (of a conductor) and the related sophisticated (time- and initial-value depending isolator) „displacement current" (both restricted to the cross section area of the imaginary „semi-conductor line") are replaced by truly „mechanical energy" based electricity and magnetism fields governed by an overall conservation of total (mechanical and dynamical) energy.

Note (solid state physics, phonon): „The energy of a lattice vibration is quantized. The quantum of energy is called a phonon in analogy with the photon of the electromagnetic wave. ... The energy of an elastic mode of angular frequency ω and the related zero point energy of the mode are equivalent to a quantum harmonic oscillator

frequency, the energy eigenvalues in the form $\left(n + \frac{1}{2}\right) \frac{h}{2\pi} \omega$ and $\frac{1}{2} \frac{h}{2\pi} \omega$. ... A phonon of wavevector K will interact with particles such as photons, neutrons, and electrons as if it had a momentum $\frac{h}{2\pi} K$. However, a phonon does not carry physical momentum", (KiC) p. 99.

Note (free-electron theory and an infinite resistance of insulators): Insulators show a specific resistance to electricity which may be 10^{26} times greater than that of metals, which is a phenomenon never properly understood on the basis of the "real theory,":

> „The success of Bohr's early and pioneering ideas on the atom was always a rather narrow one and the same applies to Ptolemy's epicycles. Our present vantage point gives an accurate description of all phenomena which these more primitive theories can describe. The same is not true any longer of the so-called free-electron theory, which gives a marvelously accurate picture of many, if not most, properties of metals, semiconductors, and insulators. In particular, it explains the fact, never properly understood on the basis of the "real theory," that insulators show a specific resistance to electricity which may be 1026 times greater than that of metals. In fact, there is no experimental evidence to show that the resistance is not infinite under the conditions under which the free-electron theory would lead us to expect an infinite resistance. Nevertheless, we are convinced that the free-electron theory is a crude approximation which should be replaced, in the description of all phenomena concerning solids, by a more accurate picture. If viewed from our real vantage point, the situation presented by the free-electron theory is irritating but is not likely to forebode any inconsistencies which are unsurmountable for us. The free-electron theory raises doubts as to how much we should trust numerical agreement between theory and experiment as evidence for the correctness of the theory. We are used to such doubts", (WiE).

Note: Mie's theory is about an electric pressure field counterbalancing the electricity field E of the Maxwell equation.

> In the statical case Mie's equation states that $E - \text{grad}(\Phi) = 0$ that is, the electric force E is counterbalanced in the ether by an „electrical pressure" Φ, (WeH1) p. 206 ff.

Note (cohesive Mie-pressure): Nuclides are composed by a combination of different atomic mechanical quantum systems. The corresponding percentage distributions of those three $N^{\pm,0}$ atomic types in a nuclide determines related potential differences between the affected two-component mathematical and/or dynamical fields, i.e. the „compensation principle" governs the decay probability resp. the life span of a nuclide. The individual decay probabilities of the three mechanical quanta $N^{\pm,0}$ may be interpreted as three independent „callibration atomic clocks" enabling the calculations of the life span of composed nuclides.

Note (cohesive Mie-pressure): The positronium N^+ can be interpreted as an atomic nucleus composed by a proton and a neutron, which are kept together by the „cohesive Mie-pressure" of its dynamical anti-quanta, which in this case is an electron, (WeH1) p. 206 ff. Analogous, the electronium can be interpreted as an atomic nucleus composed by an electron and a neutron, which are kept together by the „„cohesive Mie-pressure" of its dynamical anti-quanta, which in this case is a positron. In this sense, those two mechanical nuclei provide a model for the electric and magnetic conductivity of the related atomic type.

Note (cohesive Mie-pressure): The dynamical anti-quanta pairs provide the so-called Mie-pressure. This concept was proposed by G. Mie to modify the Maxwell equations to solve the underlying problem of matter by explaining why the field possesses a granular structure and why the knots of energy remain intact in spite of the back-and-fourth flux of energy and momentum", (WeH) p. 171. The underlying problem of matter of the Maxwell equations is, that they cannot hold the interior of the electron. (WeH1) p. 206 ff.. Consequently, the proposed model omits the purely-electricity flux model: the electric flux in the Maxwell theory is defined as the sum of a conductor specific line current and an virtual isolator based displacement current „governed by" an a priori physical existing (time-independent) charged electron without any physical case specific initial value.

Note (cohesive Mie-pressure): In a „disaggegrated" one-component Maxwell-Mie system the two-component Maxwell-Mie system accompanied by the concepts of „electric and magnetic pressure" and by electrical and magnetical currents reduces to an (only first order approximation) electric displacement current, and the electric field in a vacuum reduces to an electric (virtual) displacement current.

Note (cohesive Mie-pressure): The Maxwell fields can carry energy from one place to another. It describes the electricity dynamics of an a priori existing charged elementary particle (electron) in an idealized semiconductor world governed by an electric and a magnetic field induced by the sum of a line current (in an electrical conductor world) and a so-called displacement current (a cross-section line reduced 1st order approximation of

an electrical insulator world accompanied by the notions of „time" and „distance"). Mathematically speaking, the energy tensor of the electromagnetic fields is only known outside of the electron (particle).

Note (Dirac's (quantum) single system model): Dirac's (electron) single system model is basically about an elementary particle accompanied by three energy type attribute values and two particle type values. The three energy type attribute values describe the the energy of the atom, the electromagnetic energy of the radiation field, and the (small) coupling energy of the atom and the radiation field:

> „Dirac's theory of radiation is based on a very simple idea; instead of considering an atom and the radiation field with which it interacts as two distinct systems, he treats them as a single system whose energy is the sum of three terms: one representing the energy of the atom, a second representating the electromagnetic energy of the radiation field, and a small term representing the coupling energy of the atom and the radiation field", (FeE).

The two particle type attribute values distinguish between spin(0) and spin(1/2) elementary particles (the spin(1/2) hypothesis).

> „Identical particles obey either Fermi statistics or Bose statistics; … Electrons obey Fermi statistics. To determine the statistics of nuclei, we shall investigate how an exchange of identical nuclei will affect the sign of the wave function for a molecule", (BeH) p. 20.

Note (determining nuclear spin): Each nucleus has an intrinsic angular momentum which interacts with angular momenta of electrons or other nuclei. It is measured in units of the Planck constant and, according to quantum mechanics, can take only integral or half-integral values. Three methods of determining nuclear spin are, (BeH) p. 19:

- Hyperfine structure of spectra
- Zeeman spectra
- Band spectra.

Note (interaction effects between electro-spin and nuclear spin): Dirac's relativistic quantum mechanics is only concerned with the main part between the interaction effects between electro-spin and nuclear spin governed by the Coulomb potential. The „Lamb shift" phenomenon is interpreted as the radiation correction term of this approximation, i.e., from a modelling perspective the Lamb shift phenomenon is interpreted as a consequence of interaction between the electron and fluctuations of a quantized radiation field.

Note: In the most simple case of a 1D Coulomb potential box the solutions of the Dirac model can be interpreted as scattering or binding of particles or anti-particles, (WaA) p.. 185.

Note (scattering processes): Scattering processes are an important theoretical tool to explore microscopic interaction effects. The interpretation of the considered experiments resulted into the large number of propagated elementary particles of the SMEP, because on the short range energy level there was the need for two additional „strong and weak" EP interaction interpretations. The current supposition is that there are three related quantum field theories, the QED, the QCD, and the QFD, (WaA) p. 189.

Note: The underyling Lie-groups of the SMEP and the Teichmüller theory are related to the several unit spheres in the following form

- the 1-dimensional unit sphere S^1 in R^2 corresponds to the Lie group $U(1)$. The related number grid is built by the Eisenstein numbers
- the compactification of the field of complex numbers C, the Riemann sphere, is homeomorphic to S^2. It plays a key role in the Teichmueller theory. We note the relationship of the Teichmüller space with the fractional Hilbert space $H_{1/2}$, (NaS)
- the 3-dimensional S^3 unit sphere is isomorphic to $SU(2)$
- the S^1 and S^3 are the only spheres with a "continuous" group structure, (EbH) 7.2. The groups S^1 and S^3 have parameter representations, (EbH) 3.5.4 (2'), 7.3.2 (3). The spheres S^0, S^1, S^3, S^7 are the only parallelizable spheres.

Remark: In an one-component Maxwell-Mie system the complex Lorentz transform reduces back to the restricted Lorentz group accompanied with related restrictions of physical quantity invariances, while still keeping, e.g., the time symmetry properties of hyperbolic PDE models equipped with improper properties of underyling operator domains. The parabolic „time arrow" requirement seems to pop up for the first time, when mechanical matter becomes physical reality governed by the „potential compensation principle" accompanied by nuclide specific atomic clocks.

Note: (the Lorentz transformation group and related components, (StR)): A Lorentz transformation is a linear transformation mapping space-time onto space-time preserving the Lorentz-invariant scalar product of two four-vectors $\vec{x} := (x^0, \vec{x})$, $y := (y^0, \vec{y})$ with $\vec{x} := (x^1, x^2, x^3)$, $\vec{y} := (y^1, y^2, y^3)$ given by $x \cdot y := x^0 y^0 - \vec{x}\vec{y}$. Two Lorentz transformations can be connected to one another by a continuous curve of Lorentz transformations. Therefore, the Lorentz transformations form a group, the Lorentz group. The Lorentz group has four components, each of which is connected in the sense that any one point can be connected to any other, but no Lorentz transformation in one component can be connected to another in another component.

> „The full group of Lorentz transformations is the group of transformations that leaves the Minkowski metric invariant. Here is why. Parity (mirroring of all three spatial axes) is the Lorentz transformation. But in the space of all possible Lorentz transformations there is no continuous path that starts out at the Identity, and so are the pure Lorentz boosts, but one cannot reach Parity by pure boosts or pure rotations or combinations of the two.) So the real Lorentz group splits up into at least two disconnected components: the Lorentz transformations that one can reach via continuous path from the Identity (the „restricted" Lorentz transformations), and the Lorentz transformations that one can reach via continuous path from Parity. And there is another split, namely the split between the Lorentz transformations that include Time Reversal and the ones that do not. So the Lorentz group has at least disconnected components. In fact it has exactly four disconnected components. …. The classical real Klein Gordon field is a real scalar field whose field values are invariant under the restricted Lorentz transformations. The restricted Lorentz transformations are the ones that are continuously connected to the Identity. They include spatial rotations and Lorentz boosts. They include neither P nor T nor PT. The law of evolution on the Klein Gordon field, the Klein Gordon equation is invariant under the restricted Lorentz tranformations", (CaC) p. 636.

The four „connection" possibilities are characterized by four different $\det(.) = \pm 1$ conditions containing the four different Lorentz transformations, (1) "1", (2) space inversion $I_s = P$, (3) time inversion $I_t = T$, and (4) space-time inversion. There are three related sub-groups of the Lorentz group, (A) the orthochronous Lorentz group (containing „1" and the space inversion); (B) the proper Lorentz group (containing the „1" and the space-time inversion; it is associated to the group of $2x2$ complex matrices of determinant one, which is denoted by $SL(2, C)$), which is important in describing the tranformation properties of spinors), and (C) the orthochorous Lorentz group (containing the space inversion and the time inversion).

The Lorentz transformation in special relativity is modelled by the restricted Lorentz group, the group of $2x2$ complex matrices of determinant one, $SL(2, C)$. It is isomophic to the symmetry group $SU(2) \cong SL(2, C)$, containing as elements the complex-valued rotations, which can be written as a complex-valued matrix of type

$$\begin{pmatrix} a + ib & c + id \\ -c + id & a - ib \end{pmatrix} \text{ with determinant one.}$$

The complex Lorentz group
(StR)

The complex Lorentz group $L(C)$ has just two connected components, $L_+(C)$ and $L_-(C)$. Additionally, the transformations 1 and -1, which are disconnected in the real Lorentz group L, are connected in the complex Lorentz group. Just as the restricted Lorentz group is associated with $SL(2, C)$ the complex Lorentz group is associated with $SL(2, C) \otimes SL(2, C) \cong SU(2) \otimes SU(2)$. The latter group is the set of all pairs of $2x2$ matrices of determinant one with the multiplication law

$$\{A_1, B_1\}\{A_2, B_2\} = \{A_1 A_2, B_1 B_2\}.$$

> **In summary**: While two (real) Lorentz transformations need to be connected to one another by an appropriately defined continuous curve of Lorentz transformations (the Lie group concept), there are two pairs of components of the complex Lorentz group, which are both already connected by definition accompanied by a related multiplication law.

Remark: The Lorentz transformation in special relativity is a simple type of rotation in hyperbolic space. We note that the characteristics of hyperbolic PDE is about their „time-symmetry". We further note that the hyperbolic wave operator equipped with a $H_{(\tau)}$-based domain is stronly hyperbolic operator. This property is the counterpart of the related strongly elliptic potential operator equipped with a H_α-based domain.

Note: The complex Lorentz group plays a key role in the proof of the PCT theorem, where PCT stands for P = space inversion; T = time inversion; C = charge conjugation. This theorem is one of the rarely theorem, which is mathematically proven like the Noether theorem.

Note: All in all, there are many indications that electrons, including their strange spin behavior, are described more simple by $S^3 \cong SU(2)$. In any case, despite the elegant representation Dirac had developed, it cannot be claimed that this sheds light on the reason for the existence of spin, (UnA2) p. 183.

Note: In SMEP the group $SU(2) \cong SL(2,C)$ describes the weak force interaction with 3 bosons W^+, W^-, Z, while the charged particles W^+, W^- have resemblance to positrons and electrons, and the neutral Z particle corresponds to the photon, (UnA3) S. 191.

Remark (Invariance principles): The invariance principle plays a key role in physics. The complex Lorentz group associated with $SL(2,C) \otimes SL(2,C) \cong SU(2) \otimes SU(2) \cong S^3 \otimes S^3$ shows a perfect fit to the two-quanta component dynamical field pair concept of the proposed physical modelling framework.

Note (the hidden symmetry of the Coulomb problem): The Coulomb problem has the symmetry group $SU(2) \otimes SU(2)$, (RoH) p. 172

Note (R. Penrose's „Road To Reality"): R. Penrose's „Road To Reality" gives a complete guide to the physical laws of the universe on the basis of current physical paradigms accompanied by supporting mathematical tools.

Note (current paradigm in physics): The physical models in different physical areas are decoupled and differently scaled according to their different levels of granularity (e.g., the „SMEP"-layer, the „thermodynamics" layer, the „relativity" layer). Conceptually speaking, reducing the number of scales requires new „nature constants".

Note (A. Unzicker's "Mathematical Reality"): A. Unzicker's "Mathematical Reality" could be interpreted as a kind of re-engineering approach of current physical paradigms justified by a critical analysis from a physicists perspective of the current usage of the „nature constant" concept. The aspiration of "Mathematical Reality" is,

> „to form a consistent picture of reality by observing nature from the cosmos to elementary particles", (UnA2).

Remark (the mathematical framework for physical laws): The mathematical framework of the proposed physical modelling framework are built on functional analysis and on number theory. The central branches from functional analysis are the theory of Krein spaces enabling hermitian operators in spaces with an indefinite metric, and approximation theory in Hilbert scales enabling by their compactly embeddedness properties. Related physical requirements to those branches first appeared in papers from Dirac, Pauli, and Heisenberg. The Krein space based mathematical concepts of "potential", "potential operators", "maximal definite subspaces", "maximal dissipative operators", "hyperboloids generated by operators" etc., are accompanied by corresponding mathematical constants; those constants are supposed to provide mathematically justified "physical potential barriers" between physical-statistical worlds and an overall mathematical reality". The essential concept behind the (vacuum, plasma, electromagnetic) quanta pair number systems is based on number theory.

Note (different number of scales): In classical mechanics one deals with the three scales, „distance", „time", and „mass"; in non-relativistic quantum theory and classical relativity one deals with two scales, „distance", and „time"; in relativistic quantum theory one deals with only one scale, the „distance", (DeP) p. 551.

Note (the mass gap problem of the classical Yang-Mills theory): The Maxwell fields can carry energy from one place to another. The classical Yang-Mills theory is a generalization of the Maxwell theory of electromagnetism where the invented *chromo*-electromagnetic field also carries charges for low energy scales. As a classical field theory it has solutions which travel at the speed of light so that its quantum version should describe massless

particles (gluons). However, the postulated phenomenon of color confinement permits only bound states of gluons, forming massive particles. This is the mass gap. The proposed Maxwell-Mie quanta energy field model makes the Yang-Mills theory (which is restricted to low energy scales) obsolete.

Note (Dirac's (one system based) radiation theory of an electron): The two-component Maxwell-Mie system provides the concept of a single convection electromagnetic current. This puts the spot on Dirac's (one system based) radiation theory of an electron accompanied by three energy attributes of an „electron" one quantum system, the „*mechanical energy*" of the quantum system, the „*radiation energy*" of the quantum system, and a small remaining „*coupling energy*" between the mechanical and the radiation energy of the quantum system.

Note (Dirac's (one system based) radiation theory of an electron): Dirac's theory of an electron accompanied by a decomposition of the Dirac equation into two components and a related spin-orbit operator, which finally resulted into Sommerfeld's famous energy formula with the birthday of the underlying „fine structure constant". In his formula this constant is mathematically required to ensure convergent series, when the two-component spin-orbit operator is decomposed into two linear and radial components. In simple words, the proposed model makes the „fine structure constant" obsolete.

Note (Decay processes, time, Mach 2.0, Dirac's „Large Number Hypothesis"): The decay processes respectively the life span of the composed mechanical quanta requires resp. defines all notions which are required in the mechanical energy governed world, .like „time", „space", „velocity". In this sense, the model supports the conceptions of J. Barbour, like „matter defines/requires „time" and „space"; the link to the governing dynamics worlds supports Barbour's references to the Mach principle, which become a Mach 2.0 principle, if Dirac's „Large Number Hypothesis" is taken into account, (UnA1). Dirac's „Large Number Hypothesis" links the size and mass of the universe with the ratio of the two forces at work when a „proton" and an „electron" in a hydrogen atom orbit one another, (UnA1) p. 152.

> „It is my conviction that general relativity is deeply Machian in a sense that unfortuntely Einstein never managed to pinpoint accurately and that precisncly this very Machian nature of general relativity is the main cause of the difficulties that stand in the way of its quantization", (BaJ) p. 571.

Note: The quantum theory gets primacy regarding the classical theory with its most perfect design, the general relativity theory. Therefore, the laws of of the metric field, which are in principle independent from the laws of the quantum theory, have no absolute validity. The regularity of the metric field – indeed in a statistical way – would be tied with elementary particle interaction, like it is furthermore „located" in the sense of the Mach principle, (DEH).

Note: The Mach principle is a cosmological principle; as there are multiple cosmological models, it becomes also a selection principle to select the few physical relevant cosmological models. Therefore, in the sense of Kant, it it not a „constitutive" principle (like the general co-variance of the field equations), but a „regulative" principle, (DEH).

Note: The Planck action constant is independent from any weak or strong gravitation field. It therefore somehow mirrors the fundamental difference of physical mraco and micro world, (DEH).

Note (the Maxwell and the Einstein equations): In the Maxwell equations „charges tell the electromagnetic fields how to vary". In the Einstein's field equations „space-time geometry tells mass-energy how to move" and „mass-energy tells space-time geometry how to curve".

The Einstein operator is given by $G = R_{ik} - R\frac{g_{ik}}{2}$ with the corresponding gravity field equations $G = -\kappa T_{ik}$ and the corresponding motion equations $\frac{d}{d\tau}\left(g_{\mu,\nu}\frac{dx^\mu}{d\tau}\right) = \frac{1}{2}\frac{\partial g_{\alpha\beta}}{\partial x^\nu}\frac{\partial x^\alpha}{\partial \tau}\frac{\partial x^\beta}{\partial \tau}$ for the path $x^\mu = x^\mu(t)$ of a particle.

The change from the Newton model is about a change from the Newton potential equation $-\Delta\Phi = -4\pi k\rho$ (applying the Dirac (delta) function on the right side of the PDE) to the Einstein equation $G = -\kappa T_{ik}$, going along with a change from the motion equations from

$$\frac{d^2\vec{x}}{dt^2} = -grad\Phi \quad \rightarrow \quad \frac{d}{d\tau}\left(g_{\mu,\nu}\frac{dx^\mu}{d\tau}\right) = \frac{1}{2}\frac{\partial g_{\alpha\beta}}{\partial x^\nu}\frac{\partial x^\alpha}{\partial \tau}\frac{\partial x^\beta}{\partial \tau}.$$

Instead of one potential equation there are now 10 equations with 10 potentials Φ_{ik}; instead of a linear operator, there is now a non-linear operator. The gravity potential is no longer the sum of single gravitation potentials. The matter is described by the energy-momentum tensor T_{ik}, reflecting the principles of energy and momentum conservation. The matter generates the space-time structure, particles move along of geodesics and the potentials Φ_{ik} are functions of the energy-momentum tensor T_{ik} ($\Phi_{ik} = f(T_{ik})$).

Note: (the Cosmological Microwave Background Radiation and Big Bang models): The CMBR provides us with the most important evidence supporting the big bang model. Big Bang models are on the basis of general relativity and follow from a number of assumptions, (LaM) p. 7:

- homogeneity of space applies. Thus it is assumed that all points of space are equivalent and the properties associated with each point are the same
- isotropy of space applies. This means that there is no privileged direction in space
- the matter in the universe can be described very simple in terms of what is called a perfect fluid. In this case its properties are completely given by ist density ρ and its pressure p
- the laws of physics are the same everywhere.

Note: R. Penrose: How special was the Big Bang?

> „in order to produce an universe resembling the one in which we live, the Creator would have to aim for an absurdly tiny volume of phase space of possible universes – about $1/10^{10^{123}}$ of the entire volume, for the situation under consideration", (PeR) p. 444.

Note: The high level plasma definition is about a neutral gas composed by many electrical charged (and also neutral) particles, those behavior is primarily determined by their collective degrees of freedom, (SpK).

Note: About 95% of the universe is about the phenomenon „vacuum". The same proportion applies to the emptyness between a proton and an electron. The remaining 5% of universe's vacuum consists roughly of 5% matter, of 25% sophisticated „*dark matter*", and of 70% sophisticated „*dark energy*". Nearly all (about 99%) of the 5% matter in the universe is in "plasma state". A presumed physical concept of „*dark matter*" „explains" the phenomenon of the spiral shapes in the universe. A presumed physical concept of „*dark energy*" explains the phenomenon of the cosmic microwave background.

Note (Plasma): Plasma is an ionized gas consisting of approximately equal numbers of positively charged ions and negatively charged electrons. The nearly equal numbers of the plasma electron & positron elements is the most relevant physical differentiator between plasma matter states and „standard" matter states.
Plasma physics is about classical statistical fluid mechanics and classical fluid dynamics. The underlying related mathematical models are grouped by different physical application areas resp. chosen mathematical tools accompanied by correspondingly defined different types of „plasma matter gases" („hot", „medium", „cold"), e.g., there are

- neutral and plasma gas models, (BiJ), (ChF), (DeR)
- radiation fluid hydrodynamics, (MiD)
- gas dynamics and radiation hydrodynamics in astrophysics (ShF)
- magnetodynamics in plasma physics (CaF)
- flow radiation and vortices in superfluids (AnJ)
- condensation energy in the Ginzburg-Landau model (AnJ)
- magnetism in condensed matter, (BlS).

Note: The number of neutral particles (atomes or molecules) is irrelevant for the definition of a plasma. The number of positively and negatively charged particles per considered volume element may be arbitrarily small oder arbitrarily large, but both numbers need to be approximately identical (in order to have no internal macroscopic electrostatic fields, (BiJ) p. 46.

> A cycloton radiation occurs in magnetized plasmas, due to the magnetic centripetal acceleration of the charged particles as they spiral about magnetic fields, (BiJ) p. 6. The condition for a low-density plasma is that the average time between collisions is much more greater than the cyclotron period. „Cold" plasma is accompanied by the (Non-Maxwellian-Boltzmann) electron velocity distribution under equilibrium conditions and at rest, given by $F_0(v) = n_0\delta(v_x)\delta(v_y)\delta(v_z)$, (BiJ) p. 492. A plasma is sometimes referred to as being „hot", if it is nearly fully ionized.

Examples of fully ionized plasma are the solar wind (interplanetery medium), stellar interiors (the sun's core), and fusion plasmas (plasma-universe.com).

Note (the „hot" vs. „cold" plasma modelling case): The „hot (collisionsfree) plasma" corresponds to purely „dynamical plasma". The „cold plasma" corrresponds to „dynamical electromagnetics". The „medium heat plasma" modelling case is the given by the related weight factors of the case specific ratio between the affected two quanta pairs.

Note (Plasma dynamics): Plasma is that state of matter in which the atoms or molecules are found in an ionized state. The interactions of electrons and ions are determined by long-range electrical forces. The many forms of collective motion in a plasma are the result of coupling the charged-particle motion to the electromagnetic field. Therefore, the electromagnetic field which accompanies the particle motion is also a random nonreproducible quantity in a turbulent plasma. Measurements have shown that the fields excited in a plasma during the development of turbulence do in fact have a random nature, (TsV) p. 4.

Note (kinetic plasma theory: the Vlasov-Poisson-Boltzmann (VPB) system): The continuity equation of ideal magneto-hydrodynamics is given by, (DeR) (4.1)

$$\frac{\partial}{\partial t}\rho + \nabla \cdot (\rho \vec{v}) = 0$$

with $\rho = \rho(\vec{x}, t)$ denoting the mass density of the fluid and $\boldsymbol{v}$ denoting the bulk velocity of the macroscopic motion of the fluid. For a corresponding microscopic kinetic description of plasma fluids $\rho(\vec{x}, t)$ is replaced by a function $f(\vec{x}, \vec{v}, t)$. This function is the number density of particles whose position lies within the small volume element d^3x at the position x, and whose velocity lies within the velocity space element $d^3\vec{v}$ at $\vec{v}$, at the time t, (DeR) 5.1. The fundamental equation which $f(\vec{x}, \vec{v}, t)$ has to satisfy is the (kinetical) Boltzmann equation, (ChF) p. 230,

$$\frac{\partial}{\partial t}f + v \cdot \nabla_x f + \frac{F}{m} \cdot \frac{\partial f}{\partial v} = \left(\frac{\partial f}{\partial t}\right)_\epsilon.$$

Here F is the force acting on the particles, and $\left(\frac{\partial f}{\partial t}\right)_\epsilon$ is the time rate of change of f due to collisions. The meaning of the Boltzmann equation become clear if one remembers that f is a function of seven independent variables. Therefore, the total derivative of f with time is given by

$$\frac{df}{dt} = \frac{\partial f}{\partial t} + \frac{\partial f}{\partial x}\frac{dx}{dt} + \frac{\partial f}{\partial y}\frac{dy}{dt} + \frac{\partial f}{\partial z}\frac{dz}{dt} + \frac{\partial f}{\partial v_x}\frac{dv_x}{dt} + \frac{\partial f}{\partial v_x}\frac{dv_y}{dt} + \frac{\partial f}{\partial v_x}\frac{dv_z}{dt}.$$

From the Newton's third law $F = m\frac{dv}{dt}$ it follows

$$\frac{\partial f}{\partial v_x}\frac{dv_x}{dt} + \frac{\partial f}{\partial v_x}\frac{dv_y}{dt} + \frac{\partial f}{\partial v_x}\frac{dv_z}{dt} = \frac{F}{m} \cdot \frac{\partial f}{\partial v}.$$

Together with $v \cdot \nabla_x f = \frac{\partial f}{\partial x}\frac{dx}{dt} + \frac{\partial f}{\partial y}\frac{dy}{dt} + \frac{\partial f}{\partial z}\frac{dz}{dt}$ one gets

$$\frac{df}{dt} = \frac{\partial f}{\partial t} + v \cdot \nabla_x f + \frac{F}{m} \cdot \frac{\partial f}{\partial v}.$$

As $\frac{df}{dt}$ is the convective derivative in the phase space the Boltzmann equation simply says that $\frac{df}{dt}$ is zero unless there are collisions.

In sufficiently hot plasma the current paradigm is that collisions ($^\pm$particles interaction) can be neglected. If futhermore the force $F = m\frac{dv}{dt}$ (Newton's third law), is entirely electromagnetic the Vlasov equations takes the special form, (ChF) p. 233,

$$\frac{\partial}{\partial t}f + \vec{v} \cdot \nabla_x f + \frac{q}{m}(\vec{E} + \vec{v} \times \vec{B}) \cdot \frac{\partial}{\partial v}f = 0.$$

Vlasov's mathematical argument against the Landau equation (leading to this equation) was, that "the Landau model of pair collisions is formally not applicable to Coulomb interaction due to the divergence of the kinetic terms". Because of its comparative simplicity, this is the equation most commonly studied in kinetic plasma theory.

Based on the perturbation split $f(\vec{x}, \vec{v}, t) = f_0(\vec{v}) + f_1(\vec{x}, \vec{v}, t)$ the first order Vlasov equation for electrons is given by, (ChF) 7.4,

$$\frac{\partial}{\partial t} f_1 + \vec{v} \cdot \nabla_x f_1 - \frac{e}{m} \vec{E}_1 \frac{\partial}{\partial \boldsymbol{v}} f_0 = 0 .$$

If f_0 is a Maxwellian the corresponding dispersion relation (in a weak sense) is given by

$$1 + \frac{\omega_p^2}{k^2} \,_x H \left[\frac{\partial}{\partial v_x} \tilde{f}_0 \right] \left(\frac{\omega}{k} \right) = 0 .$$

The counterpart of the critical term of the linearized Vlasov equation ($(\nabla W * \rho) \cdot \nabla_v f^0$) in the Vlasov equation is given by the non-linear term $F[f] \cdot \nabla_v f$, whereby

$$F[f](t, x) := - \iint \nabla W(x - y) f(t, y, w) dw dy.$$

Because of the corresponding Vlasov-Poisson model

$$F = -\nabla W, \quad -\Delta_x W = \rho, \quad W = \frac{1}{4\pi|\vec{x}|} *_{\vec{x}} \rho, \quad \rho(\vec{x}, t) = \int_{R^n} f(\vec{x}, \vec{v}, t) d\vec{v}$$

the combination of both systems is called the Vlasov-Poisson-Boltzmann (VPB) system. The extension of the VPB system, where the Vlasov force F (or self-consistent force, or mean force ...) is replaced by the Lorentz force determined by the electro-magnetic field created by the particles themselves is described in (LiP).

Remark (Landau equation): The one-component plasma model of the non-linear collision operator of the Landau equation is given by

$$Q(f, f) = \frac{\partial}{\partial v_i} \left\{ \int_{R^N} a_{ij}(v - w) \left[f(w) \frac{\partial f(v)}{\partial v_j} - f(v) \frac{\partial f(w)}{\partial w_j} \right] dw \right\}$$

with

$$a_{ij}(z) := \frac{1}{|z|} \left\{ \delta_{ij} - \frac{z_i z_j}{|z|^2} \right\} := \frac{1}{|z|} P(z) = \frac{1}{|z|} [Id - \bar{Q}](z) \text{ and } \bar{Q}(z) := (R_i R_j)_{1 \le i, j \le N}.$$

Here $P(z)$ resp. R_i denote the Leray-Hopf resp. Riesz operators; the symbol function $a(z)$ is symmetric, non-negative and even in z; f denotes an unknown function corresponding at each time t to the density of particle at the point x with velocity v. Therefore, the Leray-Hopf (pseudo differentia) operator with the symbol $b_{ij}(z) = z a_{ij}(z) = \delta_{ij} - \frac{z_i z_j}{|z|^2}$ may be interpreted as a kind of linearized Landau operator. It is of order zero. Mathematically speaking, the Leray-Hopf operator may be interpreted as (mechanical collision) compact disturbance operator of a (dynamical) potential (energy) operator accompanied by H_α $\alpha \in [0,1]$, scale domains.

Note: (galactic kinematics, cosmic time, Hubble law, and ordinary differential equations): The kinematics of an universe observed to be homogeneous and isotrop on large scales are describes by the Hubble parameter $H(t)$ and a scale factor $a(t)$ depending by a cosmic time parameter t:

> "Consider the triangle defined by three nearby fundamental observers. As the universe evolves, the triangle may change in size, but cannot change in shape or orientation – in the contrary case, it would define a preferred direction, therby violating the isotropy assumption. Thus, if $r_{ij}(t)$ is the length of the side joining oberserver i and j at cosmic time t, we must have $r_{ij}(t) = r_{ij}(t_0) a(t)$, where $a(t)$ is independent of i and j. Since this argument holds for all fundamental observers, the distance between any two of them must have the form $r(t) = r(t_0) a(t)$, where the scale factor is a universal function, which may normalize so that $a(t_0) = 1$ at the present cosmic time t_0. The relative velocity of the two observers is
>
> $$v(t) = \frac{dr}{dt} = r(t_0) \dot{a}(t) = r(t) \frac{\dot{a}(t)}{a(t)} = r(t) H(t),$$

Note:The most advanced mathematics of "galactic dynamics" is about collisionless Boltzmann and Poisson equations accompanied by the probability of a given star to be found in unit phase-space volume near the phase-space position (x, v), (BiJ) p. 555.

Note (non-relativistic resp. the relativistic gravitational instability of the universe): The two magic tricks to analyse the (non-relativistic resp. the relativistic) gravitational instability of the universe is based on a simple continuity equation of fluid elements in the form

$$\frac{\partial \rho}{\partial t} + 3H(t)\rho + \nabla \cdot (\rho \vec{v}) = 0$$

in combination with a related fluid-particle Lagrangian. Taking into account gravitational and pressure forces influencing those fluids (after some linearization) the main non-relativistic equation becomes the form

$$\frac{\partial v}{\partial t} + 2H(t)\vec{v} = -\frac{1}{a^2}\left(\frac{1}{\rho_0}\nabla p_1 + \nabla \Phi_1\right),$$

while the by special relativity modified "relativistic" equation becomes the form

$$\frac{\partial \psi}{\partial t} + 2H(t)\psi = -\frac{1}{a^2}\left(\frac{p_1}{\rho_0 + \rho_0/c^2} + \Phi_1\right),$$

where the density ρ of the (non-relativistic) Poisson equation is replaced by the "relativistic" density in the form $\rho + \frac{3p}{c^2}$, (BiJ) p. 722.

Note: A combined electro-magnetic plasma field model needs to enable "interaction" of cold and hot plasma "particles", which indicates Neumann problem boundary conditions. The corresponding double layer (hyper-singular integral) potential operator of the Neumann problem is the Prandtl operator $\overline{P}$, fulfilling the following properties ((LiI) Theorems 4.2.1, 4.2.2, 4.3.2):

- the Prandtl operator $\overline{P}: H_r \to \widehat{H}_{r-1}$ is bounded for $0 \leq r \leq 1$

- the Prandtl operator $\overline{P}: H_r \to \widehat{H}_{r-1}$ is Noetherian for $0 < r < 1$

- for $1/2 \leq r < 1$, the exterior Neumann problem admits one and only one generalized solution.

Note (the Neumann and the Prandtl potential operators): The Neumann boundary value problem is given by

$$\Delta u = 0 \qquad \text{in } R^3 - S$$
$$\frac{\partial u}{\partial n} = f \qquad \text{on } S.$$

In the context of radiation and transport partial differential equations the Neumann boundary condition is considered as more problem adequate than the Dirichlet boundary condition. The Neumann potential operator is related to the Prandtl operator by

$$(\textstyle\prod v)(x) := \frac{1}{4\pi} \oiint_S v(y)\frac{\cos \phi_{xy}}{|x-y|^2}\, dS_y = f(x) \ .$$

The solution function $u(x)$ is represented as double layer potential in the form

$$u(x) := \frac{1}{4\pi} \oiint_S v(y)\frac{\cos \phi_{xy}}{|x-y|^2}\, dS_y \in H_1(R^3 - S),$$

where the unknown function $v(y)$ is to be determined by the Neumann problem with domains H_r ($1/2 \leq r < 1$).

Note: The Neumann problem for the pressure field $p(\vec{x}, t)$ of the Navier-Stokes equations is given by

$$\Delta p = \rho(\vec{v} \cdot \nabla \vec{v} - \vec{f}) \text{ in } G$$

$$\frac{\partial p}{\partial n} = -\left[\mu \Delta \vec{v} - \rho \vec{v}_1 \cdot \nabla \vec{v} - \vec{f}\right] \cdot \vec{n} \quad \text{at } \partial G$$

where $\vec{n}$ denotes the outward unit normal to the domain G. It follows that the prescription of the pressure at the bounding walls or at the initial time independently of $\vec{v}$, could be incompatible with the initial and boundary conditions of the NSE PDE system, and therefore, could render the problem ill-posed (GaG), (HeJ).

Note: Regarding the physical notions of „flux" and „mass element" there are related extended mathematical definitions from J. PLemelj (PlJ). Plemelj's (Neumann boundary condition based) notion „flux" is defined by $\bar{U}(\sigma) := -\oint_{\sigma_0}^{\sigma} \frac{\partial U}{\partial n} d\sigma$ ($\sigma_0, \sigma_0 \in surface$), whereby $\bar{U}$ relates to the conjugate of $U(\sigma)$. In case $\bar{U}(\sigma)$ is differentiable, this „flux" definition corresponds to the standard Neumann boundary operator $\frac{d\bar{U}(\sigma)}{d\sigma} = -\frac{dU}{dn}$. However, in case $\frac{dU}{dn}$ is not defined (i.e. $\bar{U}(\sigma)$ is not differentiable), the „flux" $\bar{U}(\sigma)$ is a still well defined term.

Note: The „density" concept of a point mass of an idealized particle $x \in R$ is governed by the distribution $\delta = \delta(x) \in H_{-n/2-\varepsilon}$; Plemelj's concept replaces the mass density $\mu'(x)dx$ by a „mass element" $d\mu_x$, (PlJ); as a consequence, the regularity of Dirac's model of the point mass density reduces to a mass element regularity $d\mu \in H_{-1/2}$, which is in line with a energetical quantum element $\mu \in H_{1/2}$.

Note (electro-magnetohydrodynamics): MHD is concerned with the motion of electrically conducting fluids in the presence of electric or magnetic fields. In MHD one does not consider velocity distributions. It is about notions like number density, flow velocity and pressure. The MHD equations are derived from continuum theory of non-polar fluids with three kinds of balance laws:

- conservation of mass/energy
- balance of angular momentum (Maxwell equations)
- balance of linear momentum.

Remark: (electro-magnetogasdynamics): In the one-component (atomic) (mechanical, dynamical) quanta pair system the mechanical energy is counterbalanced by the corresponding dynamical energy. In the two-component (dynamical, dynamical) quanta pair system the related dynamical quanta energies are counterbalanced. Regarding the momenta of both quanta systems the concept of a stress tensor is replaced by the potential difference resp. Mie pressures between the affected quanta pair fields.

Note (The Landau damping phenomenon): Landau damping is a characteristic of collisionless plasmas, but it may also have application in other fields. For instance, in the kinetic treatment of galaxy formation, stars can be considered as atoms of a plasma interaction via gravitational rather then electromagnetic forces", (ChF) p. 245.

Note (The Landau damping phenomenon): The Landau damping phenomenon is a wave damping without energy dissipation by elementary particle collisions, i.e., it is about the possibility of resonance between the wave phase velocity and the velocity of individual electrons.

> (DeR) p. 94: „The Landau damping phenomenon is complementary to the properties of electro-magnetic forces,
> which weaken themselves spontaneously over time w/o increase of entropy or friction. Landau damping involves a
> flow of energy between single particles on the one hand side, and collective excitations of plasma on the other side".

Note (Landau damping): The Landau damping phenomenon is a characteristic of collisionless plasma dynamics (no mechanical particle interactions); it is governed by the Coulomb potential.

Note (Debye sphere, double layer potential): The mathematical tool to distinguish between unperturbed cold and hot plasma is about the Debye length and Debye sphere (DeR). The corresponding interaction (Coulomb) potential of the non-linear Landau damping model is based on the (Poisson) potential equation with corresponding boundary conditions.

Note: Landau damping models are applied to model the capability of stars to organize themselves in a stable arrangement as resonances in an inhomogeneous medium producing wave absorption (in space rather than in time) (ShF). If stars are considered as atoms of a plasma interacting via gravitational forces rather than electromagnetic forces (as a model for kinetic treatment of galaxy formation), instabilities of the gas of stars can cause spiral arms to form, but this process is limited by Landau damping, (ChF) p. 245.

Note (linear & nonlinear Landau damping phenomenon): Current mathematical models in plasma physics distinguish between linear and nonlinear Landau damping terms (while in both cases the energetic root cause of the Landau damping phenomenon is based on the Coulomb potential), indicating that this phenomenon arises from two different physical effects.

> (ChF) p. 248-249: „There are actually two kinds of Landau damping: linear Landau damping, and nonlinear Landau damping. Both kinds are independent of dissipative collisional mechanisms. If a particle is caught in the potential well of a wave, the phenomenon is called „trapping". Particles can indeed gain or lose energy in trapping. However, trapping does not lie within the purview of the linear theory. …. Trapping is not in the linear theory. When a wave grows to a larger amplitude, collisonless damping with trapping occur. One then finds that the wave does not decay monotonically; rather the amplitutes fluctuates during the decay as the trapped particles bounce back and forth in the potential wells. This is nonlinear Landau damping. .. Since the linear Landau damping is derived from a linear theory, … the nonlinear Landau damping must arise from a different physical effect. The question is: Can untrapped electrons moving close to the phase velocity of the wave exchange energy with the wave?"

Remark (The Landau damping modelling case): The principle of „inter-dynamical quanta fields potential compensation" in case of the potential difference between the plasma and vacuum fields may be interpreted as the appropriate modelling framework for the observed Landau damping phenomenon.

Remark: A theory of the phenomena of consciousness, or of biology:

> „A much more difficult and confusing situation would arise if we could, some day, establish a theory of the phenomena of consciousness, or of biology, which would be as coherent and convincing as our present theories of the inanimate world. Mendel's laws of inheritance and the subsequent work on genes may well form the beginning of such a theory as far as biology is concerned. Furthermore,, it is quite possible that an abstract argument can be found which shows that there is a conflict between such a theory and the accepted principles of physics. The argument could be of such abstract nature that it might not be possible to resolve the conflict, in favor of one or of the other theory, by an experiment. Such a situation would put a heavy strain on our faith in our theories and on our belief in the reality of the concepts which we form. It would give us a deep sense of frustration in our search for what I called "the ultimate truth." The reason that such a situation is conceivable is that, fundamentally, we do not know why our theories work so well. Hence, their accuracy may not prove their truth and consistency. Indeed, it is this writer's belief that something rather akin to the situation which was described above exists if the present laws of heredity and of physics are confronted", (WiE).

Remark (natural teleology): The two complementary mechanical & dynamical energy types are in line with Th. Nagel's concept in „Mind & Cosmos" of „natural teleology", which requires two things

- nonteleological and timeless laws of physics
- teleological laws of physics (i.e., laws of the self-organization of matter, essentially) with higher probability to steps on the paths in the state space that have higher „velocity" toward certain outcomes.

(NaT) p. 55: Consciousness
„The existence of consciousness is both one of the most familar and one of the most astounding things about the world. No conception about natural order than does not reveal it as something to be expected can expire even to the outline of completeness. And if physical science, whatever it may have to say about the origin of life, leaves us necessarily in the dark about consciousness, that shows that it cannot provide the basic form of intelligibility for this world. There must be a very different way in which things as they are make sense, and that includes the physical world is, since the problem cannot be quarantined in the mind."

(NaT) p. 92: Cognition
„The teleology I want to consider would be an explanation not only of the appearence of physical organisms but of the development of consciousness and ultimately of reason in those organisms. But its form can be described even if we stay at the physical level. Natural teleology would require two things. First, that the nonteleological and timeless laws of physics

- those governing the ultimate elements of the physical universe, whatever they are – are not fully deterministic. Given the physical state of the universe at any moment, the laws of physics would have to leave open a range of alternative successor states, presumably with a probability distribution over them.

Second, among those possible futures there will be some that are more elegible than others are possible steps on the way to the formation of more complex systems, and ultimately of the kinds of replicating systems characteristic of life. The existence of teleology requires that successor states in this subset have a significantly higher probability that is entailed by the laws of physics alone – simply because they are on the path toward a certain outcome. Teleological laws would assign higher probability to steps on the paths in the state space that have higher „velocity" toward certain outcomes. They would be laws of the self-organization of matter, essentially – or whatever is more basic than matter."

Note (Kant's reflective judgement, expediency): Kant's definition of „judgement" is „the capability to think about „the particular as contained under the general". If the particular is given and the general is the thing what one is looking for, then this is called „reflective judgement". This „reflective judgement" requires a governing principle of „unity of the manifold" that it gives itself. This uniform principle of particular empirical laws of nature he called „expediency (Zweckmässigkeit) of nature in its diversity". The physical-mathematical counterpart of it is given by the least action principle accompanied by the calculus of variations, (HiS) pp. 20, 22, (KnA) p. 55.

Note („Expediency" $\cong$ „Leibniz' harmony"): „Der Sprachgebrauch des achtzehnten Jahrhunderts (18th century) nimmt die „Zweckmäßigkeit" (expediency) in einem weiteren Sinne; er sieht in ihr den allgemeinen Ausdruck für jede Zusammenstimmung der Teile des Mannigfaltigen zu einer Einheit, gleichviel auf welchen Gründen diese Zustimmung beruhen und aus welchen Quellen sie sich herschreiben mag. In diesem Sinne stellt das Wort nur die Umschreibung und die deutsche Wiedergabe desjenigen Begriffes dar, den Leibniz innerhalb seines Systems mit dem Ausdruck der „Harmonie" (harmony) bezeichnet hat", (CaE) S. 307.

Remark (consciousness, organic, inorganic): The three types of atomic mechanical quanta accompanied by three related dynamical molecule types ($^{\pm}$organic molecules, ^{0}anorganic molecules) put the spot on Schrödinger's „View of the World" regarding the concepts of „*Consciousness, organic, inorganic, mneme*" and the related „*on becoming conscious*" process:

(ScE2) VIII, Consciousness, organic, inorganic, mneme
„Thus Schopenhauer's line of demarcation may be regarded as highly suitable, when he says that in inorganic being 'the essential and permanent element, the basis of identity and integrity, is the material, the matter, the inessential and mutable element being the form. In organic being the reverse is true; for its life, that is, its existence as an organic being, consists precisely in a constant change of matter while the form persists"

(ScE2) IX, On becoming conscious
„Consciousness is bound up with learning in organic substance; organic competence is unconscious. Still more briefly, and put in a form which is admittedly rather obscure and open to miss-understanding: Becoming is conscious, being unconscious".

Remark (object, subject, consciousness): In the two (atomic and molecule) one-component cases the physical-mechanical energy of the considered systems is counterbalanced by the mathematical-dynamical (vacuum) energy of the system. Regarding E. Schrödinger's consideration on "the principle of objectivation", (ScE1) p. 117 ff., this framework might be interpreted as a mathematical „observer" model of an observed mechanical system, where the mathematical „vacuum" model provides the „interacting" element between „body and mind"; it might be interpreted as „consciousness" of the observer as an integrated piece of the mathematical model.

Remark (A new principle of nature): From an observer (subject-object relationship) perspective an one-component physical-mechanical system may be interpreted as a mathematical observing framework; the not „visible" background electromagnetic dynamical quanta tend to become plasma dynamical quanta, while

plasma dynamical quanta tend to become vacuum dynamical quanta. This interpretation might be declared as a principle of nature, which may be called the principle of „inter-dynamical quanta fields potential compensation.

Remark (A new principle of nature): The principle of „inter-dynamical quanta fields potential compensation" in case of the potential difference between the mechanical and electromagnetic fields corresponds to the modelling feature of the Maxwell equations „to carry energy from one dynamical system to the other". The all encompassing integrated physical-mechanical, physical-dynamical, and mathematical-dynamical system provides the modelling framework for an overall conservation of energy principle.

Note: (Euler's three classes of truths based on human cognition): Euler meint, daß sich alle innerhalb der Grenzen unserer Erkenntnis liegenden Wahrheiten in drei Klassen einteilen ließen, nämlich erstens in die Wahrheiten der Erfahrung (*experience*: beruhend auf dem Zeugnis der Sinne), zweitens in die Wahrheiten der Vernunft (*reason*: beruhend auf der richtigen Schlußweise mit Mitteln der Logik), und drittens in die Wahrheiten des Glaubens (*believe*: beruhend auf historischen Überlieferungen), (HiS1) S. 15.

Note: (Schopenhauer's will & representation, upanishads' brahma & maja): In Schopenhauer philosophy the concept of „representation" corresponds to Kant's concept of „appearance world" and to the concept of „maja" (the world of growth and decay that we experience in space and time) of the upanishads, an ancient indian philosophy. Schopenhauer's complementary concept of „will" denotes the expression of an universal universal force and energy behind the diversity of life. Its counterpart in the upanishads is called „brahma", the basic principle of the world, the world soul, an universal force and energy, (ZiR1) S. 125.

Remark: Schopenhauer's world of human imagination (Vorstellung) is described by three forms of representation:

(1) sensations (Empfindung, Wahrnehmung)

(2) perceptions (Anschauung, Wahrgenommenes) → primary understanding
i.e., perceived sensations which are corrected content of sensations enabled by the *mind* (Verstand);
the related characteristic of human consciousness is „*making* understanding (Erkenntnis) *possible*"

(3) corrected perceptions → secondary understanding
they are enabled by *reason* (Vernunft) accompanied by the concept of *notion* (Begriff)
the related characteristic of human consciousness is „*creating* understanding (Erkenntnis)"

In a nutshell, consciousness is realized through the faculties of *mind* and *reason*. The prerequisite so that thinking (the application of mind and reason) can form a represenation is that consciousness must consider his objects interconnected with each other and with itself – „in a lawful and formal a priori determinable connection".

The three layer (representation) concept is related to the first three of Schopenhauer's concept of the „fourfold root principle of sufficient reason". The fourfold root is characterized by the (i) reason for becoming (cause and effect), (ii) reason for knowledge (logical justifiction of an assertion), (iii) reason for being (determining the position of an object in space), (iv) reason for action (explaining the motive for an action). The fourth reason in combination with the central human mind actor relates to the concept of „motivation".

In the context of this paper one may identify the first three reasons with the notions, (1) observations, (2) physical notions and interpretation, and (3) physical laws. Then the scope of the physical-mechanical modelling framework corresponds to Schopenhauer's „world as representation".

Mathematics is a purely describing science with notions independent from any sensation. A fourth layer of representation form is proposed by

(4) purely mathematical models → third understanding
Technical-mechanical and morally-artistic notions are extended by notions like „zero", „infinite",
„cardinality", Snirel'man's density of a set A of integer with the symbols $0, \infty, \aleph, 2^{\aleph}, \sigma(A)$.

If we interpret (2) in the sense that it includes qualitative physical models accompanied by logical conclusions out of it, and combine (3) & (4) into one, renamed by (iii) „mathematical world", we get the three layers

i)   sensations

ii)   perceptions, i.e., sensations accompanied by *possible* physical understanding

iii)   corrected perceptions accompanied by *created* mathematical understanding.

Remark: The mathematical layer (iii) is accompanied by a kind of *making-sense-believe* based on the believe in the existence of all required mathematical notions building the foundation of analysis, (WeH3), functional analysis, and number theory (like zero, infinite, cardinality, densities of sets of integers, irrational numbers, etc.). In simple words, mathematics is understood as „the science of infinity", (TaR). We also note that the three layers (i), (ii), (iii) are in line with Euler's three classes conceptions of truths, *experience*, *reason*, and *believe*.

The notion „*making-sense-believe*" may sound strange in the context of this paper. However, if one needs to choose between the two models of an „universe creation", (1) „the Big Bang creation" or, (2) a „matter creation process by compositions of two fundamental mathematical quanta" there is a more *making-sense-believe* for model (2) than for model (1) just by probability considerations, as

> in order to produce an universe resembling the one in which we live, the Creator would have to aim for an absurdly tiny volume of phase space of possible universes – about $1/10^{10^{123}}$ of the entire volume, for the situation under consideration, (PeR) p. 444; additionally, this process is triggered by a sophisticated fluctuation process of a sophisticated a priori „quantum element" (i.e., an a priori existing physical object outside the considered physical model) accompanied by the physical notion „inflaton".
>
> We note that (2) the „matter creation process", is in line with the physical „Steady State Theory", which is based on an extension of the cosmological principle including „time". It states that the universe not only looks the same for every observer in space, but also in time (today, past, future), i.e., the density keeps constant all the time, although an extension is observed. Therefore, an ongoing creation of matter out of „nothing" is required (~ one hydrogen atom per 6 km^3 per year, too little to be observed, (BeM) p. 25).

The crucial differentiator to Schopenhauer's „world as will and representation" is with respect to the role of consciousness: in Schopenhauer's concept the understanding is just the organic action function of the brain based on sensations etc., and there is no world without the will. The mathematical-dynamical (vacuum) world (model) replaces the role of the consciousness, i.e., the one-system-world-model (iii) is independent from the observer /subject. In the context of Schopenhauer's „world as will and representation" reduces to a purely „world as representation", i.e., the subject-object problematic has been resolved, while the scope has been extended from human beings to all organisms in the universe.

The purely mathematical notion based third understanding of layer (iii) is accompanied by corrected physical-mechanical model based perceptions/interpretations and the physical-mechanical world (ii) is explained/modelled by a „least action" principle governed by an overall purely mathematical-dynamical world. The latter mathematical-dynamical world model is in line with

- o   Einstein's cosmic energy
- o   Planck's dynamical laws of single operations
- o   Schrödinger's order-from-order mechanisms
- o   Nagel's teleological laws
- o   Kant's expediency
- o   Leibniz' harmony
- o   Maupertuis' principle of nature
- o   Aristotle's causa finalis

while the excluded specific role of the self-confidence puts the spot on Hegel's phenomenogy of spirit.

Note: (H. Hesse: Das Glasperlenspiel, (HeH1) S. 486):

Musik des Weltalls und Musik der Meister
Sind wir bereit in Ehrfurcht anzuhören,
Zu reiner Feier die verehrten Geister
Begnadeter Zeiten zu beschwören.

Wir lassen vom Geheimnis uns erheben
Der magischen Formelschrift, in deren Bahn
Das Uferlose, Stürmende, das Leben,
Zu klaren Gleichnissen gerann.

Sternbildern gleich ertönen sie kristallen,
In ihrem Dienst ward unserem Leben Sinn,
Und keiner kann aus ihren Kreisen fallen,
Als nach der heiligen Mitte hin.

5. Appendix

Related stakeholder views on their worlds

Authors

Avenarius R.; Barbour J.; Bethe H. A.; Bohm D.; Cassirer E.; Chen F. F.; Courant R.; Dee K.; Deligne P.; Derbyshire J.; Dirac P. A. M.; Dürr H.-P.; Ehrenhaft F. (and W. Schauberger); Einstein A.; Euler L.; Fermi E.; Feynman R.; Gödel K.; Hawking S. W.; Heidegger M.; Heisenberg W.; Helmholtz H.; Hildebrandt S; Husserl E.; Kant I.; Klainerman S.; Kneser A.; Kramers H. A.; Leedskalnin E.; Leibniz G.-W.; Lorentz H. A.; Luckner A.; Mach E.; Maupertuis P.; Mijajlovic Z.; Miyamoto K.; Nagel Th.; Neuenschwander D. E.; Poluyan P.; Penrose R.; Peskin M.; Planck M.; Rollnik H.; Rovelli C.; Russel R.; Schauberger V.; Schiller F.; Schopenhauer A.; Schpolski E. W.; Schrödinger E.; Shu F. H. ; Smolin L.; Spatschek K. H.; Treder H.-J.; Unzicker A.; Vagt C.; Weyl H.; Weinberg S.; Wheeler J. A..

The scope of this stakeholder views includes the theories of quantum & plasma phenomena, as well as the theory of relativity. Those theories operate with different mathematical concepts. They were developed by a step by step approach, which started 1900, when Max Planck introduced the theory of „quanta with specific energies" to explain „radiation" effects. This process was and is governed by the following paradigm of physics, (DeP) p. 551:

physics is scale dependent and decoupling

- Physics is scale dependent and at each scale, there are different degrees of freedom and different dynamics
  Therefore, at each scale level to be studied, there is the need for a different theory (e.g. classical continuum mechanics, theory of granular structure, nucleus + electronic cloud, nuclear physics, QED, free-electron theory, modelling, e.g. the properties of metals, semiconductors, and insulators) to describe the behavior of the considered physical system depending on a scale (of energies, distances, momenta, etc.). For example, in quantum field theory, the dependence of the behavior on the scale is often expressed mathematically by the fact that in order to regularize (i.e. render finite) Feynman diagram integrals one must introduce auxiliary scales, cutoffs, etc. The effect of these choices on the physics is encoded into the renormalization group equation. This equation then becomes an important tool for the study of physical theories.

- Physics at large scale decouples from the physics at a smaller scale
  When passing from a smaller scale to a larger scale irrelevant degrees of freedom are averaged over. Mathematically this means that they become integration variables and thus disappear.
  - In classical mechanics one deals with three scales according to its 3 basic measurements: distance D, time T, mass M
  - In non-relativistic quantum theory and classical relativity it has two scales: D & T resp. D & M
    (mass M can be expressed through T & D using the Planck constant resp. T can be expressed via D using the speed of light)
  - In relativistic quantum theory there is only one scale: distance D

The consequences of the step-by-step development process resulted into

- paradoxes (from a natural science perspective) with respect to contradicting predictions

- related „dualism" interpretation (from a mathematics perspective) of paradoxes and case specific dynamic particle definitions.

Stakeholder views on their related worlds

Avenarius R.
Philosophie als Denken der Welt gemäß dem Prinzip des kleinsten Kraftmaßes
Prolegomena zu einer Kritik der reinen Erfahrung

(AvR) S. 3: *Diese Schrift versucht, die Entwicklung der Philosophie unter das Prinzip des kleinsten Kraftmaßes zu befassen. Freilich ist dies Prinzip zunächst ein Prinzip der Beharrung, welches hinsichtlich der Seele etwa so lauten würde: Die Änderung, welche die Seele ihren Vorstellungen bei dem Hinzutritt neuer Eindrücke erteilt, ist eine möglichst geringe; oder mit anderen Worten: Der Inhalt unserer Vorstellungen nach einer neuen Apperzeption ist dem Inhalt vor derselben möglichst ähnlich. – Insofern aber die Seele den Bedingungen organischer Existenz und deren Zweckmäßigkeitsanforderungen unterworfen ist, wird das angezogene Prinzip zu einem Prinzip der Entwicklung: Die Seele verwendet zu einer Apperzeption nicht mehr Kraft als nötig, und gibt bei einer Mehrheit möglicher Apperzeptionen derjenigen den Vorzug, welche die gleiche Leistung mit einem geringeren Kraftaufwand, mit welchem aber eine geringere Wirkungsdauer verbunden ist, eine zeitweilige Mehranstrengung vor, welche um so viel größere bez. andauerndere Wirkungsvorteile verspricht.*

(AvR) S. 6: „*Eine Auffassung, welche, gleich der hier niedergelegten, jede individuelle Gedankenbildung, also auch die eigene, mehr als ein Fremdes denn ein Eigenes betrachtet, da sie dieselbe als zum weitaus größeren Teil durch die allgemeine Gedankenentwicklung bestimmt anerkennt, - eine Auffassung, welche sich zugleich nicht verhehlt, wie in dem übrig bleibenden Teile scheinbar freier individueller Entfaltung noch so viele Einflüsse menschlich-subjektiver Befangenheit hemmend und trübend eingreifen: eine solche Auffassung hat wenig Grund, eine gerechte, rein von theoretischen Interessen geleitete Beurteilung zu scheuen. Vielmehr ist sie bereit, von der Kritik – und erst recht von der des Gegners – zu lernen, indem sie sich der Erkenntnis fügt, daß in den Regionen des Denkens, wo Exempel und Experiment versagen, es meist der Einwirkung gegensätzlicher Meinungen bedarf, um uns zu der vornehmensten Bedingung aller Selbstkritik und Selbstweiterbildung zu entwickeln: zu dem vollen Bewußtsein dessen, was unser Wissen war und was unser Wollen.*"

Barbour J.
The End of Time, The Two Big Mysteries

(BaJ1) p. 15: „*Physicists currently describe the world by means of two very different theories. Large things are described by classical physics, small things by quantum physics. There are two problems with this picture.*

First, general relativity, Einstein's theory of gravity, seems to be incompatible with the principles of quantum mechanics in a way Newtonian dynamics and the theory of electromagnetism, developed by Michael Faraday and James Clerk Maxwell in the nineteenth century, are not. For these theories, it proved possible to transform them, by a process known quantization, from classical into quantum theories. Attempts to apply the same process to general relativity and create quantum gravity *failed. It was this technical work, by Dirac and others, which brought to fore all problems about time with which this book is concerned.*

The second mystery is the relationship between quantum and classical physics. It seems that quantum physics is more fundamental and ought to apply to large objects, even the universe. There ought to be a quantum theory of the universe: quantum cosmology. *But quantum physics does not yet exist in such a form. And its present form is very mysterious. Part of it seems to describe the actual behavior of atoms, molecules and radiation, but another part consists of rather strange rules that act at the interface between microscopic and macroscopic worlds. Indeed, the very existence of a seemingly unique universe is a great puzzle within the framework of quantum mechanics. This is very unsatisfactory, since physicists have a deep faith in the unity of nature. Because general relativity is simultaneously a theory of gravity and the large-scale structure of the universe, the creation of quantum cosmology will certainly require the solution of the only slightly narrower problem of quantum gravity.*"
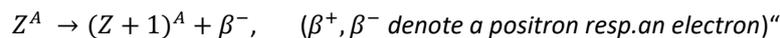
Bethe H. A.
Elementary Nuclear Theory

The size of nuclei

(BeH) p. 7-12: „*The methods of determining the size of nuclei fall into two classes: those that indicate the presence of nuclear matter even if it is electrically neutral, and those that are purely electromagnetic and are influenced only by the electric charge distribution within the nucleus.*

1. *Nuclear methods*
   a. *Cross section for fast neutrons*
   b. *Lifetimes for radioactivity*
   c. *Cross sections for nuclear reactions involving charged particles*
2. *Electromagnetic methods*
   a. *Electrostatic interaction of protons in the nucleus*
   b. *Electron scattering*
   c. *μ-Mesonic atomic x-ray energies*
   d. *Electron energy levels*
   e. *General trend of nuclear Coulomb energies*"

γ-rays disintegration

(BeH) p. 14: „*Nuclei are found in nature (and more can be produced artifically) that emit electrons spontaneously according the the reaction schema (Z^A denotes a nucleus with mass number A)*

$$Z^A \rightarrow (Z+1)^A + \beta^-, \quad (\beta^+, \beta^- \text{ denote a positron resp.an electron})"$$

(BeH) p. 17: „*Nuclei emit not only partiles (heavy particles and electrons) but also γ-radiation (light quanta). Such emission is possible only when a nucleus goes from an excited energy state to a lower energy state. The half-lives for dipole radiation (nuclear spin change $\Delta I = 0$, or ± 1) are generally of the order of 10^{-17} second to about 10^{-13} second.*

Summary of decay processes

(BeH) p. 17: „*Consider a nucleus Z^A with mass number A in some quantum state;*

1. *it may be unstable to the emission of heavy particles*

   a. *Neutrons*
   b. *Protons*
   c. *α-Particles*

2. *Emission of γ-rays or K-electron capture: … Thus the unstable nuclei can be put into three groups*

   Group I: Lives unobservablely short

   Group II: Lives observable (10^{-8} second to 10^{12} years)
   Nearly all β-radioactive nuclei, many α-radioactiv ones, and many „nuclear isomer" emitting γ-rays

   Group III: Lives unobservable long (greater that 10^{14} years)"

Spin and its measurement

(BeH) p. 19: „*Each nucleus has an intrinsic angular momentum which interacts with angular momenta of electrons or other nuclei. It is measured in units of the Planck constant and, according to quantum mechanics, can take only integral or half-integral values. Three methods of determining nuclear spin are:*

- *Hyperfine structure of spectra*
- *Zeeman spectra*
- *Band spectra*

These observed spin values are another reason for rejecting a nuclear model composed of electrons and protons. Such a model for a nucleus Z^A has A protons and $A - Z$ elecrons or $2A -$

Z particles. On this basis, nuclei with odd Z should have half-integer spin; and nuclei with even Z (and therefore an odd total number of particles) should have half-integer spin.“

<center>*Statistics*</center>

(BeH) p. 20: „Identical particles obey either Fermi statistics or Bose statistics; … Electrons obey Fermi statstics. To determine the statistics of nuclei, we shall investigate how an exchange of identical nuclei will affect the sign of the wave function for a molecule.

(BeH) p. 22: „now it was found experimentally that nuclei with even A obey Bose statistics, those with odd A Fermi statistics. This proves that the neutron must obey Fermi statistics, just as the proton for which this fact is known experimentally.“

(BeH) p. 24: With no known exceptions, all nuclei of even Z and even A have total nuclear spin zero“.

<center>*The structure of nuclei*</center>

(BeH) p. 157: „From a detailed knowledge of the forces between nucleons it would be possible to calculate the properties of all nuclei“

<center>Bohm D.
The Special Theory of Relativity</center>

(BoD) Preface: „Einstein's basically new step was in adoption of a relational approach to physics. Instead of supposing that the task of physics is the study of an absolute underlying substance of the universe (such as an ether) he suggested that it is only in the study of relationships between various aspects of this universe, relationships that are in principle observables. … Einstein's analysis of the concept of simultaneity, in which he regards time as a kind of „coordinate“ expressing the relationship of an event to a concrete physical process in which this coordinate is measured. On the basis of the observed fact of the constancy of actually measured velocity of light for all observers, one sees that observers moving at different speeds cannot agree on the same time coordinate to be asccibed to distant events. From this conclusion, it also follows that they cannot agree on the lengths of objects or the rates of clocks. Thus, the essential implications of the theory of relativity are seen qualitatively, without the need for any formulas. The transformations of Lorentz are then shown to be the only ones that can express in precise quantitative from to be the only ones that can express in precise quantitative form the same conclusions that were initially obtained without mathematics“

(BoD) p. 97: „We have seen already sees that Newton's laws of motion are not invariant to a Lorentz transformation, and that the principle of relativity therefore implies (except in the limit as v/c approaches zero), these cannot be correct laws of mechanics. … our first problem with regard to these laws is therefore to generalize them so as to obtain a new set of equations that is invariant to a Lorentz transformation. … in an isolated system of bodies the total momentum P is related to the total mass M and the velocity V of the center of mass by the formula V*M=P. It is a well known theorem in Newtonian mechanics that in such a system the total momentum P is a constant vector and the total mass is also a constant. … to generalize Newton's laws the basic idea behind our procedure is that it is essential in physical theories to be able to analyze a whole system into parts or components. Thus in a theory of a continuous medium, such as hydrodynamics, we regard the fluid as being constituted out of small elements of volume, and, in a theory which explains matter as having a discrete atomic structure, a whole system is likewise regarded as constituted out of small elements, now taken to be atoms. In both kinds of theories we can treat the total momentum of a system as the sum of momenta of its parts, likewise with total mass and the total energy. Moreover, at least in the domain where Newtonian theory applies, such systems are known by experiment (as well as from the theory) to satisfy the laws of conservation o momentum, conservation of mass, and conservation of energy“

Bohm D.
Wholeness and the implicate (and explicate) order in physical law

(BoD1) p. 111: „*What we usually call „particles" are relatively stable and conserved excitations on top of this vacuum. Such particles will be registered at the large-scale level, where apparatus is sensitive only to those fetures of the filed that will last a long time, but not to those features that fluctuate rapidly. Thus, the „vacuum" will produce no visible effects at the large-scale level, since its fields will cancel themselves out on the average, and space will be effectively „empty" for an electron in the lowest band, even though the space is full of atoms*"

(BoD1) p. 186: „*What is being suggested here is that the considerations of the difference between lens and hologram can play a significant part in the perception of a new order that is relevant for physical law. … the word „implicit" means „to fold inward"*"

(BoD1) p. 199: „*It is important to emphasize, however, that mathematics and physics are not being regarded here as separate but mutually related structures (so that, for example, one could be said to apply mathematics to physics as paint is applied to wood). Rather, it is being suggested that mathematics and physics are to be considered as aspects of a single undivided whole*"

(BoD1) p. 200: „*explicate oder arises primarily as a certain aspect of snese of perception and of experience with the content of such sense perception*"

(BoD1) *p. 200: „What is common to the functioning of instruments generally used in physical research is that the sensibly perceptible content is ultimately describable in terms of a Euclidean system of order and measure, i.e., one that can adequately be understood in terms of ordinary Euclidean geometry. …"*

(BoD1) p. 200: „*In this discussions, we shall adopts the well-known view of the mathematician Klein, who considered the general transformations are considered to be the essential determining features of a geometry. Thus, in an Euclidean space of three dimensions, there are three displacement operator D_i. Each of these operators defines a set of parallel lines which transform into themselves under the operation in question. Then, there are three rotation operators R_i. Each of these define a set of concentric cylinders around the origin which transform into themselves under the operation in question. Together, they define concentric spheres which transform into themselves under the whole set of R_i. Finally, there is the dilation operator R_0, which transforms a sphere of a given into one of a different radius. Under this operation, the radial lines through the origin transform into themselves*"

(BoD1) p. 201: „*So we may describe displacements on a numerical scale. This gives not only an order, but also a measure (in so far we treat successive displacements as equivalent in size)*"

(BoD1) p. 202: „*Implicate order is generally to be described not in terms of simple geometric transformations, such as translations, rotations, and dilations, but rather in terms of a different kind of operations. …*"

(BoD1) p. 202: „*What happens in the broader context of implicate order we shall call a metamorphosis. …*"

(BoD1) p. 202: „*A hologram is an example of a similarity transformation (or a similarity metamorphosis). It is determed by the Green's function relating amplitudes at the illuminated structure to those at the photographic plate*"

(BoD1) p. 206: „*Of course, in the quantum theory, the algebraic terms are interpreted as standing for 'physical observables' to which they correspond. However, in the approach that is being suggested here, such terms are not to be regarded as standing for anything in particular. … This means, of course, that we do not regard terms like 'particle', 'charge', 'mass', 'position', 'momentum', etc., as having primary relevance in the algebraic language. Rather, at best, they will have to come out as high-level abstractions.*"

Bohm D.
Quantum Theory
Spin and Angular Momentum

(BoD2) p. 387: „*In chapter 14 we studied the quantum properties of the angular momentum of single-particle systems. We wish now to extend this treatment to take into account the angular momentum of a system of particles. We shall also discuss the treatment of the additional angular momentum arising from the fact that the electron has an intrinsic spin.*

Electron spin

Although the Schrödinger wave equation gives excellent general agreement with experiment in predicting the frequencies of spectral lines, small discrepancies are found, which can be explained in terms of the postulate that the electron has, besides its usual orbital angular momentum, an additional intrinsic angular momentum that acts as if it came from a spinning solid body [*]. It was found that agreement with experiment could be

obtained by means of the assumption that the magnitude of the additional angular momentum was $\frac{1}{2}\frac{h}{2\pi}$. The magnetic moment needed to obtain agreement with the Zeeman effect was, however, $\mu = e\frac{h}{2\pi}(2mc)$, which is exactly the same as that arising from an orbital angular momentum of $\frac{h}{2\pi}$ (It should be noted that because it is the order of $\frac{h}{2\pi}$, spin is an essentially quantum-mechanical property). The gyromagnetic ratio, i.e., the ratio of magnetic moment to angular momentum is therefore twice as great for electron spins as it is for orbital spins."

(*) H. A. Kramers, Die Grundlagen der Quantentheorie

Cassirer E.
Kants Leben und Lehre
Die Kritik der Urteilskraft

(CaE) S. 305: *„Das Reich der Kunst und das der organischen Naturformen stellt nur darum eine andere Welt, als die der mechanischen Kausalität und der sittlichen Normen dar, weil die Verknüpfung, die wir in beiden zwischen den Einzelgebilden annehmen, unter einer eigentümlichen Gesetzesform steht, die weder durch die theoretischen „Analogien der Erfahrung", durch die Verhältnisse von Substanz, Ursächlichkeit und Wechselwirkung, noch durch die ethischen Imperative ausdrückbar ist. Welches ist diese Gesetzesform und worauf gründet sich die Notwendigkeit, die wir auch ihr zusprechen? Ist sie eine „subjektive"oder „objektive" Notwendigkeit: beruht sie auf einem Zusammenhang, der lediglich in unserer menschlichen Vorstellung besteht und von hier aus fälschlich den Gegenständen angeheftet wird, oder ist sie im Wesen dieser Gegenstände selbst gegründet? Ist der Zweckgedanke, wie Spinoza will, lediglich ein „asylum ignorantiae" oder bildet er, wie Aristoteles und Leibniz behaupten, das objektive Fundament jeder tieferen Naturerklärung? Oder, wenn wir alle diese Fragen vom Gebiet der Natur auf das der Kunst übertragen: steht die Kunst im Zeichen der „Naturwahrheit" oder im Zeichen des „Scheins"; ist sie die Nachahmung eines Bestehenden oder eine freie Schöpfung der Phantasie, die mit dem Gegebenen nach Belieben und Willkür schaltet? Durch die gesamte 'Entwicklung der organischen Naturlehre, wie durch die der Ästhetik ziehen sich diese Probleme hindurch: — jetzt aber gilt es, ihnen einen festen systematischen Platz anzuweisen und sie dadurch zur Hälfte bereits zur Lösung zu bringen"*

Chen F. F.
Plasma physics

(ChF) p.1: *„It has often been said that 99% of the matter in the universe is in the plasma state; that is, in the form of an electrified gas with the atoms dissoviated into positive ions and negative electrons.*"

Definition of plasma

(ChF) p. 3: *„Any ionized gas cannot be called a plasma, of cource; there is always some small degree of ionization in any gas. A useful definition is as follows:*

A plasma is a quasineutral gas of charged and
neutral particles which exhibits collective behavior.

We must now define „quasineutral" and „collective behavior". ...."

*Phase vs. group velocity of waves in a plasma
exceeding vs. not exceeding the velocity of light c*

(ChF) p. 81: *„The phase velocity of a wave in a plasma often exceeds the velocity of light c. This does not violate the theory of relativity, because an infinitely long wave train of constant amplitude cannot carry information. The carrier of a radio wave, for instance, carries no information until it is modulated. The modulation information does not travel at the phase velocity but at the group velocity, which is always less than c. To illustrate this, we may consider a modulated wave formed by adding („beating") two waves of nearly equal frequencies. Let these waves be*

$$E_1 = E_0 cos[(k + \Delta k)x - (\omega + \Delta\omega)t]$$
$$E_2 = E_0 cos[(k - \Delta k)x - (\omega - \Delta\omega)t]$$

E_1 and E_2 differ in frequency by $2\Delta\omega$. Since each wave must have the phase velocity ω/k appropriate to the medium in which they propagate, one must allow for the difference $2\Delta\omega$ in propagation constant. Using the abbreviation $a = kx - \omega t$, $b = (\Delta k)x - (\Delta\omega)t$ we have

$$E_1 + E_2 = E_0\, cos(a + b) + E_0\, cos(a - b)$$
$$= E_0[cos\, a\, cos\, b - sin\, a\, sin\, b + cos\, a\, cos\, b + sin\, a\, sin\, b]$$
$$= 2E_0\, cos\, a\, cos\, b$$

i.e., $E_1 + E_2 = 2E_0(cos\,kx - \omega t)cos(\Delta k)x - (\Delta\omega)t$. This is a sinusoidally modulated wave. The envelope of the wave, given by $cos(\Delta k)x - (\Delta\omega)t$, is what carries information; it travels at velocity $\Delta\omega/\Delta t$. Taking the limit $\Delta\omega \to 0$, we define the group velocity to be

$$v_g = d\omega/dk.$$

It is this quantity that cannot exceed c.

Linear vs. nonlinear Landau damping phenomena
arising from different physical effects

(ChF) p. 245: Landau damping is a characteristic of collisionless plasmas, but it may also have application in other fields. For instance, in the kinetic treatment of galaxy formation, stars can be considered as atoms of a plasma interacting via graviational rather than electromagnetic forces. Instabilities of the gas of stars can cause spiral arms to form, but this process is limited by Landau damping."

(ChF) p. 248-249: „There are actually two kinds of Landau damping: linear Landau damping, and nonlinear Landau damping. Both kinds are independent of dissipative collisional mechanisms. If a particle is caught in the potential well of a wave, the phenomenon is called „trapping". Particles can indeed gain or lose energy in trapping. However, trapping does not lie within the purview of the linear theory. …. Trapping is not in the linear theory. When a wave grows to a larger amplitude, collisonless damping with trapping occur. One then finds that the wave does not decay monotonically; rather the amplitutes fluctuates during the decay as the trapped particles bounce back and forth in the potential wells. This is nonlinear Landau damping. .. Since the linear Landau damping is derived from a linear theory, … the nonlinear Landau damping must arise from a different physical effect. The question is: Can untrapped electrons moving close to the phase velocity of the wave exchange energy with the wave?"

(ChF) P. 254: „Neither the untrapped particles nor particle trapping are responsible for linear Landau damping. … Indeed, there are particles in the original distribution which have velocities so close to v_φ that at the time t they have not yet gone half-wavelength relative to the wave. For these particles, one cannot take the average $\langle \Delta W_k \rangle$. These particles can absorb energy from the wave and are properly called the „resonant" particles. As time goes on, the number of resonant electrons increases, since an increasing number will have shifted more than $\frac{1}{2}\lambda$ from their original positions. The damping rate, however, can stay constant, since the amplitude is now smaller, and it takes fewer electrons to maintain a constant damping rate."

(ChF) p. 260: The resonant particles
„We are now in a position to see precisely which are the resonant particles that contribute to linear damping. … These particles rapidly bcome spread out in phase, so that they contribute little to the average; the intial distribution is forgotten. … Those particles may include both trapped and untrapped particles. This phenomenon is unrelated to particle trapping."

(ChF) p. 260: Two paradoxes resolved
„The function which describes the relative contribution of various velocity groups to Landau damping is an even function of $\omega - ku$ so that the particles going both faster than the wave and slower than the wave add to Landau damping. On the other hand, the slope of the curve curve of this function, … is an odd function of $\omega -$

ku; and one would infer from this particles traveling faster than the wave give energy up to it, while those traveling slower than the wave takes energy from it. The two descriptions differ by an integration by parts. Both descriptions are correct; which one is the be chosen depends on whether one wishes to have $\hat{f}_0(v)$ or $\hat{f}_0'(v)$ in the integrand (of the formula of the rate of change of the wave energy density function).

A second paradox concerns the question of Galilean invariance. If we take the view that damping requires there be fewer particles traveling faster the wave than slower, there is no problem as long as one is in the frame in which the plasma is at rest. However, if one goes into another frame moving with velocity than V, there would appear to be more particles faster than the wave than slower, and one would expect the wave to grow instead of decay. This paradox is removed by reinserting the second term $\frac{2ku}{\omega - ku}$, which we neglected. This term can make $\langle \Delta W_k \rangle$ negative … and the wave appears to have negative energy (that is, there is more energy in the quiescent, drifting Maxwelllian distribution than in the presence of an oscillation). The wave „growth", but adding energy to negavtive energy wave makes ist amplitude decrease."

(ChF) p. 261: *„We have seen that Landau damping is directly connected to the requirement that $f_0(v)$ be initially uniform in space. On the other hand, one can generate undamped electron waves if $f_0(v, t = 0)$ is made to be constant along the particle trajectories initially. Those particled will neither gain nor lose energy, on the average, if the plasma is initially prepared to that the density is constant along each trajectory. Such a wave is called a BGK mode (I. B. Bernstein, J. M. Green, M. D. Krustal)."*

<div align="center">

Microwave radiation pressure to plasma
Ponderomotive force

</div>

(ChF) p. 305, 307: *„Light waves exert radiation pressure which is usually very weak and hard to detect. … When high-powered microwaves or laser beams are used to heat or confine plasmas the radiation pressure can reach several hundred thousand atmospheres! When applied to plasma, this force is coupled to the particles in a somewhat subtle way and is called the ponderomotive force. Many nonlinear phenomena have a simple explanation in terms of the ponderomotive force."*

<div align="center">

Nonlinear Landau damping or growth
Potential due to ponderomotive force

</div>

(ChF) p. 328: *„When the amplitude of an electron or ion wave excited, say by a grid is followed in space, it is often found that the decay is not exponential, as predicted by linear theory, if the amplitude is large. Instaed, one typically finds that the amplitude decays, grows again, and then oscillates before settling down to a steady value. … although other effects may also be operative, these oscillations in amplitutes are exactly what would be expected from the nonlinear effect of particle trapping discussed in section 7.5. Trapping of velocity occurs when its energy in the wave frame is smaller than the wave potential. Small waves will trap only these particles moving at high speeds near v_φ. … When the wave is large, its linear behavior can be exspected to be greatly modified. .. There is a bounce frequency ω_B of a sinusoidal potential well with corresponding potential and equation of motion, where the frequency is not constant unless x is small, and the potential is approximattely parabolic. … When the resonant particles are reflected by the potential, they give kinetic energy back to the wave, and the amplitude increases. When the particles bounce again from the other side, the energy goes back into the particles, and the wave is damped. Thus, one would expect oscillations in amplitutde at the frequence ω_B in the wave frame. … The condition $\omega_B \geq \omega$ turns out to define the breakdown of linear theory even when other processes besides particle trapping are responsible. Another typ of nonlinear Landau damping involves the beating of two waves. Suppose there are two high-frequency electron waves (ω_1, k_1) and (ω_2, k_2). These would beat to form an amplitutde envelope traveling at a velocity $\frac{\omega_2 - \omega_1}{k_2 - k_1} \approx \frac{d\omega}{dk} = v_g$. This velocity may be low enough to lie within the ion distribution function. There can then be an energy exchange with the resonant inos. The potential the ions see is the effective potential due to the ponderomotive force, and Landau damping or growth can occur. Damping provides an effective way to heat ions with high-frequency waves, which do not ordinary interact with ions. If the ion distribution is double-humped, it can excite the electron waves, Such an instability is called a modulational instability."*

The Korteweg-de Vries and the Schrödinger equations
of nonlinear plasma physics
Ponderomotive force forming isolated structures
called envelope solitary waves

(ChF) p. 330: „*There are two nonlinear equations that have been treated extensively in connection with nonlinear plasma waves: The Korteweg-de Vries equation and the nonlinear Schrödinger equation. Each concerns a different type of nonlinearity. When an ion acoustic wave gains large amplitude, then main nonlinear effect is wave steeping, whose physical explnation was given in section 8.3.3. This effect arises from the $v \cdot \nabla v$ term in the ion equation of motion and is handled mathematically by the Korteweg-de Vries equation. The wave-train and the soliton solutions are also predicted by this equation.*

When an electron plasma wave goes nonlinear, the dominant new effect is that the ponderomotive force of the plasma waves causes the background plasma to move away, causing a local depression in density called a caviton*. Plasma waves trapped in this cavity then form an isolated structure called an* envelope soliton *or* envelope solitary wave*. Such solutions are described by the nonlinear Schrödinger equation. Considering the difference in both the physical model and the mathematical form of the governing equations, it is surprising that solitons and envelope solitons have almost the same shape*".

The Korteweg-de Vries equation

(ChF) p. 331: „*This equation occurs in many physical situations including that of a weakly nonlinear ion wave:*

$$\frac{\partial U}{\partial \tau} + U \frac{\partial U}{\partial \xi} + \frac{1}{2}\frac{\partial^3 U}{\partial \xi^2} = 0$$

where U is the amplitude, and τ and ξ are timelike and spacelike variables, respectively. Although several transformations of variables will be necessary before this form is obtained, two physical features can already be seen. The second term is easily recognized as the convective term $v \cdot \nabla v$ leading to wave steepening. The third term arises from wave dispersion; that is, the k dependence of the phase velocity".

The nonlinear Schrödinger equation

(ChF) p. 336: „*This equation has the standard dimensionless form*

$$i\frac{\partial \psi}{\partial t} + p\frac{\partial^2 \psi}{\partial x^2} - q|\psi|^2\psi = 0$$

where ψ is the wave amplitude, $i = (-1)^{1/2}$, and p and q are coefficients whose physical significance will be explained shortly. This equation differs from the usual Schrödinger equation

$$ih\frac{\partial \psi}{\partial t} + \frac{h^2}{2m}\frac{\partial^2 \psi}{\partial x^2} - V(x,t)\psi = 0$$

in tht the potential $V(x,t)$ depends on ψ itself, making Plane waves of the non-linear Schrödinger equation in the form. Note however, that V depends only on the magnitude and not on the phase of ψ. This is to be expected, as far as electron plasma waves are concerned, because th nonlinearity comes from the ponderomotive force, which depends on the gradient of the wave intensity.

Plane wave solutions of the (standard dimensionless) equation are modulationally unstable if $pq > 0$; that is, a ripple on the envelope of the wave will tend to grow. For plasma waves, it is easily to see how the ponderomotive force can cause a modulational instability. The ponderomotive force moves both electrons and ions toward the intensity minima, forming a ripple in the plasma density. Plasma waves are trapped in regions of low density".

Courant R.
Empirical evidence and mathematical existence

(HiS) p. 148: „*Empirical evidence can never establish mathematical existence – nor can the mathematician's demand for existence be dismissed by the physicist as useless rigor. Only a mathematical existence proof can ensure that the mathematical description of a physical phenomenon is meaningful*."

Khun Dee's Story

key words: steps toward thermodynamic & gravitational initiation", „two movements of mass toward aggregation (gravity) and toward dispersion (thermodynamics)" [(*)].
[(*)] *Those two kinds of movements put the spot on Viktor Schauberger's two kinds of mechanical energies governing centrifugal (linear movements) and (acting much stronger) centripetal forces*

(DeK) p. 3: „*Consider the Big Bang Theory. A mass the size of our Universe appeared out of nowhere. Even though it was the biggest black whole ever, it then exploded. Our universe is a real thing but the Big Bang Theory is a fairy tale*".

(DeK) p. 98: *Steps toward thermodynamic/gravitational initiation*
„*As an universe matures, the movement of mass goes in two directions: toward aggregation and toward dispersion. These translate into gravity and thermodynamics, the two great opposites.
To make thermodynamics work, space beyond gravity must be present. With gravity's constant force, space creation must also be a constant process.*

In view of the described shrinking at high speed with the appearance of increased space between, gravity, the great attractor, is also the great space creator. If gravity is, as the general relativity proposes, just a field in space, expansion and contraction are just the plus and the minus of the same thing. For the concentration of mass suitable to make the environment we know, both directions have no future unless there is a way to initialize or restart them at their primodial, more mixed arrangement.

The implosion theory of universe creation process is that initializer. Of course, there are provisional arrangements such as slower development (e.g. small stars), explosions and orbiting to stop failing. But current theory has no place for any long term thermodynamic/gravitational reset.

Considering the character of the flow between gravity and thermodynamic tendency, nature seems to favor stepwise energy changes. Each of these steps is separated from the next by some conditional barrier and, often, a catalyst-like agent needed to make the change to the next step. In animals, for example, metabolic energy release from otherwise stable molecules is made in a stepwise fashion and is made possible by enzymes, catalyst-like agents. In stars, there are also stable steps separated by change periods that only occur under special circumstances."

Deligne P. et. al.
Quantum fields and strings
A course for mathematicians

(DeP) p. 551: "*the behavior of a physical system depends on a scale (of energies, distances, momenta, etc.) at which the behavior is studied. Very generally speaking, the method of renormalization group is a method designed how to describe how the dynamics of some system changes when we change the scale (distance, energies) at which we probe it,. … Physics is scale dependent (requiring only a mathematical metric space framework, which has no geometric structure at all), and at each scale, there are different degrees of freedom and different dynamics, i.e. physics at a large scale decouples from the physics at a smaller scale. … In classical mechanics there are three scales of distance, time, and mass. In non-relativistic quantum theory there are two scales: the mass can be expressed through «time» and «distance» using the Planck constant) and classical relativity («time» can be expressed via «distance» using the speed of light). In relativistic quantum theory there is only the scale of distance (or equivalently – the scale of (its inverse) momenta)*".

(DeP) p. 1119 ff.: *„The effect of the required auxiliary scales, cutoffs, etc. on the physics is encoded into the renormalization group equation. The "case" if there is no related (G-invariant) renormalization realisation (example ground state energy) is called "symmetry break down. … The first quantization was about Einstein's discrete energy parcels, the photons, the second quantization was about Dirac's electron spin 1/2 model."*

Derbyshire J.
The Montgomery-Odlyzko law

(DeJ): p. 280 ff.*: „The eigenvalues (of Gaussian-random Hermitian matrices)… are struggling to keep their distance from each other. … The statistical properties of spacings between long non-uniform string of numbers are encapsulated in a creature called „pair correlations function" and a certain ratio associated with this function is called its „form factor". … The form factor for the pair correlation of random Hermitian matrices is the conjectured distribution function for the differences between the non-trivial zeros of Riemann's zeta function. …"*

(DeJ): p. 285 ff.: *„The following points look pretty plausible on the basis of related comparing figures of „the eigenvalues of a 269-by-269-random matrix"*

(DeJ): p. 289: *„The first 269 values of „t", where ½+it is a non trivial zero of the zeta function"*

(DeJ): p. 292: *"The distribution of the spacings between successive non-trivial zeros of the Riemann zeta function (suitable normalized) is statistically identical with the distribution of eigenvalue spacing in a Gaussian Unitary Ensemble (i.e. a collection of Gaussian unitary operators that share some common statistical properties)"*

(DeJ) p. 295: *„What on earth does the distribution of prime numbers have to do with the behavior of subatomic particles?"*

Dirac P. A. M.
Classical Theory of Radiation

(DiP1) *„One of the most attractive ideas in the Lorentz model of the electron, the idea that all mass is of electromagnetic origin, appears at the present time to be worng, for two separate reasons. First, the discovery of the neutron has provided us with a form of mass which it is very hard to believe could be of electromagnetic nature. Secondly, we have the theory of the positron a theory in agreement with experiment so far it is known – in which positive and negative values for the mass of an electron play symmetrical roles. This cannot be fitted in which the electromagnetic idea of mass, which insists on all mass being positive, even in abstract theory. … We are faced with the difficulty that, if we accept Maxwell's theory, the field in the immediate neighborhood of the electron has an infinite mass"*.

(DiP2) *„The modern study of cosmology is dominated by Hubble's observations of a shift to the red in the spectra of the spiral nebulae—the farthest parts of the universe—indicating that they are receding from us with velocities proportional to their distances from us. These observations show us, in the first place, that all the matter in a particular part of space has the same velocity (to a certain degree of accuracy) and suggest a model of the universe in which there is a natural velocity for the matter at any point, varying continuously from one point to a neighbouring point. Referred to a four-dimensional space-time picture, this natural velocity provides us with a preferred time-axis at each point, namely, the time-axis with respect to which the matter in the neighbourhood of the point is at rest. By measuring along this preferred time-axis we get an absolute measure of time, called the epoch. Such ideas of a preferred time-axis and absolute time depart very much from the principles of both special and general relativity and lead one to expect that relativity will play only a subsidiary role in the subject of cosmology. This first point of view, which differs markedly from that of the early workers in this field, has been much emphasized recently by Milne"*.

Dürr H.-P.
Geist, Kosmos und Physik

(DüH1), S. 122: „*Die Biologen und Hirnforscher sind immer noch an die Vorstellungen der alten Physik gebunden, die versuchen, auch das Lebendige auf die reduzierbare materiell-energetische Realität zurückzuführen. Sie halten das was von der Quantenphysik aufgedeckte urlebendige Dazwischen-Beziehungsgefüge für irrelevant wegen des vermutlich unvermeidbaren Ausmittelungseffekts für die Billionen mal größeren Lebensformen und interessieren sich, gleichnishaft gemeint, wieterhin nur für die messbare Hardware.*"

(DüH) S. 442: „*In der Quantentheorie ist dabei zu beachten, daß Translation und Rotation nicht miteinander vertauschbar sind. Man kann daher den Drehimpuls eine Systems um eine Achse nur dann durch eine Quantenzahl charakterisieren, wenn der Translationsimpuls des Systems senkrecht zu dieser Ache entweder verschwindet oder unbekannt ist.*"

(DüH) S. 446: „*Wenn es sich als unmöglich erweist, einen voll symmetrischen Zustand „Vakuum" zu konstruieren, so kann dies anschaulich wohl nur so gedeutet werden, daß es sich bei dem unsymmetrischen Grundzustand nicht eigentlich um ein Vakuum, sondern um einen Zustand „Welt" handelt, der die Grundlage für die Existenz der Elementarteilchen bildet. Dieser Zustand muß dann entartet sein; er kann z. B. einen sehr hohen Isospin besitzen. Wenn man — gewissermaßen als Idealisierung des realen Zustandes der Welt — die Translationseigenschaften des Vakuums beibehalten will, so muß er sogar unendlich hoch entartet sein.*

(DüH) S. 446: *Der Symmetrieverlust wäre in der vorliegenden Theorie also ähnlich zu deuten wie das Auftreten einer Zentrifugalkraft in der allgemeinen Relativitätstheorie, das ja auch einen Symmetrieverlust anzeigt. Die Zentrifugalkraft kann dort nur als Folge der unendlich fernen Massen im Weltall angesehen werden, obwohl diese Massen in der mathematischen Formulierung schließlich nur als eine Art Randbedingung im Unendlichen erscheinen, die eben die Zentrifugalkraft indirekt hervorruft.*

(DüH) S. 446: *Der Grundzustand hätte in der vorliegenden Theorie also einen praktisch unendlich großen Isospin (die Welt enthält neben Protonen und Elektronen beliebig viele Neutronen!) und es würde verständlich, daß die Zustände Neutron und Proton eine etwas verschiedene Masse erhalten. Sie wären gewissermaßen die beiden Dublettkomponenten eines Zustandes „Nukleon + Welt", bei dem sich der hinzukommende Isospin parallel oder antiparallel zu dem der „Welt" stellen kann, und der als Ganzes wieder einen beliebig hohen Isospin trüge*".

Ehrenhaft F.
Photophoresis

(EhF): „*Particles of matter irradiated by light between electrodes behave as if they carry positive or negative electric charges. Therefore we can say that through the action of the light uncharged particles obtain unipolar charges, either negative or positive*".

It is unlikely, that all those movement phenomena in light with or without the action of a field can be explained with the helf of today's hypothesis; we may be forced to reach for something new, [*].
[*] Acta Physicia Austriaca, Band 4, 1950 and Band 5, 1951
(AIO) p. 222: „*Completely new and amazing is the fact, that the movements of the particles in the field do not run in straight lines, but run in paths in extremly regular forms, sizes and orbital frequencies*"
Note: this is in line with V. Schauberger's implosion (cycloidal) movement in the context of the movements of planets/stars, and (sub-) atomic particles
It was also interesting too, that a centripetal force occured, which acted on the particles 130 times stronger than the gravity force. Among other things, Ehrenhaft's comment on this experiment was

„*Es ist unwahrscheinlich, daß alle diese Bewegungsphenomene im Licht mit oder ohne Einwirkung eines Feldes erklärt werden können mit Hilfe heutiger Hypothesen; wir werden vielleicht gezwungen, nach Neuem zu greifen*"

(AIO) p. 223: *W. Schauberger hat diesen Versuch so gedeutet:*

Jedes Energieteilchen in Bewegung erzeugt ein Feld – einen Energieraum -, der von der Bewegung abhängig ist, und je dichter dieses Feld ist, desto mehr wirkt es auf die Umgebung ein, sodaß auch Teilchen mit größerer Masse

als die felderzeugenden Teilchen in dieses Feld hineingezogen werden. Diese Teilchen aus Silver, Nickel oder Kohle müssen im Verhältnis zu den Lichtphotonen wie riesige Felsblöcke gewesen sein. Dennoch wurden sie in den Wirbeltanz der Photone hineingezogen. Wir müssen also lernen, Medien, die zur Verfügung stehen, in so eine Bewegung zu bringen, wie sie Elektronen und Photonen anzuwenden pflegen. … dann können wir auch mit einem relativ kleinen Energieeinsatz „Berge versetzen".

Kurz gesagt, Ehrenhafts Versuche deuten darauf hin, daß das Grundelement der Natur sich mittels mittels Schraubenbewegung bewegt und, wie V. Schauberger meinte, daß die Technik diese kopieren sollte.

(EhF) p. 243: *„In order to explain the phenomena of photophoresis one conclusion is drawn from the movement of illuminated particles in the homogeneous electric and magnetic fields. The light induces electric and magnetic charges (poles) upon the particles if they are illuminated by concentrated light preponderantly shorter wave lengths. …. For the magnetic charges this conclusion is new, but is justified because of the complete analogy of this phenomenon with the electric phenomenon"*

(EhF1)*: „…. light beams must have electric stationary components in the direction of the wave front normal, and that consequently there must be stationary electric potential differences between different points along the beam; and that there must be also a stationary magnetic field in the beam of light with potential differences. Hence, the light beam must have a magnetizing effect, and the charge of a magnet should be changed by light"*

Einstein A.
Mein Weltbild (EiA)
The World as I See it (EiA1)
Lichtgeschwindigkeit und die Statik des Gravitationsfeldes, (EiA2)

(EiA1) p. 19: Religion and Science
„Everything that the human race has done and thought is concerned with the satisfaction of felt needs and the assuagement of pain. One has to keep this constantly in mind if one wishes to understand spiritual movements and their development. Feeling and desire are the motive forces behind all human endeavour and human creation, in however exalted a guise the latter may present itself to us. Now what are the feelings and needs that have led men to religious thought and belief in the widest sense of the words? A little consideration will suffice to show us that the most varying emotions preside over the birth of religious thought and experience. With primitive man it is above all fear that evokes religious notions--fear of hunger, wild beasts, sickness, death. Since at this stage of existence understanding of causal connexions is usually poorly developed, the human mind creates for itself more or less analogous beings on whose wills and actions these fearful happenings depend. One's object now is to secure the favour of these beings by carrying out actions and offering sacrifices which, according to the tradition handed down from generation to generation, propitiate them or make them well disposed towards a mortal. I am speaking now of the religion of fear. This, though not created, is in an important degree stabilized by the formation of a special priestly caste which sets up as a mediator between the people and the beings they fear, and erects a hegemony on this basis. In many cases the leader or ruler whose position depends on other factors, or a privileged class, combines priestly functions with its secular authority in order to make the latter more secure; or the political rulers and the priestly caste make common cause in their own interests.
The social feelings are another source of the crystallization of religion. Fathers and mothers and the leaders of larger human communities are mortal and fallible. The desire for guidance, love, and support prompts men to form the social or moral conception of God. This is the God of Providence who protects, disposes, rewards, and punishes, the God who, according to the width of the believer's outlook, loves and cherishes the life of the tribe or of the human race, or even life as such, the comforter in sorrow and unsatisfied longing, who preserves the souls of the dead. This is the social or moral conception of God.

The Jewish scriptures admirably illustrate the development from the religion of fear to moral religion, which is continued in the New Testament. The religions of all civilized peoples, especially the peoples of the Orient, are primarily moral religions. The development from a religion of fear to moral religion is a great step in a nation's life. That primitive religions are based entirely on fear and the religions of civilized peoples purely on morality is a prejudice against which we must be on our guard. The truth is that they are all intermediate types, with this reservation, that on the higher levels of social life the religion of morality predominates.

Common to all these types is the anthropomorphic character of their conception of God. Only individuals of exceptional endowments and exceptionally high-minded communities, as a general rule, get in any real sense beyond this level. But there is a third state of religious experience which belongs to all of them, even though it is rarely found in a pure form, and which I will call cosmic religious feeling. It is very difficult to explain this feeling to anyone who is entirely without it, especially as there is no anthropomorphic conception of God corresponding to it.

The individual feels the nothingness of human desires and aims and the sublimity and marvellous order which reveal themselves both in nature and in the world of thought. He looks upon individual existence as a sort of prison and wants to experience the universe as a single significant whole. The beginnings of cosmic religious feeling already appear in earlier stages of development--e.g., in many of the Psalms of David and in some of the Prophets. Buddhism, as we have learnt from the wonderful writings of Schopenhauer especially, contains a much stronger element of it.

The religious geniuses of all ages have been distinguished by this kind of religious feeling, which knows no dogma and no God conceived in man's image; so that there can be no Church whose central teachings are based on it. Hence it is precisely among the heretics of every age that we find men who were filled with the highest kind of religious feeling and were in many cases regarded by their contemporaries as Atheists, sometimes also as saints. Looked at in this light, men like Democritus, Francis of Assisi, and Spinoza are closely akin to one another.

How can cosmic religious feeling be communicated from one person to another, if it can give rise to no definite notion of a God and no theology? In my view, it is the most important function of art and science to awaken this feeling and keep it alive in those who are capable of it.

We thus arrive at a conception of the relation of science to religion very different from the usual one. When one views the matter historically one is inclined to look upon science and religion as irreconcilable antagonists, and for a very obvious reason. The man who is thoroughly convinced of the universal operation of the law of causation cannot for a moment entertain the idea of a being who interferes in the course of events--that is, if he takes the hypothesis of causality really seriously. He has no use for the religion of fear and equally little for social or moral religion. A God who rewards and punishes is inconceivable to him for the simple reason that a man's actions are determined by necessity, external and internal, so that in God's eyes he cannot be responsible, any more than an inanimate object is responsible for the motions it goes through. Hence science has been charged with undermining morality, but the charge is unjust. A man's ethical behaviour should be based effectually on sympathy, education, and social ties; no religious basis is necessary. Man would indeed be in a poor way if he had to be restrained by fear and punishment and hope of reward after death.

It is therefore easy to see why the Churches have always fought science and persecuted its devotees. On the other hand, I maintain that cosmic religious feeling is the strongest and noblest incitement to scientific research. Only those who realize the immense efforts and, above all, the devotion which pioneer work in theoretical science demands, can grasp the strength of the emotion out of which alone such work, remote as it is from the immediate realities of life, can issue. What a deep conviction of the rationality of the universe and what a yearning to understand, were it but a feeble reflection of the mind revealed in this world, Kepler and Newton must have had to enable them to spend years of solitary labour in disentangling the principles of celestial mechanics! Those whose acquaintance with scientific research is derived chiefly from its practical results easily develop a completely false notion of the mentality of the men who, surrounded by a sceptical world, have shown the way to those like-minded with themselves, scattered through the earth and the centuries. Only one who has devoted his life to similar ends can have a vivid realization of what has inspired these men and given them the strength to remain true to their purpose in spite of countless failures. It is cosmic religious feeling that gives a man strength of this sort. A contemporary has said, not unjustly, that in this materialistic age of ours the serious scientific workers are the only profoundly religious people."

(UnA) p. 217*: „In a reasonable theory there are no numbers which can be only determined empirically"*

(EiA) S.130: *"Nach unserer bisherigen Erfahrung sind wir nämlich zum Vertrauen berechtigt, daß die Natur die Realisierung des mathematisch denkbar Einfachsten ist. Durch rein mathematische Konstruktion vermögen wir nach meiner Überzeugung diejenigen Begriffe und diejenige gesetzliche Verknüpfung zwischen ihnen zu finden, die den Schlüssel für das Verstehen der Naturerscheinungen liefern. Die brauchbaren mathematischen Begriffe*

können durch Erfahrung wohl nahegelegt, aber keinesfalls aus ihr abgeleitet werden. Erfahrung bleibt natürlich das einzige Kriterium der Brauchbarkeit einer mathematischen Konstruktion für die Physik. Das eigentlich schöpferische Prinzip liegt aber in der Mathematik. In einem gewissen Sinn halte ich es also für wahr, daß dem reinen Denken das Erfassen des Wirklichen möglich sei, wie es die Alten geträumt haben"

(EiA) S.131 *„... daß all diese Bildungen und deren gesetzliche Verknüpfungen sich nach dem Prinzip des Aufsuchens der mathematisch einfachsten Begriffe und deren Verknüpfungen gewinnen lassen"*

(EiA2) S. 368 *„Damit ist also erwiesen, daß man auch für unendlich kleine Raum-Zeitgebiete nicht an der Lorentztransformation festhalten kann, sobald man die universelle Konstanz von c aufgibt"*

„The principle of the constancy of the speed of light can be maintained only by restricting to space-time regions with a constant gravitational potential"

Einstein A.
The meaning of relativity

(EiA4) p. 24: „Maxwell's equations determine the electromagnetic field when the distribution of electric charges and currents is known. But we do not know the laws which govern the currents and charges. We do know, indeed, that electricity consists of elementary particles (electrons, positive nuclei), but from a theoretical point of view we cannot comprehend this. We do not know the energy factors which determine the distribution of electricity in particles of definite size and charge, and all attempts to complete the theory in this direction have failed. If then we can build upon Maxwell's equations at all, the energy tensor of the electromagnetic field is known only outside the charged particles [*]

[*] *It has been attempted to remedy this lack of knowledge by considering the charged particles as proper singularities. But in my opinion this means giving up a real understanding of the structure of matter. It seems to me much better to admit our present inability rather than to be satisfied by a solution that is only apparent.*

Einstein A.
Ether and the theory of relativity

(EiA5): *„Lorentz succeeded in reducing all electromagneitc happenings to Maxwell's equations for free space.*

As to the mechanical nature of the Lorentzian ether, it may be said of it, in a somewhat playful spirit, that immobility is the only mechanical property of which it has not been deprived by H. A. Lorentz. It may be added that the whole change in the conception of the ether which the special theory of relativity brought about, consisted in taking away from the ether its last mechanical quality, namely, its immobility. …

Generalizing we must say this: -- There may be supposed to be extended physical objects to which the idea of motion cannot be applied. They may not be thought of as consisting of particles which allow themselves to be separately tracked through time. In Minkowski's idiom this is expressed as follows: -- Not every extended conformation in the four-dimensional world can be regarded as composed of world-threads. The special theory of relativity forbids us to assume the ether to consist of particles obserbale through time, but the hypothesis of ether in itself is not in conflict with the special theory of relativity. Only we must be our guard against ascribing a state of motion to the ether"

Euler L.
The division of the truths within the boundaries of human cognition into
the truths of experience, reason, and believe

(HiS1) S. 15, 23: *„Die Vermischung (mixing) von Vernunft- (reason) und Erfahrungswahrheiten (experience) ist schon älteren Datums und liefert immer wieder Anlaß zu Streitigkeiten (disput) zwischen Mathematikern und Physikern. Ein prominentes Beispiel liefert das sogenannte Dirichletsche Prinzip, das später an Hand des isoperimetrischen Problems näher erläutert werden soll. Dieses Beweisprinzip ist deshalb in die Geschichte der Mathematik eingegangen, weil hier im vorigen Jahrhundert die Begriffe Minimum und kleinste untere Schranke verwechselt wurden, die heute jeder Mathematik- und Physikstudent schon in den ersten Vorlesungsstunden*

auseinanderzuhalten gelernt hat. Nachdem Weierstraß diesen Fehler, der selbst Gauß, Dirichlet und Riemann unterlaufen war, aufgedeckt und kritisiert hatte, wurde von Mathematikern anerkannt, daß es in jedem speziellen Fall nötig sei, die Existenz eines Minimums zu beweisen Physiker hingegen meinten, die Existenzfrage erledige sich durch „Evidenz"."

Fermi E.
Quantum Theory for Radiation

(FeE): *„Dirac's theory of radiation is based on a very simple idea; instead of considering an atom and the radiation field with which it interacts as two distinct systems, he treats them as a single system whose energy is the sum of three terms: one representing the energy of the atom, a second representating the electromagnetic energy of the radiation field, and a small term representing the coupling energy of the atom and the radiation field.*

If we neglect this last term, the atom and the field could not affect each other in any way; that is, no radiation energy could be either emitted or absorbed by the atom. A very simple example will explain these relations. Let us consider a pendulum which corresponds to the atom, and an oscillating string in the neighborhood of the pendulum which represents the radiation field. If there is no connection between the pendulum and the string, the two systems vibrate quite independently of each other; the energy is in this case simply the sum of the energy of the pendulum and the energy of the string with no interaction term. To obtain a mechanical representation of this term, let us tie the mass M of the pendulum to a point A of the string by means of a very thin and elastic thread α. The effect of this thread is to perturb slightly the motion of the string and of the pendulum. Let us suppose for instance that at the time $t = 0$, the string is in vibration and the pendulum is at rest. Through the elastic thread a the oscillating string transmits to the pendulum very slight forces having the same periods as the vibrations of the string. If these periods are different from the period of the pendulum, the amplitude of its vibrations remains always exceedingly small; but if a period of the string is equal to the period of the pendulum, there is resonance and the amplitude of vibration of the pendulum becomes considerable after a certain time. This process corresponds to the absorption of radiation by the atom. If we suppose, on the contrary, that at the time $t = 0$ the pendulum is oscillating and the string is at rest, the inverse phenomenon occurs. The forces transmitted through the elastic thread from the pendulum to the string put the string in vibration; but only the harmonics of the string, whose frequencies are very near the frequency of the pendulum reach a considerable amplitude. This process corresponds to the emission of radiation by the atom"

Feynman R.

(GlJ) p. 433:

> *„When a historian of particle physics pressed him (R. Feynman) on the question of unification, he resited.*
> *„Your career spans the period of the construction of the standard model," the interviewer said.*
> *„'The standard model'" Feynman repeated dubiously.*
> *"$SU(3) \times SU(2) \times U(1)$. From renormalization (*), to quantum electrodynamics to now?"*
> *„The standard model, standard model," Feynman said. „The standard model ---- is that the one that says that we have electrodynamics, we have weak interaction, and we have strong interaction? Okay, Yes."*
> *The interviewer said, „That was quite an achievement, putting them together."*
> *„They're not put together."*
> *„Linked together in a single theoretical package?"*
> *„No."*
> *The interviewer was having trouble getting his question onto the table.*
> *„What do you call $SU(3) \times SU(2) \times U(1)$?"*
> *„Three theories," Feynman said. „Strong interactions, weak interactions, and electromagnetic … The theories are linked because they seem to have similar characteristics … Where does it go together? Only if you add some stuff that we don't know. There isn't any theory today that has $SU(3) \times SU(2) \times U(1)$ --- whatever the hell it is --- that we know is right, that has experimental*

check … Now, these guys are all trying to put all this together. They're trying to. But they haven't. Okay?"

„Somebody makes up a theory: The proton is unstable. They make a calculation and find that there would be no protons in the universe any more! So they fiddle around with their numbers, putting higher mass into the new particle, and after much effort they predict that the proton will decay at a rate slightly less than the last measured rate the proton has shown not to decay at. When a new experiment comes along and measures the proton more carefully, the theories adjust themselves to squeeze out from the pressure", (UnA) p. 162

„Diejenigen, die die Mathematik nicht verstehen, werden kaum zu den tiefen Schönheiten der Natur vordringen können. Die Physiker können sich keiner anderen Sprache bedienen und wenn man mehr über die Natur lernen will, muß man die Sprache verstehen lernen, die sie spricht", (SpK) S. 3

Gödel K.
A new type of cosmological solutions of the gravity field equations

(GöK): *„All cosmological solutions with non-vanishing density of matter known at present have the common property that, in a certain sense, they contain an „absolute" time coordinate, owing to the fact that there exists a one-parametric system of three-spaces everywhere orthogonal on the world lines of matter. It is easily seen that the non-existence of such a system of three-spaces is equivalent with a rotation of matter relatively to the compass of inertia. In this paper I am proposing a solution (with a cosmological term $\neq 0$) which exhibits such a rotation. This solution, or rather the four-dimensional space S which it defines, has the further properties*

(1) *S is homogeneous*

(2) *…. so that any two world lines of matter are equidistant*

(3) *S has rotational symmetry*

(4) *… That is, a positive direction of time can consistently be introduced in the whole solution*

(5) *It is not possible to assign a time coordinate to each space-time point in such a way that the coordinate always increases, if one moves in a positive time-like direction; …*

(6) *… it is theoretically possible in these worlds to travel into the past, or otherwise influence the past*

(7) *There exist no three-spaces which are everywhere space-like and intersect each world line of matter in one point*

(8) *… an absolute time does not exist, even if it is not required to agree in direction with the times of all possible observers (where absolute means: definable without reference to individual objects, such as e.g. a particular galactic system).*

(9) *Matter everywhere rotates relatively to the compass of inertia with the angular velocity $2\sqrt{\pi\mu\rho}$, where ρ is the mean density of matter and μ Newton's gravitational constant."*

Hawking S. W.
A Brief History of Time
Elementary Particles and the Forces of Nature

„All known particles in the universe can be divided into two groups: particles of spin ½, which make up the matter in the universe, and particles of spin 0, 1, and 2, which give rise to forces between matter particles".

"A particle of spin 0 is like a dot: it looks the same from every direction. A particle of spin 1 is like an arrow: it looks different from different directions. Only if one turns it round a complete revolution (360 degrees) does the particle look the same. A particle of spin 2 is like a double-headed arrow: it looks the same if one turns it round half a revolution (180 degrees). Similarly, higher spin particles look the same if one turns them through smaller fractions of a complete revolution. ... there are particles that do not look the same if one turns them through just one revolution: one has to turn them through two revolutions! Such particles are said to have spin 1/2."

„The matter particles obey what is called Pauli's exclusion principle. … It says that two similar particles cannot exist in the same state; that is, they cannot have both the same position and the same velocity, within the limits given by the uncertainty principle. The exclusion principle is crucial because it explains why matter particles do not collapse to a state of very high density under the influence of the forces produced by the particles of spin 0, 1, and 2; if the matter particles have very nearly the same positions, they must hve different velocities, which means that they will not stay in the same position any longer. If the world had been created without the exclusion principle, quarks would not form separate, well-defined protons and neutrons. Nor would these, to gether with electrons, form separate, well-defined atoms. They would all collapse to form a roughly uniform, dense „soup"".

Hawking S. W.
The theory of everything
Open questions

(HaS) p. 77: *„This picture of a universe that started off very hot and cooled as it expanded is in agreement with all the observational evidence that we have today. Nevertheless, it leaves a number of important questions unanswered.*

First, why was the universe so hot?
Second, why is the universe so uniform on a large scale – why does it look the same at all points of space and in all directions?

Third, why did the universe start out so nearly the critical rate of expansion to just avoid recollapse? If the rate of expansion one second after the big bang had been smaller by even one part in a hundred thousand million million, the universe would have recollaped before it ever reached ist present size. On the other hand, if the expansion rate at one second had been larger by the same amount, the universe would have expanded so much that it would be effectively empty now.

Fourth, despite the fact the universe is so uniform and homogenous on a large scale, it contains local lumps such as stars and galaxies. These are thought to have developed from small differences in the density of the early universe from one region to another. What was the origin of these density fluctuations?

The general theory of relativity, on its own, cannot explain these features or answer these questions. This is because it predicts that the universe started off with infinite density at the big bang singularity. At the singularity, general relativity and all other physical laws would break down. One cannot predict what would come out of the singularity"

Heidegger M.
The Age of the World Picture

"modern physics is called mathematical because, in a remarkable way, it makes use of a quite specific mathematics. But it can proceed mathematically in this way only because, in a deeper sense, it is already itself mathematical"

Heidegger M.
Mathematical physical science

(HeM): *(69): „In metaphysics reflection is accomplished concerning the essence of what is and a decision takes place regarding the essence of truth. Metaphysics grounds an age, in that through a specific interpretation of what is and through a specific comprehension of truth it gives to that age the basis upon which it is essentially formed. This basis holds complete dominion over all the phenomena that distinguish the age. Conversely, in order that there may be an adequate reflection upon these phenomena themselves, the metaphysical basis for them must let itself be apprehended in them. Reflection is the courage to make the truth of our own presuppositions and the realm of our own goals into the things that most deserve to be called in question."*

(72) „Modern physics is called mathematical because, in a remarkable way, it makes use of a quite specific mathematics. But it can proceed mathematically in this way only because, in a deeper sense, it is already itself mathematical."

(73): *„The rigor of mathematical physical science is exactitude. Here all events, if they are to enter at all into representation as events of nature, must be defined beforehand as spatiotemporal magnitudes of motion. Such defining is accomplished through measuring, with the help of number and calculation. But mathematical research into nature is not exact because it calculates with precision; rather it must calculate in this way because its adherence to its object-sphere has the character of exactitude. The humanistic sciences, in contrast, indeed all the sciences concerned with life, must necessarily be inexact just in order to remain rigorous. A living thing can indeed also be grasped as spatiotemporal magnitude of motion, but then it is no longer apprehended as living. The inexactitude of the historical humanistic sciences is not a deficiency, but is only the fulfillment of a demand essential to this type of research. It is true, also, that the projecting and securing of the object-sphere of the historical sciences is not only of another kind, but is much more difficult of execution than is the achieving of rigor in the exact sciences."*

(HeM) Heidegger M., The Age of the World Picture, Cambridge University Press

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Heisenberg W.
The degeneracy of the ground state seeming to be closely
connected with the existence of long-range forces

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(HeW) vi*: „The mathematical formalism contains some unconventional features which formerly have redered its understanding somewhat difficult: the indefinite metric in Hilbert space and the degeracy of the ground state. But in recent years the indefinite metric has been studied in connexion with the Bleuler-Gupta version of quantum electrodynamics and with the Lee-model, the degeneracy of the ground state plays an important part in modern solid state physics"*

(HeW) p. 90*: „In fact the number of protons in the world seems to be very different from the number of neutrons, the number of electrons is very different from the number of neutrinos. Even the matter and antimatter should be distributed in the universe with equal average density – many galaxies might be consist of matter, equally many of antimatter – and if total isospin should be small in this way, the big asymmetry would remain, since in matter the total isospin would point in one direction, in antimatter in the opposite direction. Hence there would be a macroscopic deviation from symmetry in isospace.*

An asymmetry of the ground state and therefore a degeneracy of this state is a well-known phenomenon in many systems discussed in conventional quantum mechanics. Ferromagnetism, superfluidity, superconductivity, crystal structure are obvious examples. In such cases two important new phenomena appear ….: The degeneracy of the ground state enforces the existence of bosons of rest mass zero, as has been pointed out in a mathematical form by Goldstone (the Goldstone theorem). Some property of the ground state can be attached to the particles thereby changing normal particles into strange particles."

(HeW) p. 108: *„The asymmetry of the ground state with respect to the isospin group has been used in chapter 7 as explanation for the strange particle poles in the Green's functions and as basis for the spurion formalism. … It has been emphasized already in earlier papers on this subject, that empirically the asymmetry of the ground state seems to be closely connected with the existence of long-range forces, i.e. of particles with rest mass zero, (DuH). The asymmetry with respect to the isospin group comes in through the long-range forces of electrodynamics, the asymmetry of with respect to the the space reflection parity appears in the weak interactions, and this is the first interaction which affects neutrinos. It can be well understood that short-range forces allow a clear separation of the particles from the rest of the world, while long-range forces may lead to a dependence of the properties of the particles on the state of the world in large dimensions. This connexion has been found a mathematical expression in the theorem of Goldstone. .. In the present theory the Goldstone theorem is the basis for an understanding of quantum electrodymamics"*

Helmholtz H.
Atome der Elektrizität

(ScW) S. 2: „*Wenn wir Atome der chemischen Elemente annehmen, so können wir nicht umhin, weiter zu schließen, daß auch die Elektrizität positiv sowohl wie negativ in bestimmte elementare Quanta geteilt ist, die sich wie Atome der Elektrizität verhalten*".

Hildebrandt S.
Calculus of variations
The link between mathematics and physics

(HiS) X: „*The Greek word mathema – which means knowledge, cognition, understandaing, perception – suggests that the study of mathematics about 3000 years ago with asking questions about the world.The historical sections of our account show that a large part of the development of mathematics was the result of a desire to comprehend nature. Mathematics, however, is more than the handmaiden of other sciences. It is, as C. F. Gauss stated, irrelevant whether one applies mathematical knowledge to number theory or to the movement of a lump of matter such as a planet.*

(HiS) p. 17: Our goal will be to find an easy-to-understand link between mathematics and physics. The mathematical theory that provides this link is called the calculus of variations."
The Euler-Lagrange equations

(HiS) 29 ff.: *The mathematical (indispensible for physics) „principle of the horizontal tangent plane"*

> Question*: how, in principle, you can locate the summits in a mountainous area in the dark equipped with only a small flashlight and a level?*
> Answer*: „by employing the idea of the horizontal tangent.*

This is how the mathematician locates maxima and minima, by first reducing the questions of best and worst to a geometric question of finding summits or pits in some mathematically constructed mountain range. However these are usually not mountains in a three dimensional world, but a „higher-dimensional" space. … The mathematician uses a strategy to focus attention on a small number of points suspected to be maxima (peaks) or minima (pits). This procedure is similar to that of a detective, who uses all available circumstantial evidence to reduce the number of suspects who might have committed a crime.

From the „principle of the horizontal tangent plane" the mathematician establishes a system of differential equations (called the Euler-Lagrange equations)"

The geometric description of minimal surfaces

(HiS) P. 166: „*Now we can discuss the theorem of Lagrange in which he stated the minimal-surface equation. This theorem will provide the geometric characterization of least-area surfaces that we are seeking:*

> *At each regular point, as surface of minimal area must have a mean curvature of zero.*

That is, the surfaces of minimal area satisfy the equation $H := \frac{\kappa_1 + \kappa_2}{2} = 0$, κ_1, κ_2 denote the largest and smallest (principle) curvatures that a normal section at point P can have defining the mean curvature H, and the Gaussian curvature $K = \kappa_1 \cdot \kappa_2$."

(HiS) p. 241: „*Planets, rotating drops, and the nuclei of atoms*
Three (other) phenomena can be explained by a single variational principle founded by Bernoulli's principle of virtual work. These phenomena belong to the filds of astronomy, hydrodynamics, and neclear physics, which, at first sight, do not seem to have very much in common. Specifically, we will consider rotating and self-gravitating liquid masses of homogeneous density, then rotating liquid drops endowed with surface tension, and finally the nuclei of atoms with or without an angular momentum."

(HiS) p. 262: „*The geometry of crystals*
Among the most-admired forms in nature are those of crystalline structures. … A natural question to ask is whether the shapes of crystals can be explained by variational principle. …

We then ask for the structure or shape that, for a fixed volume, has a minimum toal surface energy. .. G. Wulff's discovery is that, given some further reasonable assumptions about the mathematical character of the surface energy, the following holds:

> *For every given volume, there is a unique convex body whose boundary consists of planar faces,*
> *such that this boundary surface has less energy than does the boundary surface of any other*
> *piecewise smooth body of the same volume.*

This theorem is remarkable in two ways. First, there is an infinite number of possible surface energies; nevertheless, for each such admissible energy, the unique minimum is a convex region bounded by planes. Second, unlike most problems in mathematics in which explicit solutions are impossible to find, the solution to our minimum problem, the optimal crystalline region, can be determined by a simple procedure known as the Wulff construction.

Maupertius' principle, calculus of variations,
and Newton's dynamics

(HiS) p. 279 ff.: „*In the Principia, the entire program of modern mechanics is formulated, not only in content but also in style. Newton began like a mathematician by first giving definitions of the basic notions, such as mass and momentum, and then formulated three basic laws or axioms from which everything else was to follow:*

> *First law: Every body remains in its state of rest or uniform motion in the same direction unless*
> *it is compelled by impressed forces to change this state*
> *Second law: The change in motion is proportional to the impressed moving force and, secondly,*
> *it will occur along the straight line in which that force is impressed.*
> *Third law: To an action there is always an equal and opposite reaction, or, the mutual actions*
> *of two bodies upon each other are equal and point in opposite directions.*

… The three laws are only the formal framework of dynamics and do not say anything about the nature of the acting forces. In fact, the second law has occasionally been considered tautogical. If we want to apply the dynamical laws to concrete cases, we must specify the acting forces. Attraction is one of the basic forces, and Newton stated how this force acts:

Every particle of matter attracts every other particle with a force proportional to the mass of each, and inversely proportional to the square of the distance between them.

This is known as Newton's universal law of gravitation. (Actually, Newton never formulated the law in this general form; instead he gave different versions in different places, which have been combined into the preceding statement). He named the attractive force of mass gravitas, meaning heaviless or weight. Today we speak of gravity or gravitation.

Hence the gravitation law expresses the difference between mass and weight: a body's mass is independent of its location in space; but if it is placed in a field of gravitation, it experiences weight caused by gravitation. Theoretically, gravitation exists everywhere, but, in practice, the gravitational effect of one body on another is zero if they are far enough apart."

(HIS) p. 286 ff.: „*A faily precise version of this principle, as currently accepted, for the simplest case, that of the motion of a single point-mass is the following:*

Consider a point-mass m that moves from time t_1 and t_2 in a field of conservative forces, such as gravitation. At each point in a force field, a force of a given magnitide and direction acts on each point-mass m moving in a field according to Newton's second law:

$$F = m \cdot a.$$

A field of forces F is conservative, if it posseses a potential energy U. This is a rule that attaches a numerical value $U(P)$ to each point P in space, in such a way that the „negative gradient" of these values U at P equals the force F at P. This means the following:

Suppose the function U describes a landscape in a four-dimensional world above the three-dimensional space. Let us now consider a point P in space and the point P^* on the energy landscpae above P. If P^* is not a stationary point on the mountain range, we can find a direction in the three-dimensional space at P that indicates the direction of steepest ascent of the landscape at the point P^* above P; opposite to it, we have the direction of steepest descent of the function U. Let us attach an arrow to P, pointing in either one of these two directions, whose size equal the rate of change of U on corresponding direction. In this way, we define two vectors whose feet lie at P. The direction of steepest ascent defines the „gradient (vector) of U," dnotes by $gradU$, and the vector pinting in the opposite direction defines the „negative gradient"," which is the arrow opposite to $gradU$ and therefore is denoted by $-gradU$.

If P^* is a stationary point, say, the top of a mountain, then the function U has a maximum at P, and there is neither a direction of strongest ascent nor one of strongest descent (this expresses the feeling that, on top of a mountain, the ground is practically horizontal, without ascent or descent). Therefore we set $gradU$ and $-gradU$ equal to zero at a stationary point.

Then our assumption that F is a conservative field of forces with the potential energy U is expressed by the equation
$$F = -gradU$$

which is to hold at each point of space.

Suppose now that the point-mass m moves with some velocity of absolute value v through space. Since v can change in time, it has to be considered as a function of the time t. Then we can define the kinetic energy T of the point-mass at each instant of time by

$$T = \frac{m}{2} v^2.$$

The expression
$$E = T + U$$

is called the total energy of the point-mass at each instant.

With some infinitesimal calculus, we can prove from the equations and that the total energy E is a constant; in other words, a point-mass in a conservative field of forces moves in such a way that ist total energy has a numerical value h that is the same at each instant. This is the law of the conservation of energy, and it is expressed by the equation $E = h$.

This law explains the term conservative to a field of forces. We look at two important cases of conservative fields of forces.

The first one is the gravitational field on the surface of the Earth, where one considers the problem of the trajectory of a stone thrown in the air. Here it is assumed that the force of attraction is the same size at each point and that it always points perpendiculary towards the surface of the Earth, which for simplicity is supposed to be a plan. The potential energy U of this field of forces is a linear function of the height h above the ground, and it increases with increasing height. This is described by the rule

$$U(P) = mgh + c.$$

Here m is the mass of the point moving in the gravitational field, c is an arbitrarily chosen gauge constant, and g is a given positive constant that, according to measurements, has a value of approximately $9.81 \ m/sec^2$.

Another model is the gravitational field of a large mass M, which rests at some fixed point Q and attracts some point-mass m that moves around Q. The potential energy $U(P)$ of this field at some point P is given by the expression

$$U(P) = -\frac{GmM}{r} + c,$$

where $r = \overline{PQ}$ is the distance of P from the center Q, G is Newton's gravitation constant, which has, with great precision, been measured by experiments, and c is a number that can be chosen arbitrarily.

The action A performed by a point-mass during its motion between times t_1 and t_2 is defined by the integral

$$A = \int_{t_1}^{t_2} 2T dt.$$

Suppose now that the point-mass m moves under the influence of a conservative field of forces. What distinguishes the actual motion from all the other motions that, in principle, were possible but actually do not occur?

According to Newton, the actual motion can be determined from the equation $F = ma$ provided that its initial data are known. There is also another way to determine the true motion which is conceptually totally different from the first.

According to Maupertuis, the acutal motion of the point-mass m from P_1 to P_2 under the influence of the force field $F = -gradU$ is distinguished among all the other motions by the property that it provides a stationary value for the action A. Actually, here we have replaced Maupertuis's minimum principle.

Seek a motion that minimizes A,

with the following somewhat weaker requirement:

Seek a motion that is stationary for A.

But, as it stands, this principle is pure nonsense, because the acting forces do not appear anywhere in the expression for A. The correct statement would be that we do not need to seek a stationary value for A among all motions from P_1 to P_2, but only amoung those which at each instant have the same constant total energy E, say $E = E_0$ as the actual motion. (We need to know the actual motion to compute the energy constant E_0; it can, for instance, be obtained from the initial data or from any other complete set of data.)

There is one more complication: in general it is not possible to get from a given point P_1 to another point P_2 by means of a motion of fixed total energy if we prescribe the initial time t_1 and the final time t_2. Therefore, the demand to minimize the value of action amoung all possible motions of the point-mass from P_1 to P_2 which have the same total energy point P_1 to another point E, the same initital time t_1, and the same final time t_2, does not make sense, since there might be not any suchmotion. The way out of this dilemma is to minimize action amoug all possible (or virtual) motions from P_1 to P_2 of fixed total energy, for which neither the time of departure nor the time of arrival is fixed.

In this form, the action principle turns out to be correct, but often it is not easy to handle. Therefore, we shall state another version, which was devised by Lagrange.

First, we define P_1 to $L = T - U$, the so-called Lagrangian *or action density; it is the difference between kinetic and potential energy. We can then infer from $E = T + U$ that $2T = L + E$, and thus we find for the moions with a constant total energy of the value E_0 that*

$$2T = L + E_0.$$

Now we consider the areas under the graps of two functions $2T$ and $L + E_0$ between two t −values t_1 and t_2. AS the two graphs coincide, we infer that

$$\int_{t_1}^{t_2} 2T dt = \int_{t_1}^{t_2}(L + E_0)dt = \int_{t_1}^{t_2} L dt + \int_{t_1}^{t_2} E_0 dt.$$

The *integral on the left-hand side is the action integral A, while the integral $\int_{t_1}^{t_2} E_0 dt$ is the are area of a rectangle of the height E_0 above the t-axis which has the interval between t_1 and t_2 on the t-axis as one of its edges. Therefore, this integral has the value $E_0(t_2 - t_1)$, and we obtain*

$$\int_{t_1}^{t_2} L dt = A + E_0(t_1 - t_2).$$

From this equation we guess correctly that the integral also can be used to formulate a variational principle for the actual motion from P_1 to P_2. This variational principle says:

If the actual motion begins at P_1 at time t_1, and ends at P_2 at time t_2, then it gives the integral $\int_{t_1}^{t_2} L dt$
 A stationary (and sometimes even a minimal) value, among all motion beginning at P_1 and ending at P_2 at the same time as the acutal motion.

The new features of this variational principle are that, contrary to the first one, no subsidary condition $E = E_0$ and no variation of the limits are needed! In other wrds, the virtual motions are not restricted to those with constant energy E, and we may fix t_1 and t_2. This makes the integral $\int \ \ L dt$ much easier to handle than $\int \ \ 2T dt$. In fact, the variational principle

$$\text{Seek a stationary motion for } \int_{t_1}^{t_2} L dt$$

is the form of the action principle that can easily be generalized to more difficult situations and to other physical problems.

Klainerman S.
The global nonlinear stability of the Minkowski space

(ChD) pp. 1, 10-13: „Einstein's field equations is about an unified theory of space-time and gravitations; the space-time (M, g) is the unknown, where M denotes a 4-dimensional manifold; one has to find an Einstein metric g, fulfilling the Einstein field equations. This is basically the equality $G = T$, whereby G denotes the Einstein tensor and T denotes the energy momentum tensor (e.g. the Maxwell equations). The Einstein-Vacuum equations (in the absense of matter, i.e. $T = 0$) are given by $R = 0$, whereby R denotes the Ricci tensor. Its simplest solution is the Minkowski space-time with its canonical coordinate system. Apart from Minkowski space-time it is not known, if there are any smooth, geodesically complete solution, which becomes flat at the infinity on any given spacelike direction. The main difficulties one encounters in the proof for the Cauchy Einstein-Vacuum equations with given initial data are:

> *(1) the problem of coordinates*

> *(2) the strongly nonlinear hyperbolic features of the Einstein equations.*

The problem of coordinates comes along with the concept of manifolds. To write the equations in a meaningful way, one seems forced to introduce coordinates. Such coordinates seem to be necessary even to allow the formulation of well-posed Cauchy problems and a proof of a local in time existence result. Nevertheless, as the particular case of wave coordinates illustrates, the coordinates may lead, in the large, to problems of their own"

Phenomenology
Logische Untersuchungen
(providing a new foundation for pure logic and epistemology)

(ZaD) S. 9: „*The fundamental mistake of psychologism is that it does not distinguish correctly between the object of knowledge and the act of knowing. Whereas the act is a psychical process that elapses in time and that has a beginning and an end, this does not hold true for the logical principles or mathematical truths that are known (Hua 24/141). When one speaks of a law of logic or refers to mathematical truths, to theories, principles, sentences, and proofs, one does not refer to a subjective experience with a temporal duration, but to something atemporal, objective, and eternally valid. Although the principles of logic are grasped and known by consciousness, we remain conscious of something ideal that is irreducible to and utterly different from the real psychical acts of knowing. This distinction between the ideal and real is so fundamental and urgent to Husserl, that in his criticism of psychologism he occasionally approaches a kind of (logical) Platonism: The validity of the ideal principles are independent of anything actually existing.2 No truth is a fact, i.e. something determined as to time. A truth can indeed have as its meaning that something is, that a state exists, that a change is going on etc. The truth itself is, however, raised above time: i.e. it makes no sense to attribute temporal being to it, nor to say that it arises or perishes (Hua 18/87 [109-110]). The truth that 2 + 3 = 5 stands all by itself as a pure truth whether there is a world, and this world with these actual things, or not (Hua 9/23).*"

The Lifeworld and the Crisis of Science

(ZaD) S. 126: „*According to Husserl's diagnosis, this crisis is a direct consequence of the objectivism that has dominated since the Scientific Revolution in the Renaissance, a revolution characterized by its quantitative ideal of method, its sharp distinction between facts and values, and its insistence that science and science only can describe reality as it is in itself. To quote Galileo, who, according to Husserl, personifies this entire enterprise:*

> Philosophy is written in this grand book, the universe, which stands continually open to our gaze. But the book cannot be understood unless one first learns to comprehend the language and read the letters in which it is composed. It is written in the language of mathematics, and its characters are triangles, circles, and other geometric figures without which it is humanly impossible to understand a single word of it; without these, one wanders about in a dark labyrinth.

According to Husserl, the only way to overcome the present scientific crisis and to heal the disastrous rupture between the world of science and the world of everyday life is by criticizing this reigning objectivism. This is why Husserl commences his analysis of the lifeworld, a lifeworld which, although it constitutes the historical and systematical foundation of science, has been forgotten and repressed by it."

(ZaD) S. 128: „*Husserl does acknowledge the validity of scientific theories and descriptions, and would even concede that they attain a higher degree of objectivity than our daily observations. But, as he repeatedly points out, we are faced with a faulty inference if against that background, we conclude that 1) only scientific accounts can capture true reality, or that 2) these accounts manage to grasp something which, in a very radical sense, is independent of our experiential and conceptual perspective. To think that science can give an absolute description of reality, that is, a description from a view from nowhere, is simply a misunderstanding. We must reject the assumption that physics is the sole arbiter of what there is, and that all notions to be taken seriously should be reducible to the vocabulary and the conceptual apparatus of the exact sciences.*
As Husserl points out, natural science by itself undermines the categorical distinction between the sensuously given and the physically described. After all, it does insist that it investigates the water I am drinking, or the diamond I am admiring, rather than a completely different object. It maintains that it is the true nature of the experienced object that it seeks to capture.

The physical thing which he [the physicist] observes, with which he experiments, which he continually sees, takes in his hand, puts on the scale or in the melting furnace: that physical thing, and no other, becomes the subject of the predicates ascribed in physics, such as weight, temperature, electrical resistance, and so forth (Hua3/ii3).

According to Husserl, physics does not present us with an entirely new physical object, but rather with a different, higher, and more exact objective determination of the very same object that we encounter in our daily life (Ms. A III 9 8b). In contrast to my own estimation of whether the water is warm or hot or whether it tastes

strange, a definition of water as H_2O is not only valid for me personally, but for all subjects. Even the most exact and abstract scientific results, however, are rooted in the intuitively given subject-relative evidence of the lifeworld—a form of evidence that does not merely function as an unavoidable, but otherwise irrelevant, way point toward scientific knowledge, but as a permanent and quite indispensable source of meaning and justification (Hua 6/142).

In its urge toward idealization, in its search for exact and objective knowledge, science has made a virtue out of its decisive showdown with subject-relative evidence, but it has thereby overlooked that its own more refined measurements inevitably continue to draw on the contribution of intuition, as when one sets up the experiment, reads the measuring instruments, or interprets, compares, and discusses the results with other scientists. We should not forget that empirical theories are based on experimental and experiential evidence (Hua 6/128). Although scientific theory in its idealization transcends the concrete, intuitively given lifeworld, the latter remains as a reference point and meaning-foundation (Hua 6/129)."

(Hua) Husserliana

Kant I.
The Critique of Teleological Judgement
Objective Purposiveness

(KaI) § 62: *On Merely Formal, as Distinguished from MaterIal, Objective Purposiveness*

(KaI) § 63: *On Relative* („material" as distinguished from „formal")*, as Distinguished from Intrinsic, Purposiveness of Nature*
„Only in one case does experience lead our power of judgment to the concept of a purposiveness that is both objective and material lor reali, i.e., to the concept of a purpose of nature-namely, when we have to judge a relation of cause to effect which is such that we can see it as law-governed only if we regard the cause's action as based on the idea of the effect, with this idea as the underlying condition under which the cause itself can produce that effect. We can do this in two ways: we may regard the effect either as directly the product of art, or as only the material that other possible natural beings employ in their art; in other words, we may regard the effect either as a purpose, or as a means that other causes employ purposively. The second purposiveness is called either usefulness (for human beings) or benefit (for any other creature), and this second purposiveness is merely relative, whereas the first is an intrinsic purposiveness of the natural being"

(KaI) § 64: *On the Character Peculiar to Things (Considered) as* („intrinsic" as distinguished from „relative") *Natural Purposes*

„To say that a thing is possible only as a purpose is to say that the causality that gave rise to it must be sought, not in the mechanism of nature, but in a cause whose ability to act is determined by concepts. And seeing that a thing is possible only as a purpose requires that the thing's form could not have arisen according to mere natural laws, laws we can cognize by understanding alone as applied to objects of sense, but requires that even empirical cognition of this form in terms of its cause and effect presupposes concepts of reason. [Thereforel the form of such a thing is, as far as reason is concerned, contingent in terms of all empiricallaws. But reason, even if it tries to gain insight only into the conditions attached to the production of a natural product, must always cognize not only the product's form but the form's necessity as well. And yet in that given form it cannot assume that necessity. Hence that very contingency of the thing's form is a basis for regarding the product as if it had come about through a causality that only reason can have. Such a causality would be the ability to act according to purposes (i.e., a will), and in presenting an object as possible only through such an ability we would be presenting it as possible only as a purpose.

Suppose that someone coming to a seemingly uninhabited country perceived a geometric figure, say a regular hexagon, traced in the sand. As he reflected on this figure, working out a concept for it, reason would make him aware, even if obscurely, of the unity of the principle [requiredJ for producing this concept. And so, following reason, he would not judge that such a figure is made possible by the sand, the adjoining sea, the wind, or even animals that leave footprints familiar to him. or by any other nonrational cause; for it would seem to him that coming across such a concept [a regular hexagon}, one that is possible only in reason, is so infinitely contingent that there might as well be no natural law for it at all, and hence that such an effect could also not have been

caused by anything in nature, which operates merely mechanically, but could have been caused only by the concept of such an object, a concept that only reason can provide and compare the object with. It would seem to him therefore that, although this effect [the figure] can be considered a purpose, it cannot be considered a natural purpose, but can be considered only a product of art (vestigium hominis video). …

If, on the other hand, we cognize something as a natural product and yet are to judge it to be a purpose, and hence a natural purpose -unless perhaps the very (thought) is contradictory-then we need more (than the above example provided). I would say, provisionally, that a thing exists as a natural purpose if it is both cause and effect of itself (although (of itself) in two different senses). For this involves a causality which is such that we cannot connect it with the mere concept of a nature without regarding nature as acting from a purpose; and even then, though we can think this causality, we cannot grasp it. Before we analyze this idea of a natural purpose in full, let me elucidate its meaning by the example of a tree. ….“

(KaI) *§ 65: Things (Considered) as Natural Purposes Are Organized Beings*
„*We said in the preceding section that if a thing is a natural product but yet we are to cognize it as possible only as a natural purpose, then it must have this character: it must relate to itself in such a way that it is both cause and effect of itself. But this description is not quite appropriate and determinate and still needs to be derived from a determinate concept.“*

Kneser A.
Das Prinzip der kleinsten Wirkung von Leibniz bis zur Gegenwart
The principle of least action from Leibniz until present (1928)

(KnA) p. 1: „*Die Leibnizsche Teleologie, die Vorstellung, daß der Weltverlauf ein Maximum des Guten gewähre, hat bei Leibniz selbst, abgesehen von anderen Anwendungen, den bestimmten Sinn, daß die Naturvorgänge aus Integralprinzipien nach der Methode des Größten und des Kleinsten abgeleitet werden können. Das bedeutet folgendes. Bei einem beliebig definierten, beliebigen Kräften unterworfenen Massensystem wird jeder in einer kleinen Zeit dt vor sich gehenden Bewegung durch besondere Definition ein Wirkungselement wdt zugeordnet. Betrachtet man nun die Bewegung in einem endlichen Zeitintervall, das durch Summierung der Elemente dt entsteht, so summieren sich die Elemente wdt zu einer Größe*

$$A = \int wdt \, ,$$

der Wirkung oder dem Aufwande von Wirkung für das betrachtete Intervall. Und nun besteht das Prinzip darin, daß, wenn man die wirkliche Bewegung mit gewissen fingierten, näher zu definierenden Nachbarbahnen, Nachbarbewegungen vergleicht, die Größe A bei bei ersterer, verglichen mit ihren Werten A' bei fingierten Bewegungen, ein Maximum oder Minimum wird; allgemeiner braucht auch nur die Differenz $A' - A$ im Verhältnis zu den Dimensionen der Abweichung der fingierten von der wirklichen Bahn klein zu sein; A braucht nur, wie schon Leibniz sagt, ein ausgezeichneter Wert zu sein. Natürlich sind alle hier ziemlich unbestimmt bezeichneten Größen und Operationen exakt mittels der Begriffe der Infinitesimalrechnung zu definieren.“

(KnA) p. 55: „*... so dürfen wir endgültig als Beziehung unseres Prinzips der zur Kantischen Urteilskraft feststellen: Das Prinzip der kleinsten Wirkung in seiner modernsten Allgemeinheit ist eine Maxime der reflektierenden Urteilskraft*“ [*]

[*] The Einstein field equations can be derived from the Einstein-Hilbert action by using the principle of least action

Kramers H. A.
Bohrs Komplementaritätsbegriff

(KrH) S. 4: „*So haben die Grenzen der Anwendungsmöglichkeit des klassischen Partikelbegriffs eine einfach Formulierung erhalten durch die Heisenbergsche Ungestimmtheitsrelationen, und die Eigenart der heutigen Quantentheorie wird in durchsichtiger Weise durch den von Bohr eingeführten Komplementaritätsbegriff aufgedeckt, nach dem Gesetzmässigkeiten, welche sich auf raumzeitliche Zusammenhänge, und diejenigen, die sich auf Energie- und Impulszusammenhänge beziehen (oder allgemeiner auf den kausalen Zusammenhang der Erscheinungen), sich komplementär zueinander verhalten, d.h. einander ausschließen, soweit es sich um ihre*

genaue quantitative Feststellbarkeit durch messende Beobachtung handelt. Der Kern dieser neuen Auffassungen liegt vor allem in einer Kritik des Beobachtungsbegriffes, und die früheren Schwierigkeiten hatten besonders ihren Grund darin, daß man sich durch Extrapolation der klassischen Begriffe ein Weltbild zu schaffen suchte, nach dem man widerspruchslos von einem „objektiven", wirklichen Geschehen in Raum und Zeit reden konnte. Die Diskussion der empirischen physikalischen Gesetze hat uns tatsächlich gelehrt, daß eine solche Extrapolation unerlaubt ist, daß vielmehr eine jedliche Messung mit einer objektiv nicht beschreibbaren, also – wenn man so will – irrationellen Wechselwirkung zwischen dem Beobachtungsapparat und dem Beobachteten behaftet ist."

Leedskalnin E.
Magnetic current is the same as electric current

(LeE) p. 31: *A magnetic current is the same as an electric current, those are two currents, which are made up of individual North Pole particles and South Pole particles. One current runs against one another with high velocity in a whirling helical form.*

In order to let a current flow, it must must be necessarily run against the other current.

Leibniz G.-W.
Preestablished harmony

(HiS) p. 22: „*Leibniz developed the idea that our world is organized to be the best of all possible worlds. …. By very much simplifying it, we may describe Leibniz's theory as follows. God does not interfere, like a clumsy clockmaker, from time to time with the affairs of this world, to regulate the hands of His clock. On the contrary, God created his world in preestablished harmony. Like a skilled clockmaker looking after his clockwork, God brought the nature of each single part of His world for all eternity into agreement with the nature of all the others; thus all parts are forever in complete harmony with each other. This alone is worthy of God, the most intelligent and almighty being. …*

Leibniz understood perfectly well that this world, being merely the best selection out of what is possible, may be much worse than what we might hope for. However, popular misunderstandings of Leibniz's views reduced his thoughts to this oversimplification: all that exists is good."

Lorentz H. A.

(SuL) 1.6.2*: „Light speed is caused by the movements of bodies through the ether. Because of various kinds of ether pressures, objects are squeezed and therefore shortened"*

Luckner A.
Martin Heidegger: „Sein und Zeit"

§5. Die ontologische Analytik des Daseins als Freilegung des Horizontes
für eine Interpretation des Sinnes von Sein überhaupt

(LuA) S. 20-22: „*In diesem Paragraphen stellt Heidegger das Programm für den ersten Teil von* Sein und Zeit *vor, von dessen drei Abschnitten wiederum nur die ersten beiden veröffentlicht sind. Nachdem der Gegenstandsbereich der Analyse eingegrenzt ist, stellt sich nun die Frage, wie das Dasein einer existenzialen Analyse zugänglich ist.*

Ontisch ist das Dasein uns das nächste, denn wir sind als Fragende selbst ein Seiendes von der Art des Daseins. Ontologisch aber sind wir uns selbst denkbar fern, so wie für das Auge eine aufgesetzte Sonnenbrille am nächsten ist, aber wir sie normalerweise selbst nicht sehen, wenn wir durch sie schauen.

Wie soll nun vorgegangen werden bei dieser Aanalyse, wenn wir hierfür nicht auf die Wissenschaften vom Menschen zurückgreifen können? Zunächst sind wir erst einmal auf eine phänomenologische *Beschreibung des Daseins angewiesen. Nur eine phänomenologische Beschreibung – im Unterschied zu einer immer schon eine bestimmten Seinsweise fraglos voraussetzenden wissenschaftlichen Erklärung – kann gewährleisten, daß das Dasein „sich an ihm selbst von ihm selbst her zeigen kann" (16). Hierfür ist es notwendig, das Dasein so zu beschreiben, wie es sich gerade in seiner Alltäglichkeit zeigt, ohne vorherige Unterscheidung in wesentliche und unwesentliche Züge.*

Heidegger nimmt in diesem Paragraphen thetisch das Ergebnis der vorbereitenden Analytik des Daseins (= 1. Abschnitt von Sein und Zeit*) vorweg, ohne daß wir es hier schon überprüfen könnten: Als Sinn des Seins des Daseins, der Existenz, wird sich die* Zeitlichkeit *erweisen. Das heißt: Dasein existiert zeitlich, auf diese Weise „ist" das Dasein. Wenn dies so ist, lassen sich alle Strukturmomente des Daseins, die in der Analytik zutage gefördert wurden, auf diesem Programmhintergrund als Modi der Zeitlichkeit interpretieren: das ist das Programm des zweiten Abschnitts von* Sein und Zeit*.*

Dasein ist (wesentlich) Zeitlichkeit. Dieses Ergebnis kann uns den Boden bereiten, die Seinsfrage sinnvoll zu stellen, denn wenn 1. Das Dasein ontologisch an ihm selbst ist, d.h. ein Seinsverständnis immer schon besitzt, 2. Dasein wesenhaft zeitlich existiert, dann ist jedes Verständnis von Sein nur auf dem Hintergrund der Zeit verständlich. Wenn wir vom Sein reden, sprechen wir von der Zeit. Die Frage nach dem Sinn von „Sein" ist also immer auch und von vornherein die Frage nach der Zeit. Die Zeit ist der Horizont *alles Seinsverständnisses und daher auch, als zentrale Problematik aller Ontologie, Fluchtpunkt der Fundamentalontologie. Die Zeit als Thema der Ontologie ist freilich nicht neu, im Gegenteil, sie ist ja von Anaximander bis heute so etwas wie ein Dauerbrenner der Metaphysik. Aber der Zeitbegriff wurde immer in Opposition zum Ewigen, Unzeitlichen abgehandelt und daher auf einer Ebene, die Heidegger aus gutem Grund unterlaufen möchte. Eine Darstellung und Analyse des, wie er es nennt, „vulgären" Zeitverständnisses – solches, welches die Zeitlichkeit auf ein „in der Zeit sein" verkürzt – kann zeigen, daß gerade das Unzeitliche und Ewige sich überhaupt nur als ein Modus der Zeit denken läßt. Bis zu diesem Punkt reicht das Textfragment* Sein und Zeit*.*

Von dem Befund ausgehend, daß jedes Seinsverständnis im Horizont der Zeit steht, wäre nun die Aufgabe des dritten Abschnitts gewesen, die Temporalität *des Seins herauszuarbeiten. Im Unterschied zum Ausdruck „Zeitlichkeit", der für die Seinsweise des Daseins reserviert ist, betrifft der Ausdruck „Temporalität" alle möglichen Seinsweisen. Die Zeitlichkeit ist also wiederum, als spezifische Seinsweise des Daseins, fundiert in der Temporalität des Seins selbst. Deren Bestimmung wäre die Beantwortung der Frage nach dem Sinn von „Sein". Es ist klar, daß hiermit die Sphäre der Daseinsanalyse verlassen werden muß: Der Weg verläuft vom Sein des Daseins zum Aufweis seiner fundamentalen Zeitlichkeit, danach sollte der Weg im Abschnitt „Zeit und Sein" eine* Kehre *machen."*

Mach E.
Beziehungen der Mechanik zur Physik

(MaE) S. 519: „1. Rein mechanische Vorgänge gibt es nicht. Wenn Massen gegenseitige Beschleunigungen bestimmen, so scheint dies allerdings ein reiner Bewegungsvorgang zu sein. Allein immer sind mit diesen Bewegungen in Wirklichkeit auch thermische, magnetische und elektrische Änderungen verbunden, und in dem Maße, als diese hervortreten, werden die Bewegungsvorgänge modifiziert. Umgekehrt können auch thermische, magnetische, elektrische und chemische Umstände Bewegungen bestimmen. Rein mechanische Vorgänge sind also Abstraktionen, die absichtlich oder notgedrungen zum Zwecke der leichtern Übersicht vorgenommen werden. Dies gilt auch von den übrigen Klassen der physikalischen Erscheinungen. Jeder Vorgang gehört genau genommen allen Gebieten der Physik an, welche nur durch eine teils konventionelle, teils physiologische, teils historisch begründete Einteilung getrennt sind.

2. Die Anschauung, dass die Mechanik als Grundlage aller übrigen Zweige der Physik betrachtet werden müsse und dass alle physikalischen Vorgänge mechanisch *zu erklären seien, halten wir für ein Vorurteil. Das historisch Ältere muss nicht immer die Grundlage für das Verständnis des später Gefundenen bleiben. In dem Maße, als mehr Tatsachen bekannt und geordnet werden, können auch ganz neue leitende Anschauungen Platz greifen. Wir können jetzt noch gar nicht wissen, welche von den physikalischen Erscheinungen am* tiefsten *gehen, ob nicht*

die mechanischen gerade die oberflächlichsten sind, ob nicht alle gleich tief *gehen. Auch in der Mechanik betrachten wir ja nicht mehr das älteste Gesetz, das Hebelgesetz, als die Grundlage aller übrigen".*

(MaE) S. 482: „*Die Vorstellung von der Art, wie die Summe der Bewegung zu rechnen sei, hat sich von Descartes auf Leibniz und später bei den Nachfolgern sehr bedeutend modifiziert, und es ist nach und nach das entstanden, was man heute „Gesetz der Erhaltung der Energie" nennt.*"

(MaE) S. 483: „*Er (Lagrange) führt einen Neubau der Mechanik (die ganze Mechanik gründet auf dem Eulerschen Prinzip der kleinsten Wirkung) auf anderen Grundlagen aus, und kein Sachverständiger kann dessen Vorzüge verkennen. Alle späteren bedeutenden Naturforscher haben sich der Auffassung von Lagrange angeschlossen, und damit was im wesentlichen die heutige Stellung der Physik zur Theologie gegeben*."

(UnA1) pp. 62,65, 66*: Mach's hypothesis*

- *the laws of dynamics could depend only on the motion of masses relatively to each other*

- *the laws of nature are independent to accelerated motion.*

The Mach hypothesis is that distant celestial objects must be responsible for masses having gravitational properties. It anticipates Einstein's later comparison of inertial and gravitational mass known as the equivalence principle.

The Mach principle has two different aspects. First, and qualitatively, just as the (Einstein) equivalence of principle, it says that inertia and gravitational mass are mystereriously connected. Secondly, Mach also claimed that inertia (i.e. the resistance to acceleration) must have its origin in the relative acceleration with respect to all other masses in the universe.This meant that the strength of gravity was also determined by every other celestial body – and suddenly we have a quantitiative statement".

Maupertuis P.
The general (least-action) principle of nature

(HiS) p. 20: „*The „metaphysical principle" of Maupertuis is the assumption that nature always operates with the greatest possible economy. For example, in a homogeneous medium, light would take the shortest possible path. From this idea he drew the following conclusion, which he stated as his general principle:*

> If there is some change in nature, the amount of action necessary for this change must be as small as possible.

What is this „action" that nature is supposed to consume so thriftily?

We shall define action as the product of distance, velocity, and mass:

$$Action = Mass \times Distance \times Velocity.$$

Moreover, according to Leibniz, the kinetic energy E is given by the formula

$$E = \frac{1}{2} \times Mass \times (Velocity)^2;$$

So action has the same physical dimension as $Energy \times Time$, because velocity is distance divided by time. … Actually, our preceding reasoning to motivate this definition of action is taken from one of the Leibniz's letters (To Bernoulli, March 1696)"

Mijajlovic Z., et.al.
Regularity varying solutions of Friedman acceleration equation

(MiZ): „*The Friedman acceleration equation together with the fluid equation and the Friedman equation (which are all just Ordinary Differential Equations determines the expansion scale factor $\alpha(t)$ of the Universe. The nature of the solution strongly depends on the sign of the energy density term. In order to explain the expansion of the universe the cosmological constant is added (Einstein's „grösste Eselei"). It is well known that there are significant discrepancies in the prediction of what order should be the value of the cosmological constant. The reason may lay in the course tuned asymptotic description of the scale of the acceleration factor $\alpha(t)$ such as $\alpha(t) = t^\alpha$. The theory of regularly varying function provides the means for such an analysis, particularly for solutions of the the Friedmann (accelaration) equation.*

(MiZ): „*The 'standard' model of cosmology is founded on the basis that the expansion rate of the universe is accelerating at present — as was inferred originally from the Hubble diagram of Type Ia supernovae. There exists now a much bigger database of supernovae so we can perform rigorous statistical tests to check whether these 'standardisable candles' indeed indicate cosmic acceleration. Taking account of the empirical procedure by which corrections are made to their absolute magnitudes to allow for the varying shape of the light curve and extinction by dust, we find, rather surprisingly, that the data are still quite consistent with a constant rate of expansion*".

Miyamoto K.
Fundamentals of Plasma Physics and Controlled Fusion
Charge neutrality and Landau damping

(MiK) p. 1: „*One of the fundamental property of plasma is the shielding of the electric potential applied to the plasma. When a probe is inserted into a plasma and positive (negative) potential is applied, the probe attracts (repulses) electrons and the plasma tends to shield the electric disturbance.*

(MiK) p. 3: *The other fundamental process of plasma is collective phenomena of charged particles. Waves are associated with coherent motions of charged particles. When the phase velocity v_{ph} of wave or perturbation is much larger than the thermal velocity v_T of charged particles, the wave propagates through the plasma media without damping or amplification. However when the refractive index N of plasma media becomes large and plasma becomes hot, the phase velocity $v_{ph} = c/N$ (c is light velocity) of the wave and the thermal velocity v_T become comparable ($v_{ph} = \frac{c}{N} \sim v_T$), then the exchange of energy between the wave and the thermal energy of plasma is possible. The existence of a damping mechanism of wave was found by L. D. Landau. The process of Landau damping involves a direct wave-particle interaction in collisionless plasma without necessity of randamizing collision. This process is fundamental mechanism in wave heatings of plasma (wave damping) and instabilities (inverse damping of perturbations).*

Nagel Th.
Mind & Cosmos

(NaT) p. 14: Antireductionism and the Natural Order
„*We and other creatures with mental lives are organisms, and our mental capacities apparently depend on our physical constitution. So what explains the existence of organisms like us must also explain the existence of mind. … If evolutionary biology is a physical theory – as it is generally taken to be – then it cannot account for the appearance of consciousness and of other phenomena that are not physically reducible. So if mind is a product of biological evolution – if organisms with mental life are not miraculous anomalies but integral part of nature – then biology cannot be a purely physical science. The possibility opens up of pervasive conception of the natural order very different from materialism – one that makes mind central, rather than a side effect of physical law*".

(NaT) p. 55: Consciousness
„*The existence of consciousness is both one of the most familar and one of the most astounding things about the world. No conception about natural order than does not reveal it as something to be expected can expire*

even to the outline of completeness. And if physical science, whatever it may have to say about the origin of life, leaves us necessarily in the dark about consciousness, that shows that it cannot provide the basic form of intelligibility for this world. There must be a very different way in which things as they are make sense, and that includes the physical world is, since the problem cannot be quarantined in the mind."

(NaT) p. 92: Cognition
„The teleology I want to consider would be an explanation not only of the appeerence of physical organisms but of the development of consciousness and ultimately of reason in those organisms. But its form can be described even if we stay at the physical level. Natural teleology would require two things. First, that the nonteleological and timeless laws of physics - those governing the ultimate elements of the physical universe, whatever they are – are not fully deterministic. Given the physical state of the universe at any moment, the laws of physics would have to leave open a range of alternative successor states, presumably with a probability distribution over them.

Second, among those possible futures there will be some that are more elegible than others are possible steps on the way to the formation of more complex systems, and ultimately of the kinds of replicating systems characteristic of life. The existence of teleology requires that successor states in this subset have a significantly higher probability that is entailed by the laws of physics alone – simply because they are on the path toward a certain outcome. Teleological laws would assign higher probability to steps on the paths in the state space that have higher „velocity" toward certain outcomes. They would be laws of the self-organization of matter, essentially – or whatever is more basic than matter."

Neuenschander D. E.
Emmy Noether's wonderful theorem
Symmetry, invariance, and conservation laws

(NeD) pp. 1, 4: *„The conservation principles of energy, linear momentum, angular momentum, and electric charge are among the most fundamental principles of physics. … „Conservation" as in „conservation of energy" is not the same as „invariant". They are related, …, but they are not synonymous. The momentum or energy of a system of particles may be conserved but not necessarily invariant. For example, imagine one billiard table, prior to the collision one ball moves and the other sits at rest, and the momentum of the system is nonzero. But in the center-of-mass reference frame the system's total momentum sums to zero because the balls approach one another with opposite momentum. In both frames, the collision is analyzed using conservation of momentum within that frame. The table frame sees nonzero momentum, but the center-of-mass frame sees zero momentum. Momentum is conserved within each frame but is not invariant between these two frames. „Invariant" means that a quantity's numerical value is not altered by a coordinate transformation. „Conserved", in contrast, means that within a given coordinate system the quantity does not change throughout a process. „Invariant" compares a quantity between reference frames. „Conservation" compares the quantity before and after collision or reaction or process within a reference frame. Noether's theorem relates conservation to invariance, and thus to symmetry.*

We will see that conservation of energy, conservation of linear momentum, and conservation of angular momentum are related to invariance under time translations, space translations, and rotations, respectively. These invariances, signify underlying symmetries: the homogeneity of time, the homogeneity of space, and the isotropy of space. The conservation of electric charge emerges from a more abstract symmetry called „gauge invariance". … The invariant quantities in the conservation laws of mechanics and electrodynamics are called „functionals".

(NeD) p. 194: *„there is no continuous infinitesimal transformation for charge conjugation. No states exist that carry charge values in a continuum from the -e electric charge of an electron to the +e of the positron, or between the $I_z = \pm 1/2$ isospin eigenvalues. How do we define invariance for discrete symmetries?"*

Poluyan P.
Non-standard analysis of non-classical motion
do the hyperreal numbers exist in the quantum-relative universe?

(PoP): „In Einstein´s theory the rule of speed addition is used, when adding units does not lead to endless increase of the sum, it is limited by the maximum velocity-of-light limit. But in this case the matter is not in the breaking up of the Eudocks-Archimedean axiom, but in the special features of Lorentz transformations, actual for pseudo-Euclidean continuum of space-time. Obviously, it can be admitted, that the analogical rule of addition will work when dealing with simple quantities, such as the length or the time space. But still, it is not clear why we must limit the endless space with some set of radius, to which the sum of the added quantities would aspire. The prospect law exists, but we do understand that lessening of length within the distance is the optic illusion, but not the characteristic of the spacial metrics.

Now let us stake the quantum mechanics. It is known, that the so-called „ultra-violet-catastrophe" was the direct consequence from the formulae of the classical mathematical analysis – for the balance of radiation in the field of high frequencies the result was endless quantity of energy. But the way out was found not in the modification of mathematical principles, but in realizing experimental data: Max Planck´s hypothesis put the limit to the endless energy subdivision $E = h\nu$ appered to be non-divided. And at the moment the clinical formulae of analysis being used, and what concerns all „disturbing" modern physic-theoretic learnt as Richard Feynman said, to „sweep them under the rug".

There is no absolute motion, two points can be move only with regard to each other. If we take one of them for standard point, we believe it is stable, and the second one moves with regard to the first one. And vice versa: we can take the second moving point for the stable starting point and consider the first one to be moving. The notion of motion quite naturally and necessarily requires the principle of relativity as the distance change between these two points BETWEEN THEM with some time. Sketchily the principle of relativity is explained with the example of two points A and C. We take one of them fort he starting point, the other moves with regards to the starting point, and vice versa. Let us imagine, in space there are two points (mathematically size less), separated by some distance. Now let us try to imagine that the distance changes… But how can we check this „change"? Anri Poincare, illustrating these cases, made the imaginary experience- he asked: what would happen if the distance between the two points becomes twice bigger? And he answered: the world would not notice it. I think it is clear. To be able to speak of the change of the distance between two points, there must be one more point which would be stable with regard to one of the two given points".

Penrose R.
The emperor's new mind

(PeR) p. 444: „In order to produce an universe resembling the one in which we live, the Creator would have to aim for an absurdly tiny volume of phase space of possible universes – about $1/10^{10^{123}}$ of the entire volume, for the situation under consideration".

How do nerve signals works?

(PeR) p. 506 „When a signal reaches a synaptic knob, it emits a chemical substance known as a neurotransmitter. This substance travels across the synaptic cleft to another neuro – either at a point on one of its dendrites or on the soma itself. Now some neurons have synaptic knobs which emit a neurotransmitter chemical with a tendency to encourage th:e soma of the next neuron to „fire", i.e. to initiate a new signal out along its axon. These synapses are called excitatory. Others tend to discourage the next neuron from firing and are called inhibitory. The total effect of the excitatory synapses which are active at any moment is added up, and the total of the active inhibitory ones substracted from this, and if the net result reaches a certain critical threshold, the next neuron is indeed induced to fire. (The excitatory ones cause positive electrical potential difference between the inside and the outside of the next neuron and the inhibitory ones cause a negative potential difference. These potential differences add up appropriately. The neuron will fire when this potential differences reaches a critical level on the attached axon, so that the potassium can't got out fast enough to restore equilibrium)

Penrose R.
The road to reality
Dirac's route to the positron

(PeR4) p. 622: „*Not only is the electron's charged-particle behaviour correctly described; in addition Dirac's electron responds in accordance with its possessing a* magnetic moment *of very little specific amout, namely* $\left(\frac{h}{2\pi}\right) e/(4\mu c)$, *where* $-e$ *is the electron's charge and* μ *is its mass.*"

(PeR4) p. 623: „*There is a strong physical need for the electron's two spin states. Indeed, the very subject of chemistry, as we know it, depends upon this. In an atom, the electrons sourrounding the nucleus are constrained to orbit the nucleus in particular states known as „orbitals". By Pauli's exclusion principle, it would seem that each electron orbital can be occupied by no more than* one *electron, yet we find that a second electron is always allowed in each of the orbitals. The pair of them can coexist and still satisfy the exclusion principle because their states are* not *identical but have opposite spins. There can be no more than two electrons in any one orbital, however, because there are only two independent spin states for the electron. The chemical notion of „covalent bond" depends upon the same phenomenon, two shared electrons seeming to coexist in the same state, because their spins are opposite.*"

Penrose R.
The road to reality
The electroweak symmetry group

(PeR4) p. 641: In the standard model the weak and the electromagnetic interactions are unified in what is called electroweak theory, where there is a special symmetry related to W^+, W^-, Z^0, and the photon γ, according to the groups $SU(2) \times U(1)$ or, more correctly, $U(2)$, [*].
[*] (PeR4) p. 654: The group might be expressed as $SU(2) \times U(1)/Z_2$, where the $'Z_2'$ means „factor out by a Z_2 subgroup". However, there is more than one such subgroup, so this notation is not fully explicit. The notation $'U(2)'$ automatically picks out the correct one. (I am grateful to Florence Tsou for this observation.) It seems that the reason that the electroweak symmetry group is not conventionally referred to as $'U(2)'$ is that this does not easily extend to the symmetry of the full standard model, which also incorporates the strong symmetry group $SU(3)$, the full group being a version $SU(3) \times SU(2) \times U(1)/Z_6$.

Peskin M.
The Parton Model of Hadron Structure

(PeM) p. 473: „*Which particular quantum field theories describe the interactions of elementary paricles?*

Since the mid-2970s, most high-energy physicists have agreed that the elementary partciles that make up matter are a set of fermions, interacting primarily through the exchange of vector bosons. The elementary fermions include the leptons (the electron, its heavy counterparts μ and τ, and n neutral, almost massless neutrino corresponding to each of these species), and the quarks, whose bound states form the particles with nuclear interactions, mesons and baryons (collectively called hadrons). These fermions interact through three forces: the strong, the weak, and the electromagnetic interactions. Of these, the strong interaction is responsible for nuclear binding and the interactions of constituents of nuclei, while the weak interaction is responsible for the radioactive beta decay processes. The electromagnetic interaction is the familar Quantum Electrodynamics, coupled minimally to all charged quarks and leptons. It is not clear that these three forces suffice to explain the most subtle properties of the elementary fermions, but these three forces are certainly the most prominent. All three are now understood to be mediated by the exchange of vector bosons."

(PeM) p. 474 ff: „*How can a model of noninteracting quarks represent the behavior of a force that, under other circumstances, is extremely strong?*

In fact, there are many circumstances in the study of the strong interaction at high energy in which this force has unexpectedly weak effect. Historically, the first of these appeared in proton-proton collisions. At high energy, above 10GeV or so in the center of mass, collisions of protons (or any other hadrons) product large number of pions. One might have imagined that these pions would fill all of the allowed phase space, but, in fact, they are mainly proded with momenta almost collinear with the collision axis. The probability of

producing a pion with a large component of momentum transverse to the collision axis falls off exponentially in the value of this transverse momentum, suppressing the production substancially for transverse momenta greater than a few hundered MeV.

This phenomenon of limited transverse momentum led to a picture of a hadron as a loosly bound assemblage of many components. In this picture, a proton struck by another proton would be torn into a cloud of pieces. These pieces would have momenta roughly collinear with the original momentum of the proton and would eventually reform into hadrons moving along the collision axis. By hypothesis, these pieces could not absorb a large momentum transfer. We can characterize this hypothesis mathematically as follows: In a high-energy collison, the momenta of the two initial hadrons are almost lightlike. The scattered pieces of the hadrons, arrayed along the collision axis, also have lightlike momenta parallel to the original momentum vectors. This final state can be produced by exchanging momenta q among other pieces in such a way that, though the components of q might be large, the invariant q^2 is always small. The ejection of a hadron at large transverse momentum would require large (spacelike) q^2, but such a process was very rare. Thus it was hypothesized that hadrons were loose clouds of constituents., like jelly, which could not absorb a large q^2."

Planck M.
The dynamical and the statistical type of law

(PlM) S. 90: *„… Auch die Physik hat, wie schon lange vorher die sozialen Wissenschaften, die hohe Bedeutung einer von der rein kausalen gänzlich verschiedenen Betrachtungsweise kennengelernt und hat dieselbe seit etwa der Mitte des vorigen Jahrhunderts mit immer steigendem Erfolge angewendet; es ist dies die statistische Methode, mit deren Ausbildung die ganze neuere Entwicklung der theoretischen Physik aufs engste zusammenhängt. Statt den zur Zeit noch völlig im Dunkeln liegenden dynamischen Gesetzen eines Einzelvorganges ohne eine Aussicht auf greifbaren Erfolg nachzuforschen, werden zunächst einmal nur die an einer großen Zahl von Einzelvorgangen einer bestimmten Art gemachten Beobachtungen zusammengestellt und aus ihnen Durchschnitts- oder Mittelwerte gebildet. Für diese Mittelwerte ergeben sich dann je nach den besonderen Umstanden des Falles gewisse erfahrungsmäßige Regeln, und die so gewonnenen Regeln gestatten, allerdings niemals mit absoluter Sicherheit, aber doch mit einer Wahrscheinlichkeit, die sehr häufig der Gewißheit praktisch gleichkommt, den Ablauf auch zukünftiger Vorgänge im voraus anzugeben, zwar nicht in allen Einzelheiten, wohl aber - und daraufkommt es bei den Anwendungen oft gerade am meisten an - in ihrem durchschnittlichen Verlauf …*
… Immerhin erhellt aus der geschilderten Sachlage wohl hinreichend deutlich die überaus hohe Bedeutung, welche die Durchführung einer sorgfältigen und grundsatzlichen Trennung der beiden besprochenen Arten von Gesetzmaßigkeit: der dynamischen, streng kausalen, und der lediglich statistischen, für das Verständnis des eigentlichen Wesens jeglicher naturwissenschaftlichen Erkenntnis besitzt".

Rollnik H.
Der Spin des Elektrons und die Gruppe $SU(2)$

(RoH) S. 214: *„In der klassischen Physik gibt es keinen Magnetismus! Denn dazu müßte ein Stück Materie, das aus vielen Atomen besteht, im thermodynamischen Gleichgewicht ein resultierendes magnetisches Moment besitzen"*

(RoH) S. 217 ff.: *„Bei der genaueren experimentellen Untersuchung der Atomspektren und ihrer Aufspaltung in magnetischen und elektrischen Feldern stieß man in der Mitte der zwanziger Jahre des vorherigen Jahrhunderts auf eine Reihe gravierender, da qualitativer Widersprüche zu den theoretischen Erwartungen. Sie lassen sich in der Feststellung zusammenfassen:*

Man beobachtete die Aufspaltung von Spektrallinien oder von Elektronenstrahlen in eine gerade Anzahl von Komponenten, während die Drehimpulsmultipletts nur ungerade Multipletts (die zu einer festen Energie gehörenden Eigenzustände des Hamiltonoperators von physikalischen Zuständen), nämlich mit der Anzah $2l+1$ erwarten lassen. Im einzelnen fand man:

    i)   *Es gibt Spektren mit einer geradzahligen Multiplettstruktur*

ii) *Die Zahl der Zeeman-Terme und deren Aufspaltungsregeln widersprechen in vielen Fällen dem Experiment, insbesondere beim Wasserstoff und den Alkali-Atomen. Es gilt wieder die Multiplizitätsregel: eine ungerade Elektronenzahl ist mit einer geraden Anzahl von Zeeman-Termen verbunden und umgekehrt*

iii) *Der Stern-Gerlach Versuch bestätigt die in den Spektren gefundenen Multiplizitätsregeln.*

Diese Phänomene legen aufgrund der Drehimpulsregel „Multiplizität = 2l + 1 das Auftreten von j = 1/2 nahe. Konkret wurde nach vielen tastenden Vorüberlegungen im Herbst 1925 von Uhlenbeck und Goudsmit die Hypothese des Elektronenspins eingeführt. In moderner Sprache lautet sie:

Hypothese des Elektronenspins

Neben den Observablen Q und P besitzt ein Elektron eine neue Observable, einen inneren Drehimpuls, genannt Spin hS mit den folgenden Eigenschaften

a) S ist ein Drehimpuls und es gilt $S \times S = iS$

b) Für jede Komponente von S gibt es zwei mögliche Eigenwerte, daher gehört S zur Drehimpulsquantenzahl $j = 1/2$, und sein Quadrat hat den Wert $S^2 = \frac{1}{2}\left(\frac{1}{2} + 1\right) = \frac{3}{4}$

c) Die Komponenten des Spins kommutieren mit den Bahnvariablen Q und P, $[S_j, Q_k] = 0$, $[S_j, P_k] = 0$, so daß z.B. der Ort Q und die dritte Komponente des Spins S_3, gleichzeitig gemessen werden können

d) Der Gesamtdrehimpuls eines Elektrons J wird durch die Summe von Bahndrehimpuls L und des Spins S gegeben, $J = L + S$

e) Der Spin S ist mit einem magnetischen Moment der Größe $\mu_s = g_s \frac{eh}{4\pi m_e c} S = -g_s \frac{|e|h}{4\pi m_e c} S$ verbunden.
    Dabei wird der g_s-Faktor – das gyromagnetische Verhältnis – durch $g_s \sim 2$ gegeben (für die Bahnbewegung gilt lediglich der Wert $g_s \sim 1$). Dieser Wert ($g_s \sim 2$) ist notwendig, um die Aufspaltung der Atomniveaus quantentheoretisch richtig zu beschreiben.

Rovelli C.
Quantum gravity

(RoC) p. 9: *„The physical meaning of general relativity (GR): GR is the discovery that spacetime and the gravitational field are the same entity. What we call „spacetime" is itself a physical object, in many respects similar to the electromagnetic field. We can say that GR is the discovery hat there is no spacetime at all. What Newton called „space", and Minkowski called „spacetime", is unmasked: it is nothing but a dynamic object – the gravitational field – in a regime in which we neglect its dynamics. …., the universe is not made up of fields on spacetime; it is made up of fields on fields"*

(RoC) p. 34: *„I call „gravitational field" the tetrad field rather than Einstein's metric field.*
In General Relativity (GR) a frame field (also called a tetrad field) is a set of four (one time-like and three space-like) orthogonal vector fields, defined on a Lorentz manifold. All tensorial quantities defined on the manifold can be expressed by the frame field and ist dual coframe field. The related gravitational field e is a one-form $e^I(x) = e^I_\mu(x)dx^\mu$ with values in Minkowski space. A tetrad field e determines uniquely a torsion-free spin connection $\omega = \omega[e]$. Its compatibility condition with e ((RoC) (2.6)) and the Einstein equations ((RoC) (2.11)) are the field equations of GR in the absence of other fields. They are the Euler-Lagrange equations of the action $S[e, \omega]$ ((RoC) (2.12)). Replacing ω with $\omega[e]$ leads to the second order action formalism $S[e]$ ((RoC) (2.16)). The two Lagrange formalisms are not equivalent in the presence of fermions.

There are three reasons for this

(1) the standard model cannot be written in terms of g because fermions require the tetrad formalism

(2) the tetrad field e is nowadays more utilized than g in quantum gravity, and

(3) I think that e represents the gravitational fields in a more conceptually clean way than g (see section 2.2.3)"

(RoC) p. 36*: „the formalism in (2.12) where e and ω (the spin connection, which is also a one-form with values in the Lie algebra of the Lorentz group SO(3,1)) are independent is called the first-order formalism. The two formalism are not equivalent in the presence of fermions; we do not know which one is physically correct, because the effect of gravity on single fermions is hard to measure"*

(RoC) p. 143: *The thermal time hypothesis: In Nature, there is no preferred physical time variable t. There are no equilibrium states ρ_0 preferred a priori. Rather, all variables are equivalent: we can find the system in an arbitrary state ρ; if the system is in a state ρ, then a preferred variable is singled out by the state of the system. This variable is what we call time. …. In other words, it is the statistical state that determines which variable is physical time, and not any a priori hypothetical „flow" that drives the system to a preferred statistical state"*

Russel R.
The philosophy of Leibniz

(RuB) p. 108: „*Leibniz rejected atoms, the vacuum, and action at a distance*"
Schauberger V.
Implosion als Abbild planetarer oder atomarer Bewegung

(LaS) S. 226: „Der eine Pfeiler, auf dem Schaubergers Implosionsprinzip ruht, ist das Prinzip der „planetaren Bewegung". In einer schraubenartigen Bewegung sollen sich nach Kepler die Planeten unseres Sonnensystems um ihre eigenen Achse drehen (Kreiseln), und sich in ellipsoiden Bahnen um die in einem Brennpunkt der Ellipse befindlichen Sonne kreisen.

Nach dem Motto: Wie im Großen so im Kleinen, können wir dieses Bewegungsmodell auch in kleinsten Teilchen, den Atomen, feststellen. Im Bohrschen Atommodell stellt der Atomkern die Sonne dar, um den sich die Elektronen als Planeten drehen. Sie bewegen sich nach Arnold Sommerfeld auch auf ellipsenförmigen Bahnen um den Atomkern. Man nennt die kreiselnde Bewegung der Elektronen auch „Spin".
Wenn diese Bewegungsform im Makrokosmos (Universum) und im Mikrokosmos (Atom) feststellbar ist, dann muß sie auch in den materiellen Zwischenformen unserer physischen Realität feststellbar sein, überlegte Schauberger. Und sie muß eine besondere Bedeutung haben, da sich in der Natur scheinbar alles Aufbauende in dieser Weie bewegt oder bewegt wird, schloß er weiter. Er sollte später noch erkennen, daß er dem evolutiven Prinzip der Natur auf die Spur gekommen war. Aufgrund dieser Erkenntnisse und seiner Naturbeobachtungen kam Schauberger zu dem Schluß, daß Mensch (die Wissenschaft) und Natur verschiedene Wege gehen. Wir bleiben im Sinne der Schauberger'schen Dialektik bei der Wissenschaft als Antithese zur Natur. Die Wissenschaft, so Schauberger, arbeitet in jeder Richtung gegen die Natur und ihre Intensionen. Er sah diesen Unterschied vornehmlich in der Diskrepanz zweier Bewegungsformen: Die Natur tendiert dazu, ihre Massen planetar zu bewegen (spiral-konzentrisch), die Wissenschaft hingegen tendiert dazu, Massen gleichförmig-geradlinig zu bewegen. Wobei bekannt ist, daß es keine geradlinige Bewegung gibt, sondern aufgrund der Raumkrümmung und Endgravitation jede geradlinig intendierte Bewegung gekrümmt verläuft.
Schauberger bezeichnet die der Intelligenz der Natur entspringende Bewegung „Implosion" und die der Intelligenz der Wissenschaft entspringende Bewegung „Explosion". Die Natur, der Kosmos, Planeten, Sterne, Atome, Moleküle, Wasser, Wellen, Wind (vor allem Wirbelstürme), Wolken, Blut und Pflanzensäfte, folgen der implosiven Bewegung. Die konzentrisch-spiralförmige „Implosionsbewegung" hat saugenden, ziehende Charakter. Man bedenke, welche Saugkräfte der Rüssel eines Tornados entwickelt. Nur der Mensch (die Wissenschaft) fociert die „widernatürliche" geradlinige (drückenden) Bewegungsform, die im Widerstand Wärme erzeugt und abbauende Eigenschaften hat, so Schauberger. Dazu Ludwig Boltzmann: Nur die geradlinige Bewegung steigert den Druck und die Temperatur. Bei der Implosionsbewegung soll durch die Saugwirkung eine minimale Reibung entstehen und eine Abkühlung erfolgen, da die Wärmeenergie in Bewegungsenergie umgewandelt wird, durch die zum Beispiel der Wirbelsturm auf Touren gebracht wird.
(LaS) S. 230: Viktor Schauberger sah also einen eigen Zusammenhang zwischen der Bewegung der Planeten, der Atome und der materiellen Zwischenstufen (Moleküle, Wasser, Wellen, Wind (vor allem Wirbelstürme), Wolken, Blut und Pflanzensäfte usw.) Ee benütze für die Planetenbewegung auch den schwierigen Begriff „zykloide Raumkurvenbewegung". … Nach Schauberger spiralen sie um die Sonne. Er begründete dies damit, daß alles, was sich im Kreise dreht, nicht von Fleck kommt. Statt „zykloide Raumkurvenbewegung" sagte er auch „planetare Bewegung". Also dreht sich auch die Erde in dieser Weise. Die „planetare Bewegung" der Erde hat

auch Einfluß auf die Massenbewegung, sagte Schauberger. Das Wasser, Blut, Pflanzensäfte, Winde und Meereswellen, Gase, Rauchschwaden, etc. werden in dieser Weise bewegt.

Univ. Prof. Felix Ehrenhaft, Vorstand des ersten Physikalischen Institutes der Universität Wien, machte mit seinen Mitarbeitern die Entdeckung, daß kleinste freischwebende Materieteilchen in einem konzentrierten Lichtstrahl sich auf Schraubenbahnen bewegen. Teils in der Fortpflanzung des Lichts, teils in der entgegengesetzten Richtung. Dieser Versuch wird Photophorese genannt.

Grundsätzlich neuartig und aufregend, so Prof. Ehrenhaft, ist das Phänomen, daß die Bewegung von Materieteilchen in Feldern nicht auf geraden Bahnen, sondern auf Schraubenbahnen der regelmäßgsten Form, Größe und Umlauffrequenz erfolgt. Zu der Bewegung um die Schraube, kommt oft noch eine Bewegung um die eigene Achse.

Nach Dipl.-Ing. Walter Schauberger spielt sich die Erscheinung in allen Gasen, insbesondere auch in Edelgasen (Argon) und bei allen Drücken ab. Der Inder Satyendra Nat Ray bewies, daß auch in Flüssigkeiten derartige Bewegungen auftreten. G. Fachini in Italien hat ebenfalls Photophorese in Flüssigkeiten festgestellt. W. W. Barkas im Porterschen Laboratorium zu London hat auch in Röntgenstrahlen Photophorese gefunden … Die Photophorese – die schraubenförmige-spiralige Bewegung kleinster Materieteilchen – würde Viktor Schaubergers Implosionstheorie (planetarer Bewegung) im Prinzip bestätigen."

(LaS) S. 232: „Schauberger verstand unter „Implosion" also zentripetale Massenbewegungsform, die auf einer konzentrisch-spiralförmigen Bahn von außen nach innen verläuft, deren Zentrum saugend ist. … Diesen Naturvorgang (Wirbel) versuchte Schauberger technisch zu kopieren. Massen, wie Luft oder Wasser, die in diesen Bewegungsvorgang geraten, werden aufgrund des immer enger werdenden Raumes der konzentrischen Bahn verdichtet. Dabei wird auf atomarer Ebene Kernenergie frei, jene Bindungsenergie, welche die Atome im Innersten zusammenhält. Zugleich erfolgt eine qualitative Veränderung des ursprünglichen Stoffes. In der Physik wird dieser Vorgang Massendefekt bezeichnet: Paarbildung – Massendefekt – Freie Energie. Zum Beispiel bei der Umwandlung von Wasserstoff in Helium. Das Ursprüngliche wird quantitativ leichter, verliert an Masse, wird aber auf ein höheres Ordnungsniveau gehoben und gewinnt dadurch an Qualität. Jeder Stoff hat eine spezifische Eigenfrequenz und Struktur. Wenn nun die Eigenfrequenz beziehungsweise Struktur eines Stoffes durch Zufuhr von Energie verändert (erhöht) wird, verändert sich auch seine Qualität. Endprodukt eines solchen Bewegungs (=Veredelungs)-vorganges ist beispielsweise Edelwasser."

(LaS) S. 233: „Der Wirbel sorgt für Ordnung. Schauberger nannte diesen Vorgang auch „Atomumwandlung statt Atomzertrümmerung". Bei der Atomzertrümmerung werden Zerfallsprozesse eingeleitet. Uranatome werden gespalten, wodurch Energie frei wird. Uran ist bereits ein hochwertiges Element, das durch den Kernspaltungsvorgang in ein minderwertiges, hochgiftiges Abfallprodukt verwandelt wird. Aus Ordnung wird Chaos.

Beim Verfahren der natürlichen Atomumwandlung nach Schauberger werden Atome nicht gespalten, sondern durch die saugende, verdichtende Implosionskraft auf ein höheres Ordnungsnivau gebracht. Die ursprüngliche Atomstruktur wird aufgelöst und neu gruppiert, eingespeicherte Energie wird frei. Ein Trennen und Wiedervereinen auf höherer (qualitativer) Ebene. Aus Chaos wird Ordnung.

Schauberger meinte, daß man das Chaos „überchaotisieren" müsse, um Ordnung zu schaffen. Jedenfalls verhalten sich Atome nach einer „Wirbelbehandlung", oder – neuesten Erkenntnissen zufolge – auch nach einer elektromagnetischen Beeinfußung nicht mehr chaotisch, sondern kohärent. Man kann auch sagen, wenn man ihnen von außen Energie zuführt, „erinnern" sie sich wieder an ihre Ordnung."

(LaS) S. 244: „Nach Schauberger ist Wachstum das Ergebnis eines Druckausgleiches zweier bipolarer (gegengeschlechtlicher) feinstofflicher Energien, die sich gegensinnig kreuzen (vermählen, vereinen), woraus ein Drittes entsteht. Diese feinstofflichen Energien sind für unser menschliches Auge unsichtbar. … Erst das Produkt aus der Kreuzung dieser feinstofflichen Energien, die Auswirkung, das sogenannte „Dritte", das „Grobstoffliche" (summa summarum unsere gesamte materielle Welt) ist für uns sichtbar und greifbar. ….

Durchlebte Materie zerfällt und eingespeicherte Energie wird frei, die sich laut Schauberger wiederum mit einfallender, gegenpoliger („kosmischer") Energie trifft, um erneut Ausgleiche einzugehen."

(LaS) S. 250: „Ein bißchen Lichteinfluß, ein bißchen Lichtabschluß, ein bißchen Wärme, ein bißchen Kälte rhythmisch geordnet genügt, um das edelste Wasser, das durch Mutatoren fließt, hochwertig aufzuladen (zu ionisieren").

Ich löse in neuester Zeit aus edelsten Bergkristallen die eingebauten Kraftstoffe, und die freiwerdenden Strahlungsenergien akkumuliere ich dann in das Wasser. Auf diese Weise bekomme ich die Ur-Eiweißstoffe oder die lebensanfachenden Vitamine."

Schiller F.
On the aesthetic education of man
Eleventh Letter, (ScF) p. 48 ff.
This is about ~*„the sensuous-rational nature of Man"*

„When abstraction mounts as high as it is possible can, it arrives at two final concepts, at which it must halt and recognize its limits. It distinguishes in Man something that edures and something that perpetually alters. The enduring is called person*, the changing is his* condition*.*

Person and condition – the self and its determinations – which we think of in the absolute Being as one and the same, are eternally two in the finite. Throughout the persistence of the person the condition changes, through every change of condition the person persists. We pass from rest to activity, from passion to nidifference, from assent to contradiction; but we always exist, and what springs immediately from our self remains. In the absolute Person alone all the determinations persist alongside the personality, since they flow out of personality. All that Divinity is, it is just because it is; consequently it is everything to eternity, because *it is eternity.*

Since in Man, as finite being, person and condition are distinct, neither can the condition be derived from the person nor the person from the condition. In the latter case, the person would have to alter; in the former case, the condition would habe to persist, and thus in each case either the personality or the finiteness would cease. Not because we think and will and feel do we exist; not because we exist and think and will do we feel. We exist because we exist; we feel, think and will because there is something other besides ourselves.
The person must therefore be its own ground, for the enduring cannot issue from alteration; and so we have in the first place the idea of absolute being grounded in itself, that is to say of freedom*. Condition must have a ground; since it does not exist through the person, and is thus not absolute, it must* result*; and so we have in the second place the qualification of all depending being and becoming,* time*. ,Time is the condition of all* Becoming' *is an identical proposition, for it merely asserts that the result is the condition of something resulting.*

The person that is revealed in the eternally persisting ego, and only there, cannot become, cannot have a beginning in time; the reverse is rather the case – time must begin in it, because something constant must form the basis of change. There must be something that alters, if alternation is to occur; this something cannot therefore itself be alternation. In saying that the flower blooms and fades, we make the flower the thing that persits through the transformation and lend it, so to say, a personality in which both those conditions are manifested. It is no objection that Man has first to become; For Man is not simply person in general but person situated in a particular condition. But every condition, every definite instance arises in time, and so Man as a phenemonen must have his beginning, although the pure intelligence in him is eternal. Without time, that is to say without becoming it, he would never be a definite existence; his personality would certainly exist in potentiality, but not in fact. Only through the succession of its perceptions does the persisting ego itself come to appear.

The subject matter of activity, therefore, or the reality which the supreme Intelligence creates out of itself, must first be received *by Man, and he does in fact receive it as something eternal to himself in space and as something changing within himself in time, through the medium of perception. This changing substance in him is accompanied by his never-changing ego – and to remain remain perpetually himself throughout all change, to turn every perception into experience, that is, into unity of knowledge, and to make each of his manifestations in time a law for all time, is the rule which is prescribes for him by his rational nature. Only as he alters does* he *exist; only as he remains unalterable does* he *exist. Man conceived in his perfection would accordingly be the constant unity which admidst the tides of change remains eternally the same.*

Now although an infinite being, a divinity, cannot become*, we must surely call the divine a tendency which has for its infinite task the proper characteristic of divinity, absolute realization of capacity (actually of all that is possible) and absolute unity of manifestation (necessity of all that is actual). Beyond question Man carries the potentiality for divinity within himself; the path to divinity, if we may call a path what never reaches its goals, is open to him in his* sense*.*

His personality, regarded in itself alone and independently of all sense material, is merely the potentiality of a possible infinite expression; and so lang as he neither contemplates nor fells he is still nothing but form and empty capacity. His sense faculty, regarded in itself and dissociated from all spontaneous activity of the mind, can do nothing beyond making himself material – for without it he is mere form – but by no means uniting him to matter. So long as he only perceives, only desires and acts from mere appetite, he is still nothing but world*, if we understood by this simply the formless content of time. It is indeed his sense faculty alone which turns his capacity into operative power; but it is only his personality which makes his operation really his own. Thus in order not to be merely world, he must lend form to his material; in order to be not merely form, he must make actual the potentiality which he bears within hinself. He realizes form when he create time, and opposes constancy with alteration, the eternal unity of his ego with diversity of the world; he gives form to matter when he proceeds to annul time, affirms persistence within change, and subjects the diversity of the world to the unity of his ego.*

Hence flow two contrary demands upon Man, the two fundamental laws of his sensuous-rational nature. The first insists upon absolute reality*; he is to turn everything that is mere form into world, and realize all his potentialities; the second insists upon absolute* formality*: he is to eradicate in himself everything that is merely world, and produce harmony in all its mutations; in other words, he is to turn outwards into internal, and give form to everything external. Both tasks, considered in their supreme fulfilment, lead back to the conception of divinity from which I started"*

Outlook to the Twelfth Letter, which is *„on the fulfilment of this twofold tasks"* regarding the sensuous impulse and the formal impulse*: If the first impulse only furnishes* cases*, the other gives* laws*.*

Schopenhauer A.
Die Welt als Wille und Vorstellung
Die Vorstellung unterworfen dem Satze vom Grunde:
Das Objekt der Erfahrung und Wissenschaft

(ScA) §2: *„Dasjenige, was Alles erkennt und von Keinem erkannt wird, ist das Subjekt. Es ist sonach der Träger der Welt, die durchgängige, stets vorausgesetzte Bedingung alles Erscheinenden, alles Objekts: denn nur für das Subjekt ist, was nur immer da ist. Als dieses Subjekt findet Jeder sich selbst, jedoch nur sofern er erkennt, nicht sofern er Objekt der Erkenntniß ist. Objekt ist aber schon sein Leib, welchen selbst wir daher, von diesem Standpunkt aus, Vorstellung nennen. Denn der Leib ist Objekt unter Objekten und den Gesetzen der Objekte unterworfen, obwohl er unmittelbares Objekt ist. Er liegt, wie alle Objekte der Anschauung, in den Formen alles Erkennens, in Zeit und Raum, durch welche die Vielheit ist. Das Subjekt aber, das Erkennende, nie Erkannte, liegt auch nicht in diesen Formen, von denen selbst es vielmehr immer schon vorausgesetzt wird: ihm kommt also weder Vielheit, noch deren Gegensatz, Einheit, zu. Wir erkennen es nimmer, sondern es eben ist es, das erkennt, wo nur erkannt wird.*

Die Welt als Vorstellung also, in welcher Hinsicht allein wir sie hier betrachten, hat zwei wesentliche, nothwendige und untrennbare Hälften. Die eine ist das Objekt: dessen Form ist Raum und Zeit, durch diese die Vielheit. Die andere Hälfte aber, das Subjekt, liegt nicht in Raum und Zeit: denn sie ist ganz und ungetheilt in jedem vorstellenden Wesen; daher ein einziges von diesen, eben so vollständig, als die vorhandenen Millionen, mit dem Objekt die Welt als Vorstellung ergänzt: verschwände aber auch jenes einzige; so wäre die Welt als Vorstellung nicht mehr. Diese Hälften sind daher unzertrennlich, selbst für den Gedanken: denn jede von beiden hat nur durch und für die andere Bedeutung und Daseyn, ist mit ihr da und verschwindet mit ihr. Sie begränzen sich unmittelbar: wo das Objekt anfängt, hört das Subjekt auf. Die Gemeinschaftlichkeit dieser Gränze zeigt sich eben darin, daß die wesentlichen und daher allgemeinen Formen alles Objekts, welche Zeit, Raum und Kausalität sind, auch ohne die Erkenntniß des Objekts selbst, vom Subjekt ausgehend gefunden und vollständig erkannt werden können, d.h. in Kants Sprache, a priori in unserm Bewußtseyn liegen. Dieses entdeckt zu haben, ist ein Hauptverdienst Kants und ein sehr großes. Ich behaupte nun überdies, daß der Satz vom Grunde der gemeinschaftliche Ausdruck für alle diese uns a priori bewußten Formen des Objekts ist, und daß daher Alles,

was wir rein a priori wissen, nichts ist, als eben der Inhalt jenes Satzes und was aus diesem folgt, in ihm also eigentlich unsere ganze a priori gewisse Erkenntniß ausgesprochen ist."

(ScA) §4: *„Wer die Gestaltung des Satzes vom Grunde, welche in der reinen Zeit als solcher erscheint und auf der alles Zählen und Rechnen beruht, erkannt hat, der hat eben damit auch das ganze Wesen der Zeit erkannt. Sie ist weiter nichts, als eben jene Gestaltung des Satzes vom Grunde, und hat keine andere Eigenschaft. Succession ist die Gestalt des Satzes vom Grunde in der Zeit; Succession ist das ganze Wesen der Zeit. - Wer ferner den Satz vom Grunde, wie er im bloßen rein angeschauten Raum herrscht, erkannt hat, der hat eben damit das ganze Wesen des Raumes erschöpft; da dieser durch und durch nichts Anderes ist, als die Möglichkeit der wechselseitigen Bestimmungen seiner Theile durch einander, welche Lage heißt. Die ausführliche Betrachtung dieser und Niederlegung der sich daraus ergebenden Resultate in abstrakte Begriffe, zu bequemerer Anwendung, ist der Inhalt der ganzen Geometrie, - Eben so nun, wer diejenige Gestaltung des Satzes vom Grunde, welche den Inhalt jener Formen (der Zeit und des Raumes), ihre Wahrnehmbarkeit, d.i. die Materie, beherrscht, also das Gesetz der Kausalität erkannt hat; der hat eben damit das ganze Wesen der Materie als solcher erkannt: denn diese ist durch und durch nichts als Kausalität, welches Jeder unmittelbar einsieht, sobald er sich besinnt. Ihr Seyn nämlich ist ihr Wirken: kein anderes Seyn derselben ist auch nur zu denken möglich. Nur als wirkend füllt sie den Raum, füllt sie die Zeit: ihre Einwirkung auf das unmittelbare Objekt (das selbst Materie ist) bedingt die Anschauung, in der sie allein existirt: die Folge der Einwirkung jedes andern materiellen Objekts auf ein anderes wird nur erkannt, sofern das letztere jetzt anders als zuvor auf das unmittelbare Objekt einwirkt, besteht nur darin. Ursache und Wirkung ist also das ganze Wesen der Materie: ihr Seyn ist ihr Wirken. …*

… Nun aber erhält das Gesetz der Kausalität seine Bedeutung und Nothwendigkeit allein dadurch, daß das Wesen der Veränderung nicht im bloßen Wechsel der Zustände an sich, sondern vielmehr darin besteht, daß an dem selben Ort im Raum jetzt ein Zustand ist und darauf ein anderer, und zu einer und der selben bestimmten Zeit hier dieser Zustand und dort jener: nur diese gegenseitige Beschränkung der Zeit und des Raums durch einander giebt einer Regel, nach der die Veränderung vorgehn muß, Bedeutung und zugleich Nothwendigkeit. Was durch das Gesetz der Kausalität bestimmt wird, ist also nicht die Succession der Zustände in der bloßen Zeit, sondern diese Succession in Hinsicht auf einen bestimmten Raum, und nicht das Daseyn der Zustände an einem bestimmten Ort, sondern an diesem Ort zu einer bestimmten Zeit. Die Veränderung, d. h, der nach dem Kausalgesetz eintretende Wechsel, betrifft also jedesmal einen bestimmten Theil des Raumes und einen bestimmten Theil der Zeit zugleich und im Verein. Demzufolge vereinigt die Kausalität den Raum mit der Zeit. Wir haben aber gefunden, daß im Wirken, also in der Kausalität, das ganze Wesen der Materie besteht: folglich müssen auch in dieser Raum und Zeit vereinigt seyn, d.h. sie muß die Eigenschaften der Zeit und die des Raumes, so sehr sich Beide widerstreiten, zugleich an sich tragen, und was in jedem von jenen Beiden für sich unmöglich ist, muß sie in sich vereinigen, also die bestandlose Flucht der Zeit mit dem starren unveränderlichen Beharren des Raumes, die unendliche Theilbarkeit hat sie von Beiden. Diesem gemäß finden wir durch sie zuvörderst das Zugleichseyn herbeigeführt, welches weder in der bloßen Zeit, die kein Nebeneinander, noch im bloßen Raum, der kein Vor, Nach oder Jetzt kennt, seyn konnte. Das Zugleichseyn vieler Zustände aber macht eigentlich das Wesen der Wirklichkeit aus: denn durch dasselbe wird allererst die Dauer möglich, indem nämlich diese nur erkennbar ist an dem Wechsel des mit dem Dauernden zugleich Vorhandenen; aber auch nur mittelst des Dauernden im Wechsel erhält dieser jetzt den Charakter der Veränderung, d.h. des Wandels der Qualität und Form, beim Beharren der Substanz, d.i. der Materie. Im bloßen Raum wäre die Welt starr und unbeweglich: kein Nacheinander, keine Veränderung, kein Wirken: eben mit dem Wirken ist aber auch die Vorstellung der Materie aufgehoben. In der bloßen Zeit wiederum wäre alles flüchtig: kein Beharren, kein Nebeneinander und daher kein Zugleich, folglich keine Dauer: also wieder auch keine Materie. Erst durch die Vereinigung von Zeit und Raum erwächst die Materie, d.i. die Möglichkeit des Zugleichseyns und dadurch der Dauer, durch diese wieder des Beharrens der Substanz, bei der Veränderung der Zustände. Im Verein von Zeit und Raum ihr Wesen habend, trägt die Materie durchweg das Gepräge von Beiden. Sie beurkundet ihren Ursprung aus dem Raum, theils durch die Form, die von ihr unzertrennlich ist, besonders aber (weil der Wechsel allein der Zeit angehört, in dieser allein und für sich aber nichts Bleibendes ist) durch ihr Beharren (Substanz), dessen Gewißheit a priori daher ganz und gar von der des Raumes abzuleiten ist: ihren Ursprung aus der Zeit aber offenbart sie an der Qualität (Accidenz), ohne die sie nie erscheint, und welche schlechthin immer Kausalität, Wirken auf andere Materie, also Veränderung (ein Zeitbegriff) ist. Die Gesetzmäßigkeit dieses Wirkens aber bezieht sich immer auf Raum und Zeit zugleich und hat eben nur dadurch Bedeutung. Was für ein Zustand zu dieser Zeit an diesem Ort eintreten muß, ist die Bestimmung, auf welche ganz allein die Gesetzgebung der Kausalität sich erstreckt. Auf dieser Ableitung der Grundbestimmungen der Materie aus den uns a priori bewußten Formen unserer Erkenntniß beruht es, daß wir ihr gewisse Eigenschaften a priori zuerkennen, nämlich Raumerfüllung, d.i. Undurchdringlichkeit, d.i. Wirksamkeit, sodann Ausdehnung, unendliche Theilbarkeit, Beharrlichkeit, d.h.

Unzerstörbarkeit, und endlich Beweglichkeit: hingegen ist die Schwere, ihrer Ausnahmslosigkeit ungeachtet, doch wohl der Erkenntniß a posteriori beizuzählen, obgleich Kant in den „Metaphys. Anfangsgr. d. Naturwiss.", S. 71 (Rosenkranz. Ausg., S. 372) sie als a priori erkennbar aufstellt.

Wie aber das Objekt überhaupt nur für das Subjekt daist, als dessen Vorstellung; so ist jede besondere Klasse von Vorstellungen nur für eine eben so besondere Bestimmung im Subjekt da, die man ein Erkenntnißvermögen nennt. Das subjektive Korrelat von Zeit und Raum für sich, als leere Formen, hat Kant reine Sinnlichkeit genannt, welcher Ausdruck, weil Kant hier die Bahn brach, beibehalten werden mag; obgleich er nicht recht paßt, da Sinnlichkeit schon Materie voraussetzt. Das subjektive Korrelat der Materie oder der Kausalität, denn Beide sind Eines, ist der Verstand, und er ist nichts außerdem. Kausalität erkennen ist seine einzige Funktion, seine alleinige Kraft, und es ist eine große, Vieles umfassende, von mannigfaltiger Anwendung, doch unverkennbarer Identität aller ihrer Äußerungen. Umgekehrt ist alle Kausalität, also alle Materie, mithin die ganze Wirklichkeit, nur für den Verstand, durch den Verstand, im Verstande. Die erste, einfachste, stets vorhandene Aeußerung des Verstandes ist die Anschauung der wirklichen Welt: diese ist durchaus Erkenntniß der Ursache aus der Wirkung: daher ist alle Anschauung intellektual. Es könnte dennoch nie zu ihr kommen, wenn nicht irgend eine Wirkung unmittelbar erkannt würde und dadurch zum Ausgangspunkte diente. Dieses aber ist die Wirkung auf die thierischen Leiber. Insofern sind diese die unmittelbaren Objekte des Subjekts: die Anschauung aller andern Objekte ist durch sie vermittelt. Die Veränderungen, welche jeder thierische Leib erfährt, werden unmittelbar erkannt, d.h. empfunden, und indem sogleich diese Wirkung auf ihre Ursache bezogen wird, entsteht die Anschauung der letzteren als eines Objekts. Diese Beziehung ist kein Schluß in abstrakten Begriffen, geschieht nicht durch Reflexion, nicht mit Willkür, sondern unmittelbar, nothwendig und sicher. Sie ist die Erkenntnißweise des reinen Verstandes, ohne welchen es nie zur Anschauung käme; sondern nur ein dumpfes, pflanzenartiges Bewußtsein der Veränderungen des unmittelbaren Objekts übrig bliebe, die völlig bedeutungslos auf einander folgten, wenn sie nicht etwan als Schmerz oder Wollust eine Bedeutung für den Willen hätten. Aber wie mit dem Eintritt der Sonne die sichtbare Welt dasteht; so verwandelt der Verstand mit einem Schlage, durch seine einzige, einfache Funktion, die dumpfe, nichtssagende Empfindung in Anschauung. Was das Auge, das Ohr, die Hand empfindet, ist nicht die Anschauung: es sind bloße Data. Erst indem der Verstand von der Wirkung auf die Ursache übergeht, steht die Welt da, als Anschauung im Raume ausgebreitet, der Gestalt nach wechselnd, der Materie nach durch alle Zeit beharrend: denn er vereinigt Raum und Zeit in der Vorstellung Materie, d.i. Wirksamkeit. Diese Welt als Vorstellung ist, wie nur durch den Verstand, auch nur für den Verstand da. Im ersten Kapitel meiner Abhandlung „Ueber das Sehn und die Farben" habe ich bereits auseinandergesetzt, wie aus den Datis, welche die Sinne liefern, der Verstand die Anschauung schafft, wie durch Vergleichung der Eindrücke, welche vom nämlichen Objekt die verschiedenen Sinne erhalten, das Kind die Anschauung erlernt, wie eben nur dieses den Aufschluß über so viele Sinnenphänomene giebt, über das einfache Sehn mit zwei Augen, über das Doppeltsehn beim Schielen, oder bei ungleicher Entfernung hinter einander stehender Gegenstände, die man zugleich ins Auge faßt, und über allen Schein, welcher durch eine plötzliche Veränderung an den Sinneswerkzeugen hervorgebracht wird."

Schopenhauer's will & (Einstein's) cosmic energy

(ZiR) S. 110: „Der Wille ist das verbindendende Band zwischen allen Lebewesen; … Alles was ist, ist nur Erscheinung von Willen, verkörperter Wille. … Die Welt ist für uns Vorstellung, in Wahrheit aber ist sie Wille, die Erscheinung einer in allem Leben wirkende Kraft, eine irrational kosmische Energie, die sich im Prisma unserer Erkenntnis in unendlichen Gestalten bricht, deren einzigen Zweck es ist: zu leben, also Ausdruck des Willens zu sein. Die Welt des Willen ist zwar die „wahre" Welt, aber sie ist nicht, wie Platons Welt der Ideen, jenseitig und transzendent. ES ist die Welt, in der wir leben: Sie erscheint uns als Vorstellung, aber die Vorstellung ist nur die Form, in der der Mensch die Welt des Willens erkennt. Damit hat Schopenhauer die Welt auf jene beiden Begriffe gebracht, um die sich seine ganze Philosophie dreht: Wille und Vorstellung, die Tiefendimensionen der Welt und ihre Form der Erscheinung.

Die Idee einer Tiefenrealität in Form einer in der Natur allseits wirkenden Kraft war keineswegs neu (Alexander v. Humboldt, Ansichten über die Natur", „ewige, all-verbreitete Kraft".

Der Schopenhauersche Wille hat keinen Urheber, er darf also nicht mit dem Willen einer Person verwechselt werden. Er ist auch keine Ursache von irgendetwas – den Zusammenhang zwischen Ursache und Wirkung gibt es nur in der Welt der Vorstellungen. Schopenhauers Wille ist schlicht die letzte Realität, eine kosmische Energie, die keine Frage nach dem Warum oder Wozu mehr zulässt"

Schposki E. W.
Atomphysik

(ScW) S. 187: *„In der Literatur findet man hin und wieder die Behauptung, daß sich bei Prozessen, die mit einer Freisetzung von Energie einhergeht (z.B. bei Kernreaktionen) „Masse in Energie umwandelt". Eine solche Formulierung ist nicht exakt und deshalb abzulehnen. Masse und Energie sind untrennbar miteinander verbunden, sie stellen sozusagen zwei Seiten derselben universellen Eigenschaft der Materie dar und können sich daher nicht ineinander „umwandeln". Es ist natürlich richtig, daß bei Prozessen, bei denen die kinetische Energie zunimmt, die Ruhmasse $\sum m_0$ eine entsprechende Verminderung erfährt. Aber dem Überschuß an kinetischer Energie, also ΔE_{kin}, der bei der Reaktion entsteht, entspricht die Masse $\Delta E_{kin}/c^2$, die die Verminderung von $\sum m_0$ exakt kompensiert, ebenso wie dieser letzteren Größe die Energie $\sum m_0 c^2$ entspricht, die zusammen mit ΔE_{kin} exakt gleich $\sum m\, c^2$ vor der Reaktion ist"*

Schrödinger E.
Statistical Thermodynamics (ScE)
What is Life? (ScE1)

(ScE) p. 1*: „There is, essentially, only one problem in statistical thermodynamics: the distribution of a given amount of energy E over N identical systems. Or perhaps better: to determine the distribution of an assembly of N identical systems over the possible states in which this assembly can find itself, given that the energy of the assembly is a constant E"*

(ScE) pp. 76-82*: „According to physical laws the regular course of events is never the consequence of one well-ordered configuration of atoms. … On the contrary, in biology a single group of atoms existing only in one copy produces orderly event, marvellously tuned in with each other and with the environment according to most subtle laws. … It appears that there are two different „mechanisms" by which orderly events can be produced: the „statistical mechanism" which produces „order from disorder" and the biological „mechanism", producing „order from order". …. According to Schrödinger the latter principle is nothing else that the principle of quantum theory over again and the distinction between M. Planck's physical-statistical type of laws and „dynamical" laws, (PlM), is precisely the one being labbelled as „order from order" and „order from disorder"*

(ScE1) p. 80*: „The orderliness encountered in the unfolding of life springs from a different source. It appears that there are two different „mechanisms" by which orderly events can be produced: the „statistical mechanism" which produces „order from disorder" and the new one, producing „order from order". To the unprejudiced mind the second principle appears to be much simpler, much more plausible. No doubt it is. That is where physicists were so proud to have fallen in with the other one, the „order-from-disorder" principle, which is actually followed in Nature and which alone conveys an understanding of the great line of natural events, in the first place of their irreversibility. But we cannot expect that the „laws of physics" derived from it suffice straightaway to explain the behaviour of living matter, whose most striking features are visible based to a large extent on the „order-from-order" principle. You would not expect two entirely different mechanisms to bring about the same type of law – you would not expect your latch-key to open your neighbour's door as well"*
(ScE1) p. 81: *I remember an interesting little paper by Max Planck on the topic „The Dynamical and the Statistical Type of Law" („Dynamische und Statistische Gesetzmässigkeit"), (PlM). The distinction is precisely the one we have here labbelled as „order from order" and „order from disorder". The object of that paper was to show how the interesting statistical type of law, controlling large-scale events, is constituted from the „dynamical" laws supposed to govern the small-scale events, the interaction of the single atoms and molecules. The latter type is illustrated by large-scale mechanical phenomena, as the motion of the planets or of a clock, etc."*
(ScE1) Mind & Matter, p. 152: *"To my view the 'statistical theory of time' has an even stronger bearing on the philosophy of time than the theory of relativity. The latter, however revolutionary, leaves untouched the undirectional flow of time, which is presupposes, while the statistical theory constructs it from the order of the events. This means a liberation from the tyranny of old Chronos"*

Is Life based on the Laws of Physics?

We seem to arrive at the ridiculous conclusion that the clue to the understanding of life is that it is based on a pure mechanism, a „clock-work" in the sense of Planck's paper, (PlM). The conclusion is not ridiculous and is, in my opinion, not entirely wrong, but it has to be taken „with a very big grain of salt".

New laws to be expected in the organism

What I wish to make clear in this chapter is, in short, that from all we have learnt about the structure of living matter, we must be prepared to find it working in a manner that cannot be reduced to the ordinary laws of physics. And that not on the ground that there is any „new force" or what not, directing the behaviour of the single atoms within a living organism, but because the construction is different from anything we have yet tested in the physical laboratory. To put it crudely, an engineer, familar with heat engines only, will, after inspection the construction of an electric motor, be prepared to find it workling along principles which he does not yet understand. He finds the copper familar to him in kettles used here in the form of long, long wires wound in coils; the iron familar to hum in levers and bars and steam cylinders is here filling the interior of those coils of copper wire. He will be convinced that it is the same copper and the same iron, subject to the same laws of Nature, and he is right in that. The difference in construction is enough to prepare him for an entirely different way of functioning. He will not suspect that an electric motor is driven by a ghost because it is spinning by the turn of a switch, without boiler and steam.

Reviewing the biological situation

The unfolding of events in the life cycle of an organism exhibits an admirable regularity and orderliness, unrivalled by anything we meet with in inanimate matter. We find it controlled by a supremely well-ordered group of atoms, which represent only a very small fraction of the sum total in every cell. Moreover, from the view we have formed of the mechanism of mutation we conclude that dislocation of just a few atoms within the group of „governing atoms" of the germ cell suffices to bring about a well-defined change in the large-scale hereditary characteristics of the organism.

These facts are easily the most interesting that science has revealed in our days. We may be inclined to find them, after all, not wholly unacceptable. An organism's astonishing gift of concentration of a „stream of order" on itself and thus escaping the decay into atomic chaos – of „drinking orderliness" from a suitable environment – seems to be connected with the presence of the „aperiodic solids", the chromosome molecules, which doubtless represent the highest degree of well-ordered atomic association we know of – much higher than the ordinary periodic crystal – in virtue of the individual role every atom and every radical is playing here.
To put it briefly, we witness the event that existing order displays the power of maintaining itself and of producing orderly events. That sounds plausible enough, though in finding it plausible we, no doubt, draw on experience concerning social organization and other events which involve the activity of organisms. And so it might seem that something like a vicious circle is implied.

Summarizing the physical situation

However that may be, the point to emphasize again and again is that to the physicist the state of affairs is not only not plausible but most common exciting, because it is unprecedented. Contrary to the common belief, the regular course of events, governed by the laws of physics, is never the consequence of one well-ordered configuration of atoms – not unless that configuration of atoms repeats itself a great number of times, either as in the period crystal or as in a liquid or in a gas composed of a great number of identical molecules.

Even when the chemist handles a very complicated molecule in vitro he always faced with an enormous of like molecules. To them his laws apply. He might tell us, for example, that one minute after he has started some particular reaction half of the molecules will have reacted, and after a second minute three-quarters of them will have done so. But whether any particular molecule, supposing you could follow its course, will be among

those which have reacted or among those which are still untouched, he could not preduct. That is a matter of pure chance.

This is not a purely theoretical conjecture. It is not that we can never observe the fate of a single small group of atoms or even of a single atom. We can, occasionally. But whenever we do, we find complete irregularity, co-operating to product regularity only on the average. …. The Brownian movement of a small particle suspended in a liquid is completely irregular. But if there are many similar particles, they will by their irregular movement give rise to the regular phenomenon of diffusion.

The disintegration of a single radiactive atom is observable (it emits a projectile which causes a visible scintillation on a fluorescent screen). But if you are given a single radioactive atom, its probable lifetime is much less certain that that of a healthy sparrow. Indeed, nothing more can be said about it than this: as long as it lives (and that may be for thousands of years) the chance of its blowing up within the next second, whether large or small, remains the same. This patent lack of individual determination nevertheless results in the exact exponential law of decay of a large number of radioactive atoms of the same kind.

The striking contrast

In biology we are faced with entirely different situation. A single group of atoms existing only in one copy produces orderly event, marvellously tuned in with each other and with the environment according to most subtle laws. I said, existing only in one copy, for after all we have the example of the egg and of the unicellular organism. In the following stages of higher organism the copies are muliplied, that is true. But to what extent? Something like 10^{14} in a grown mammal, I understand. What is that! Only a millionth of the number of molecules in one cubic inch of air. Though comparatively bulky, by coalescing they would form but a tiny drop of liquid. And look at the way they are actually distributed. Every cell harbours just one of them (or two, if we bear in mind diploidy). Since we know the power this tiny central office has in the isolated cell, do they not resemble stations of local government dispersed through the body, communicating with each other with great ease, thanks to the code that is common to all of them?

Well, this is a phantastic description, perhaps less becoming a scientist that a poet. However, it needs no poetical imagination but only clear and sober scientific reflection to recognize that we are here obviously faced with events whose regular and lawful unfolding is guided by a „mechanism" entirely different from the „probability mechanism" of physics. For it is simply a fact of observation that the guiding principle in every cell is embodied in a single atomic association existing only in one copy (or sometime two) – and in fact of observation that it results in producing events which are a paragon of orderliness. Whether we find it astonishing or whether we find it quite plausible that a small but highly organized group of atoms be capable of acting in this manner, the situation is unprecedented, it is unknown anywhere else ecept in living matter. The physicist and the chemist, investigating inanimate matter, have never witnessed phenomena which they had to interpret in this way. The case did not arise and so our theory does not cover it – our beautiful statistical theory of which we were so justly proud because it allowed us to look behind the curtain, to watch the magnificent order of exect physical law coming forth from atomic and molecular disorder; because it revealed that the most important, the most general, the all-embracing law of entropy increase could be understood without a special assumption ad hoc, for it is nothing but molecular disorder itself.

Two ways of producing orderliness

The orderliness encountered in the unfolding of life springs from a different source. It appears that there are two different „mechanisms" by which orderly events can be produced: the „statistical mechanism" which produces „order from disorder" and the new one, producing „order from order". To the unprejudiced mind the second principle appears to be much simpler, much more plausible. No doubt it is. That is where physicists were so proud to have fallen in with the other one, the „order-from-disorder" principle, which is actually followed in Nature and which alone conveys an understanding of the great line of natural events, in the first place of their irreversibility. But we cannot expect that the „laws of physics" derived from it suffice straightaway to explain the behaviour of living matter, whose most striking features are visible based to a large extent on the „order-from-order" principle. You would not expect two entirely different mechanisms to bring about the same type of law – you would not expect your latch-key to open your neighbour's door as well.

We must therefore not be discouraged by the difficulty of interpreting life by the ordinary laws of physics. For that is just what is to be expected from the knowledge we have gained of the structure of living matter. We must be prepared to find a new type of physical law prevailing in it. Or are we to term it a non-physical, not to say a super-physical law?

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The new principle is not alien to physics

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No, I do not think that. For the new principle that is involved is a genuinely physical one: it is, in my opinion, nothing else that the principle of quantum theory over again. To explain this, we have to go to some length, including a refinement, not to say an amendment, of the assertion previously made, namely, that all physical laws are based on statistics.

This assertion, made again and again, could not fail to arouse contraction. For, indeed, there are phenomena whose conspicuous features are visible based directly on the „order-from-order" principle and appear to have nothing to do with statistics or molecular disorder.

The order of the solar system, the motion of the planets, is maintained for an almost indefinite time. The constellation of this moment is directly connected with the constellation at any particular moment in the times of the Pyramids; it can be traced back to it, or vice versa. Historical eclipses have been calculated and have found in close agreement with historical records or have even in some cases served to correct the accepted chronology. These calculations do not imply any statistics, they are based solely on Newton's law of universal attraction.

Nor does the regular motion of a good clock or of any similar mechanism appear to have anything to do with statistics. In short, all purely mechanical events seem to follow distinctly and directly the „order-from-order" principle. And if we say „mechanical", the term must be taken in a wide sense. A very useful kind of clock is, as you know, based on the regular transmission of electric pulses from the power station.

I remember an interesting little paper by Max Planck on the topic „The Dynamical and the Statistical Type of Law" („Dynamische und Statistische Gesetzmässigkeit"), (PlM). The distinction is precisely the one we have here labbelled as „order from order" and „order from disorder". The object of that paper was to show how the interesting statistical type of law, controlling large-scale events, is constituted from the „dynamical" laws supposed to govern the small-scale events, the interaction of the single atoms and molecules. The latter type is illustrated by large-scale mechanical phenomena, as the motion of the planets or of a clock, etc.

Thus it would appear that the „new" principle, the order-from-order principle, to which we have pointed with great solemnity as being the real clue to the understanding of life, is not at all new to physics. Planck's attitude even vindicates priority to it. We seem to arrive at the ridiculous conclusion that the clue to the understanding of life is that it is based on a pure mechanism, a „clock-work" in the sense of Planck's paper. The conclusion is not ridiculous and is, in my opinion, not entirely wrong, but it has to be taken „with a very big grain of salt".
(PlM) Planck M., Dynamische und Statistische Gesetzmässigkeit, (the Dynamical and the Statistical Type of Law). In: Roos, H., Hermann, A. (eds) Vorträge Reden Erinnerungen. Springer, Berlin, Heidelberg, (2001) 87-102.

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Schrödinger E.
Mind and Matter
(ScE1) p. 95 ff.

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„To my mind the key is to be found in the following well-known facts. Any succession of events in which we take part with sensations, perceptions and possibly with actions gradually drops out of the domain of consciousness when the same string of events repeats itself in the same way very often. But it immediately shot up into the conscious region, if at such a repetition either the occasion or the environmental conditions met with on its pursuit differ from what they were on all the previous incidences. Even so, at first anyhow, only those modifications or „differentials" intrude into the conscious sphere that distinguish the new incidence from previous ones and thereby usually can for „new considerations". Of all this each of us supply dozens of examples out of personal experience, so that I may forgo enumerating any at the moment.

The gradual fading from consciousness is of outstanding importance to the entire structure of our mental life, which is wholly based on the process of acquiring practice by repetition, a process which Richard Semon has generalized to the concepts of Mneme, about which we shall have more to say later. A single experience that is never to repeat itself is biologically irrelevant. Biological value lies only in learning the suitable reaction to situation that offers itself again and again, in many cases periodically, and always requires the same response if the organism is to hold its ground. Now from our own inner experience we know the following. On the first few repetitions a new element turns up in the mind, the „already met with" or „notal" as Richard Avenarius has called it. On frequent repetition the whole string of events becomes more and more of a routine, it becomes more and more uninteresting, the responses becomes even more reliable according as they fade from consciousness. …. But whenever the situation exhibits a relevant differential – let us say the road is up at the place where we used to cross it, so that we have to make a detour – this differential and our response to it intrude into consciousness, from which, however, they soon fade below the threshold, if the differential becomes a constantly repeated feature. Faced with changing alternatives, bifurcations develop and may be fixed in the same way. We branch off to the University Lecture Rooms or to the Physics Laboratory at the right point without much thinking, provided that both are frequently occuring destinations.

Now this fashion differentials, variants of response, bifucations, etc., are piled up one upon the other in unsurveyable abundance, but only the most recent ones remain in the domain of consciuosness, only the most recent ones remain in the domain of consciousness, only the most recent ones remain in the domain of consciousness, oonly those with regard to which the living substance is still in the stage of learning or practising. One might say, metaphorically, that consciousness is the tutor who supervises the education of the living substances, but leaves his pupil alone to deal with all those tasks for which he is already sufficently trained. But I wish to underline three times in red ink that I mean this only as a metaphor. The fact is only this, that new situations and the new responses they prompt are kept in the light of consciousness; old and well prectised ones are no longer so."

Schrödinger E.
Mind and Matter
The Principle of Objectivation
(ScE1) p. 117 ff.

„Nine years ago I put forward two general principles that form the basis of the scientific method, the principle of the understandability of nature, and the principle of objectivation. Since then I have touched on this matter now and again, last time in my little book Nature and the Greeks. *I wish to deal here in detail with the second one, the objectivation. Before I say what I mean by that, let me remove a possible misunderstanding which might arise, as I came to realize from several reviews of that book, though I thought I had prevented it from the outset. I t is simply this: some people seemed to think that my intention was to lay down the fundamental principles which ought to be at the basis of scientific method or at least which justly and rightly are at the basis of science and ought to be kept at all cost. Far from this, I only maintained and maintain that they are - and, by the way, as an inheritance from the ancient Greeks, from whom all our Western science and scientific thought has originated.*

The misunderstanding is not very astonishing. If you hear a scientist pronounce basic principles of science, stressing two of them as particularly fundamental and of old standing, it is natural to think that he is at least strongly in favour of them and wishes to impose them. But on the other hand, you see, science never imposes anything, science states*. Science aims at nothing but making true and adequate statements about its object. The scientist only imposes two things, namely truth and sincerity, imposes them upon himself and upon other scientists. In the present case the object is science itself, as it has developed and has become and at present is, not as it ought to be or ought to develop in future.*

Now let us turn to these two principles themselves. As regards the first, 'that nature can be understood', I will say here only a few words. The most astonishing thing about it is that it had to be invented, that it was at all necessary to invent it. I t stems from the Milesian School, the physiologoi. *Since then it has remained untouched, though perhaps not always uncontaminated. The present line in physics is possibly a quite serious contamination. The uncertainty principle, the alleged lack of strict causal connection in nature, may represent a step away from it, a partial abandonment. It would be interesting to discuss this, but I set my heart here on discussing the other principle, that which I called objectivation.*

By this I mean the thing that is also frequently called the 'hypothesis of the real world' around us. I maintain that it amounts to a certain simplification which we adopt in order to master the infinitely intricate problem of nature. Without being aware of it and without being rigorously systematic about it, we exclude the Subject of Cognizance from the domain of nature that we endeavour to understand. We step with our own person back into the part of an onlooker who does not belong to the world, which by this very procedure becomes an objective world. This device is veiled by the following two circumstances. First, my own body (to which my mental activity is so very directly and intimately linked) forms part of the object (the real world around me) that I construct out of my sensations, perceptions and memories. Secondly, the bodies of other people form part of this objective world. Now I have very good reasons for believing that these other bodies are also linked up with, or are, as it were, the seats of spheres of consciousness. I can have no reasonable doubt about the existence or some kind of actualness of these foreign spheres of consciousness, yet I have absolutely no direct subjective access to any of them. Hence I am inclined to take them as something objective, as forming part of the real world around me. Moreover, since there is no distinction between myself and others, but on the contrary full symmetry for all intents and purposes, I conclude that I myself also form part of this real material world around me. I so to speak put my own sentient self (which had constructed this world as a mental product) back into it - with the pandemonium of disastrous logical consequences that flow from the aforesaid chain of faulty conclusions. We shall point them out one by one; for the moment let me just mention the two most blatant antinomies due to our awareness of the fact that a moderately satisfying picture of the world has only been reached at the high price of taking ourselves out of the picture, stepping back into the role of a non-concerned observer.

The first of these antinomies is the astonishment at finding our world picture 'colourless, cold, mute'. Colour and sound, hot and cold are our immediate sensations; small wonder that they are lacking in a world model from which we have removed our own mental person.

The second is our fruitless quest for the place where mind acts on matter or vice-versa, so well known from Sir Charles Sherrington's honest search, magnificently expounded in Man on his Nature. *The material world has only been constructed at the price of taking the self, that is, mind, out of it, removing it; mind is not part of it; obviously, therefore, it can neither act on it nor be acted on by any of its parts. (This was stated in a very brief and clear sentence by Spinoza, see p. 122.)*

I wish to go into more detail about some of the points I have made. First let me quote a passage from a paper of C.G. Jung which has gratified me because it stresses the same point in quite a different context, albeit in a strongly vituperative fashion. While I continue to regard the removal of the Subject of Cognizance from the objective world picture as the high price paid for a fairly satisfactory picture, for the time being, Jung goes further and blames us for paying this ransom from an inextricably difficult situation. He says:

All science (*Wissenschaft*) however is a function of the soul, in which all knowledge is rooted. The soul is the greatest of all cosmic miracles, it is the *conditio sine qua* non of the world as an object. It is exceedingly astonishing that the Western world (apart from very rare exceptions) seems to have so little appreciation of this being so. The flood of external objects of cognizance has made the subject of all cognizance withdraw to the background, often to apparent non-existence.

Of course Jung is quite right. It is also clear that he, being engaged in the science of psychology, is much more sensitive to the initial gambit in question, much more so than a physicist or a physiologist. Yet I would say that a rapid withdrawal from the position held for over 2,000 years is dangerous. We may lose everything without gaining more than some freedom in a special - though very important - domain. But here the problem is set. The relatively new science of psychology imperatively demands living-space, it makes it unavoidable to reconsider the initial gambit. This is a hard task, we shall not settle it here and now, we must be content at having pointed it out.

While here we found the psychologist Jung complaining about the exclusion of the mind, the neglect of the soul, as he terms it, in our world picture, I should now like to adduce in contrast, or perhaps rather as a supplement, some quotations of eminent representatives of the older and humbler sciences of physics and physiology, just stating the fact that 'the world of science' *has become so horribly objective as to leave no room for the mind and its immediate sensations.*

Some readers may remember A.S. Eddington's 'two writing desks'; one is the familiar old piece of furniture at which he is seated, resting his arms on it, the other is the scientific physical body which not only lacks all and

every sensual qualities but in addition is riddled with holes; by far the greatest part of it is empty space, just nothingness, interspersed with innumerable tiny specks of something, the electrons and the nuclei whirling around, but always separated by distances at least 100,000 times their own size. After having contrasted the two in his wonderfully plastic style he summarizes thus:

In the world of physics we watch a shadowgraph performance of familiar life. The shadow of my elbow rests on the shadow table as the shadow ink flows over the shadow paper ... The frank realization that physical science is concerned with a world of shadows is one of the most significant of recent advances.

Please note that the very recent advance does not lie in the world of physics itself having acquired this shadowy character; it had it ever since Democritus of Abdera and even before, but we were not aware of it; we thought we were dealing with the world itself; expressions like model or picture for the conceptual constructs of science canle up in the second half of the nineteenth century, and not earlier, as far as I know.

Not much later Sir Charles Sherrington published his momentous Man on his Nature. *The book is pervaded by the honest search for objective evidence of the interaction between matter and mind. I stress the epithet 'honest', because it does need a very serious and sincere endeavour to look for something which one is deeply convinced in advance cannot be found, because (in the teeth of popular belief) it does not exist. A brief summary of the result of this search is found on p. 357:*

Mind, the anything perception can compass, goes therefore in our spatial world more ghostly than a ghost. Invisible, intangible, it is a thing not even of outline; it is not a 'thing'. It remains without sensual confirmation and remains without it forever.

In my own words I would express this by saying: Mind has erected the objective outside world of the natural philosopher out of its own stuff. Mind could not cope with this gigantic task otherwise than by the simplifying device of excluding itself - withdrawing from its conceptual creation. Hence the latter does not contain its creator.

I cannot convey the grandeur of Sherrington's immortal book by quoting sentences; one has to read it oneself. Still, I will mention a few of the more particularly characteristic.

> Physical science ... faces us with the impasse that mind per se cannot play the piano - mind per se cannot move a finger of a hand (p.222).

> Then the impasse meets us. The blank of the 'how' of mind's leverage on matter. The inconsequence staggers us. Is it a misunderstanding? (p. 232).

*Hold these conclusions drawn by an experimental physiologist of the twentieth century against the simple statement of the greatest philosopher of the seventeenth century: B. Spinoza (*Ethics, Pt III, Prop. 2):

> Nec corpus mentem ad cogitandum, nec mens corpus ad motum, neque ad quietem, nec ad aliquid (si quid est) aliud determinare potest.

> [Neither can the body determine the mind to think, nor the mind determine the body to motion or rest or anything else (if such there be).]

The impasse is *an impasse. Are we thus not the doers of our deeds? Yet we feel responsible for them, we are punished or praised for them, as the case may be. It is a horrible antinomy. I maintain that it cannot be solved on the level of present-day science which is still entirely engulfed in the 'exclusion principle' - without knowing it - hence the antinomy. To realize this is valuable, but it does not solve the problem. You cannot remove the 'exclusion principle' by act of parliament as it were. Scientific attitude would have to be rebuilt, science must be made anew. Care is needed.*

So we are faced with the following remarkable situation. While the stuff from which our world picture is built is yielded exclusively from the sense organs as organs of the mind, so that every man's world picture is and always remains a construct of his mind and cannot be proved to have any other existence, yet the conscious mind itself remains a stranger within that construct, it has no living space in it, you can spot it nowhere in space. We do not usually realize this fact, because we have entirely taken to thinking of the personality of a human being, or for that matter also that of an animal, as located in the interior of its body. To learn that it cannot really be found

there is so amazing that it meets with doubt and hesitation, we are very loath to admit it. We have got used to localizing the conscious personality inside a person's head – I should say an inch or two behind the midpoint of the eyes. From there it gives us, as the case may be, understanding or loving or tender - or suspicious or angry looks. I wonder has it ever been noted that the eye is the only sense organ whose purely receptive character we fail to recognize in naïve thought. Reversing the actual state of affairs, we are much more inclined to think of 'rays of vision', issuing from the eye, than of the 'rays of light' that hit the eyes from outside. You quite frequently find such a 'ray of vision' represented in a drawing in a comic paper, or even in some older schematic sketch intended to illustrate an optic instrunlent or law, a dotted line emerging from the eye and pointing to the object, the direction being indicated by an arrowhead at the far end. –

Dear reader or, or better still, dear lady reader, recall the bright, joyful eyes with which your child beams upon you when you bring him a new toy, and then let the physicist tell you that in reality nothing emerges from these eyes; in reality their only objectively detectable function is, continually to be hit by and to receive light quanta. In reality! A strange reality! Something seems to be missing in it.

It is very difficult for us to take stock of the fact that the localization of the personality, of the conscious mind, inside the body is only symbolic, just an aid for practical use. Let us, with all the knowledge we have about it, follow such a 'tender look' inside the body. We do hit there on a supremely interesting bustle or, if you like, machinery. We find millions of cells of very specialized build in an arrangement that is unsurveyably intricate but quite obviously serves a very far-reaching and highly consummate mutual communication and collaboration; a ceaseless hammering of regular electrochemical pulses which, however, change rapidly in their configuration, being conducted from nerve cell to nerve cell, tens of thousands of contacts being opened and blocked within every split second, chemical transformations being induced and may be other changes as yet undiscovered. All this we meet and, as the science of physiology advances, we may trust that we shall come to know more and more about it. But now let us assume that in a particular case you eventually observe several efferent bundles of pulsating currents, which issue from the brain and through long cellular protrusions (motor nerve fibres), are conducted to certain muscles of the arm, which, as a consequence, tends a hesitating, trembling hand to bid you farewell - for a long, heart-rending separation; at the same time you may find that some other pulsating bundles produce a certain glandular secretion so as to veil the poor sad eye with a crape of tears. But nowhere along this way from the eye through the central organ to the arm muscles and the tear glands - nowhere, you may be sure, however far physiology advances, will you ever meet the personality, will you ever meet the dire pain, the bewildered worry within this soul, though their reality is to you so certain as though you suffered them yourself - as in actual fact you do!

The picture that physiological analysis vouchsafes to us of any other human being, be it our most intimate friend, strikingly recalls to me Edgar Allan Poe's masterly story, which I am sure many a reader remembers well; I mean The Masque of the Red Death. *A princeling and his retinue have withdrawn to an isolated castle to escape the pestilence of the red death that rages in the land. After a week or so of retirement they arrange a great dancing feast in fancy dress and mask. One of the masks, tall, entirely veiled, clad all in red and obviously intended to represent the pestilence allegorically, makes everybody shudder, both for the wantonness of the choice and for the suspicion that it might be an intruder. At last a bold young man approaches the red mask and with a sudden jolt tears off veil and head-gear. It is found empty.*

Now our skulls are not empty. But what we find there, in spite of the keen interest it arouses, is truly nothing when held against the life and the emotions of the soul.
To become aware of this may in the first moment upset one. To me it seems, on deeper thought, rather a consolation. If you have to face the body of a deceased friend whom you sorely miss, is it not soothing to realize that this body was never really the seat of his personality but only symbolically 'for practical reference'?

As an appendix to these considerations, those strongly interested in the physical sciences might wish to hear me pronounce on a line of ideas, concerning subject and object, that has been given great prominence by the prevailing school of thought in quantum physics, the protagonists being Niels Bohr, Werner Heisenberg, Max Born and others. Let me first give you a very brief description of their ideas. It runs as follows:

We cannot make any factual statement about a given natural object (or physical system) without 'getting in touch' with it. This 'touch' is a real physical interaction. Even if it consists only in our 'looking at the object' the latter must be hit by light-rays and reflect them into the eye, or into some instrument of observation. This means that the object is affected by our observation. You cannot obtain any knowledge about an object while

leaving it strictly isolated. The theory goes on to assert that this disturbance is neither irrelevant nor completely surveyable. Thus after any number of painstaking observations the object is left in a state of which some features (the last observed) are known, but others (those interfered with by the last observation) are not known, or not accurately known. This state of affairs is offered as an explanation why no complete, gapless description of any physical object is ever possible.

If this has to be granted - and possibly it has to be granted - then it flies in the face of the principle of understandability of nature. This in itself is no opprobrium. I told you at the outset that my two principles are not meant to be binding on science, that they only express what we had actually kept to in physical science for many, many centuries and what cannot easily be changed. Personally I do not feel sure that our present knowledge as yet vindicates the change. I consider it possible that our models can be modified in such a fashion that they do not exhibit at any mornent properties that cannot in principle be observed simultaneously - models poorer in simultaneous properties but richer in adaptability to changes in the environment. However, this is an internal question of physics, not to be decided here and now. But from the theory as explained before, from the unavoidable and unsurveyable interference of the measuring devices with the object under observation, lofty consequences of an epistemological nature have been drawn and brought to the fore, concerning the relation between subject and object. It is maintained that recent discoveries in physics have pushed forward to the mysterious boundary between the subject and the object. This boundary, so we are told, is not a sharp boundary at all. We are given to understand that we never observe an object without its being modified or tinged by our own activity in observing it. We are given to understand that under the impact of our refined methods of observation and of thinking about the results of our experiments that mysterious boundary between the subject and the object has broken down.

In order to criticize these contentions let me at first accept the time-hallowed distinction or discrimination between object and subject, as many thinkers both in olden times have accepted it and in recent times still accept it. Among the philosophers who accepted it - from Democritus of Abdera down to the 'Old Man of Konigsberg' *- there were few, if any who did not emphasize that all our sensations, perceptions and observations have a strong, personal, subjective tinge and do not convey the nature of the* 'thing-in-itself, to use Kant's term. *While some of these thinkers might have in mind only a more or less strong or slight distortion, Kant landed us with a complete resignation: never to know anything at all about his* 'thing-in-itself'. *Thus the idea of subjectivity in all appearance is very old and familiar. What is new in the present setting is this: that not only would the impressions we get from our environment largely depend on the nature and the contingent state of our sensorium, but inversely the very environment that we wish to take in is modified by us, notably by the devices we set up in order to observe it.*

Maybe this is so - to some extent it certainly is. May be that from the newly discovered laws of quantum physics this modification cannot be reduced below certain well ascertained limits. Still I would not like to call this a direct influence of the subject on the object. For the subject, if anything, is the thing that senses and thinks. Sensations and thoughts do not belong to the 'world of energy', *they cannot produce any change in this world of energy as we know from Spinoza and Sir Charles Sherrington.*

All this was said from the point of view that we accept the time-hallowed discrimination between subject and object. Though we have to accept it in everyday life 'for practical reference', *we ought, so I believe, to abandon it in philosophical thought. Its rigid logical consequence has been revealed by Kant: the sublime, but empty, idea of the 'thing-in-itself' about which we forever know nothing.*
It is the same elements that go to compose my mind and the world. This situation is the same for every mind and its world, in spite of the unfathomable abundance of 'cross-references' *between them. The world is given to me only once, not one existing and one perceived. Subject and object are only one. The barrier between them cannot be said to have broken down as a result of recent experience in the physical sciences, for this barrier does not exist."*

Schrödinger E.
My View of the World

(ScE2) *VIII, „Consciousness, organic, inorganic, mneme*
Thus Schopenhauer's line of demarcation may be regarded as highly suitable, when he says that in inorganic being 'the essential and permanent element, the basis of identity and integrity, is the material, the matter, the inessential and mutable element being the form. In organic being the reverse is true; for its life, that is, its existence as an organic being, consists precisely in a constant change of matter while the form persists"

(ScE2) *IX, „On becoming conscious*
Consciousness is bound up with learning in organic substance; organic competence is unconscious. Still more briefly, and put in a form which is admittedly rather obscure and open to miss-understanding: Becoming is conscious, being unconscious"

Shu F. H.
The Physics of Astrophysics, Gas Dynamics
The capability of stars to organize themselves in a stable arrangement

(ShF) p. 402: *"In its purest form, Landau damping represents a phase-space behavior peculiar to collisionless systems. Analogs to Landau damping exist, for example, in the interactions of stars in a galaxy at the Lindblad resonances of a spiral downsity wave. Such resonances in an inhomogeneous medium can produce wave absorption (in space rather than in time), which does not usually happen in fluid systems in the absence of dissipative forces (an exception in the behavior of corotation resonances for density waves in a gaseous medium)"*

Smolin L.
The Trouble with Physics
The Unfinished Revolution

(SmL1) p.3 ff.*:*
„Problem 1: Combine general relativity and quantum theory into a single theory that can claim to be the complete theory of nature.

Problem 2: Resolve the problems in the foundations of quantum mechanics, either by making sense of the theory as it stands or by inventing a new theory that does make sense.

Problem 3: Determine whether or not the various particles and forces can be unified in a theory that explains them as manifestations of a single, fundamental entity.

Problem 4: Explain how the values of the three constants in the standard model of particle physics are chosen in nature.

Problem 5: Explain dark matter and dark energy. Or, if they don't exist, determine how and why gravity is modified on large scales. More generally, explain why the constants of the standard model of cosmology, including dark matter, have the values they do"

Smolin L.
Time Reborn
From the Crisis in Physics to the Future of the Universe

(SmL) p. 154: *„Can the demand for sufficient reason be satisfied even in quantum physics? This depends on whether quantum mechanics can be extended to the universe as a whole and give the most fundamental description of nature possible or is only an approximation to a very different cosmological theory. If we can extend quantum theory to the universe as a whole, then the free-will theorem applies at the cosmological scale. Since we assume there is no theory more fundamental, it implies that nature is truly free. The freedom of quantum systems at the cosmological scale would imply a limit to the principle of sufficient reason, because no rational or sufficient reason could be given for the myriad of free choises quantum systems make"*

(SpK) S. 1: *„Ein System von Teilchen oder Quasiteilchen (Ionen, Elektronen, Moleküle, Quarks, Gluonen, Löcher etc.) wird unter recht unterschiedlichen Bedingungen* Plasma *genannt. Bei der Formulierung der Bedingungen treten in der Literatur Unterschiede auf, je nachdem ob man an ionisierten Gasen, Festkörpern, an voll- oder teilionisierten Systemen, oder an makroskopisch neutralen oder nicht-neutralen Anordnungen interessiert ist. Wie so oft werden die Unterschiede und ihre Auswirkungen erst deutlich, wenn allgemeine Kenntnisse vorhanden sind, die einen Einblick in die grundsätzlich neuen Phänomene zulassen. Wir werden deshalb zunächst von einer einfachen und nicht allzu strengen Definition ausgehen und die Systeme weitgehend vereinfachen, um dann im weiteren Verlauf zu verallgemeinern und zu vertiefen.*

Bei diesem Vorgehen lassen wir uns von zwei Gesichtspunkten leiten: Wir müssen enerseits die enorm wichtigen – aber einem Themenkreis für sich darstellenden – Fragen der Struktur der einzelnen „Teilchen" ausgrenzen und wollen andererseits die charakteristischen Erscheinungen eines Vielteilchensystems mit langreichweitiger Wechselwirkung in möglichst einfacher Form herauskristallisieren. Wir starten deshalb mit der Arbeitshypothese, nach der ein Plasma ein makroskopisch neutrales Gas aus vielen elektrisch geladenen (und gegebenenfalls neutralen) Teilchen ist, dessen Verhalten wesentliche durch kollektive Freiheitsgrade bestimmt wird."

(SpK) S. 8*: „An dieser Stelle wird bereits deutlich, warum ein Plasma nicht lediglich ein – wenn auch komplizierteres – Übungsbeispiel für die klassische Elektrodynamik ist. So wie die Elektrodynamik im Rahmen von Kursvorlesungen behandelt wird, handelt es sich bei ihr um einen Theorie der elektromagnetischen Felder und der Bewegung von Teilchen in äußeren vorgegebenen Feldern. Die kollektiven Effekte, die bei der Bewegung vieler Teilchen unter Berücksichtigung der langreichweitigen Wechselwirkung auftreten, stellen demgegenüber neue Erscheinungen da, die spezifische Eigenschaften des Plasmas ausmachen. Die elektrischen Ladungen im Plasmen erzeugen elektromagnetische Felder, die ihrerseits wieder Kräfte auf die Ladungen ausüben und deren Dynamik beeinflussen. Die Beschreibung eines Plasmas muß daher bereits im einfachsten Fall in selbstkonsistenter Weise durch die mechanischen und elektromagnetischen Grundgleichungen gemeinsam erfolgen. Es ist zu beachten, daß nicht notwendig in allen „Plasmen" die Coulomb-Kräfte die einzige bzw. wesentliche Form der Wechselwirkung darstellen. Generell sollen kollektive Prozesse in Plasmen immer Vorgänge sein, an denen eine große Zahl von Teilchen in geordneter Weise teilnimmt."*

(SpK) S. 9*: „Eine detailiertere Behandlung von Plasmen erfordert offensichtlich wegen des Vielteilchencharakters Methoden der statistischen Physik. Nur wenige Erscheinungen lassen sich bereits im Rahmen sehr einfacher Modelle, z.B. des Einteilchenmodells für die Bewegung einzelner geladener Teilchen in vorgebenen eletromagnetischen Feldern, berechnen. Im Rahmen der Magnetohydrodynamik wird das Plasma als leitfähiges kontinuierliches Medium angesehen, das mit den Gleichungen der Hydro- und Elektrodynamik beschrieben werden kann. Das Zweiflüssigkeitenmodell erlaubt die getrennte Behandlung von Ionen und Elektronen. Im allgemeinen ist jedoch eine kinetische Beschreibung angebracht, die die verschiedenen neuen Phänomene, z.B. auch die Welle-Teilchen-Wechselwirkung, erfassen kann."*

(SpK) S. 12*: „Eine wesentliche Eigenschaft fast aller Plasmen ist die Quasineutralität. Darunter versteht man die elektrische Neutralität bis in Teilvolumina, die klein im Vergleich zu dem gesamten Plasmavolumen sind. Die Quasineutralität beruht darauf, daß jeder Ladungsüberschuß aufgrund der starken elektrischen Felder, die er hervorruft, schnell wieder ausgeglichen wird. Neutrale Plasma sind solche, die makroskopisch neutral sind. In jüngster Zeit haben aber auch nichtneutrale Plasmen erheblich an Bedeutung gewonnen. Es zeigt sich, daß ein Ensemble von Elektronen oder Ionen in einer elektromagnetischen Falle ziemlich gut eine Materieform verkörpert, die als Ein-Komponenten-Plasma bezeichnet werden kann. Die neuesten Experimente in Mikroplasmen, die aus wenigen in einer Paul-Falle eingeschlossenen geladenen Teilchen bestehen, erlauben nichtideales Verhalten in (stark gekoppelten) Systemen systematisch zu studieren."*

(SpK) S. 47*: „Gleichgewichtsstatistik eines Plasmas: Das Vielteilchensystem Plasma ist im thermodynamischen Gleichgewicht mit den bekannten Methoden der Gleichgewichtsstatistik und Thermodynamik beschreibbar. Insofern stellen die Rechnungen dieses Kapitels „nur" eine Anwendung der in der entsprechenden Kursvorlesung entwickelten Prinzipien dar. Allerdings sind die Auswertungen keinesfalls trivial; im Gegenteil: in Systemen mit innerer Wechselwirkung stößt man schnell auf sehr große mathematische Schwierigkeiten, deren Auflösung bis heute Gegenstand intensiver Forschung sind."*

(TrH1) S. 42: „*Gegen die Gravitationsgleichungen*

$$(*) \quad E_{ik} = R_{ik} - \frac{1}{2} g_{ik} R = \kappa T_{ik} \, , \quad T_{ik} : \text{Materietensor,}$$

hat Einstein selbst den Einwand erhoben, daß hier auf an sich unverständliche Weise geometrische Größen mit den nichtgeometrischen Größen

$$\frac{\delta L_{mat}}{\delta g_{ik}} = \frac{1}{2} \sqrt{-g} T_{ik} \, , \quad L_{mat} : \text{kovariant verallgemeinerte Wirkungsfunktionen,}$$

verknüpft werden und so ein Dualismus in die Physik hineingetragen wird. So erschien es Einstein konsequenter, die geometrische Struktur der Materie völlig miteinander zu identifizieren, wie dies in der allgemeinen Relativitätstheorie für Geometrie und Gravitationsfeld gelungen war.

Während jedes nichtgravische Feld über den Materietensor T_{ik} zum Gravitationsfeld beiträgt, also notwendig mit einem Gravitationsfeld gekoppelt ist, zeigt die Einsteinsche Gravitationstheorie die Existenz von freien Gravitationsfeldern. In der Tat bedeutet der Grenzübergang $\kappa \to 0$ in den Gravitationsgleichungen (*) nicht etwa gravitationsfreie Felder, sondern Gravitation ohne Quellen. Bei Verschwinden der rechten Seite gehen die Einsteinschen Feldgleichungen (*) in die Vacuumgleichungen $R_{ik} = 0$ über, die einen Einstein-Raum definieren, der für $R_{ik\mu}^{\sigma} \neq 0$ nicht mit dem speziell relativistischen Minkowski-Raum identisch ist. Solche Einstein-Räume existieren auch dann, wenn die rechte Seite von (*) überall verschwindet."

Unzicker A.
Bankrupting Physics

(UnA) p. 10: „*Cosmology's „concordance model" uses six numbers, which are called „free parameters" because they cannot be explained within the model but rather are fitted to the measurements. The standard model of particle physics needs not only six of them, but impressive 17.*"
(UnA) p. 11: *In his book „The Trouble with Physics", Lee Smolin comments on the 17 free parameters (of the SMEP). „The fact that there are that many freely specifiable constants in what is supposed to be a fundamental theory is a tremendous embarrassment.*"

(UnA) p. 48: Mach vs. Newton: Space without matter doesn't matter
„*We can see already that space and time are not such simple concepts, especially when we are considering the cosmos as a whole. It is one thing to have increasingly sophisticated technology for ever more precise clocks to measure time and spacecraft to measure distance. But it is the very nature of this basis for our perception that is still puzzling. What is time? What is space? …*

When we say that one second today is the same as one second yesterday, what does that mean? This is not a play on words, since all we have as measures of time is the observation of Nature's periodicities. Envisioning an absolute time, with flows without any relation to matter, might be completely false, as false as Newton's notion that absolute space without matter exists."

(UnA) p. 49: „*He (Mach) suggested that in such a case (in a rotating bucket filled with water, the centrifugal force will make the water level rise at the inside wall of the bucket), when the bucket's wall became increasingly thicker and more massive, the centrifugal force may vanish. He argued that there is no absolute space but rather that it is distant celestial bodies that tell us what means to be at rest. In other words, all that matters in our motion relative to other masses out in the universe, without presupposing an inertial framework of absolute space.*

J. Barbour has written books and organized conferences on Mach's principle. Barbour's central idea, portrayed in his book The End of Time, is that time is defined through the various periodicities we observe in Nature. It is a profound generalization of Mach's principle. Barbour is a truly unconventional thinker. His theory, which even

calls into question the expansion of the universe, is so far off the mainstream that cosmologists must fear for their jobs if it turns out to be right."

(UnA) p. 50: „*What can we learn from Barbour? For one thing, we can recognize that it is probably much too naive to think that time is something „objective" that runs independently from what happes in the rest of the universe. Imagine a wristwatch ticking away from the beginning of the universe, telling us when the Big Bang took place, when the atomic nuclei formed, and a little later, when cosmic background raditation emerged. But unless atoms exist, there is nothing to tick. There really is no way to count time from the precise moment of the Big Bang.*

For simple reason, we should remain skeptical about the fairy-tale stories about what happened in the 10^{-35} seconds after the Big Bang. No clock can measure such tiny intervals, and although this is evident, many cling to this all-too-simplistic picture of time.

Unfortunately, once you discard the idea of an imaginary wristwatch ticking away time from the moment of the Big Bang, trying to define time is not trying to nail Jell-O to the wall.The cosmologist John Barrow has noted „The question if there is a unique absolute standard of time which globally is defined by the inner geometry of the universe, is a big unresolved problem of cosmology,*" And it is not an unimportant one*."

(UnA) p. 53: „*However, classical electrodynamics has its own problems. One is that steadily accelerated electrical charges radiate energy. But remember, that, due to the equivalence of inertia and weight, acceleration and gravity are fundamentally the same thing; thus, charges should radiate energy in a gravitational field even when they just sit there. This remains an unresolved puzzle.*

Actually there are far worse problems arising from fundamental law that accelerated charges radiate light (electromagnetic radiation of any wavelength). You may think that once the acceleration is known, physics has a formula for calculating the amount of radiation. Unfortunately, it doesn't, as Richard Feynman explains in his Lectures. Feynman's books refreshingly differ from many others in that they address unsolved problems, rather than camouflaging them under a bunch of brilliant mathematical formulae.

The deeper reason for the mystery of the inability to calculate radiation is that classical electrodynamics is inconsistent. If you combine the formula for energy density with that of force field, a single electron has an infinite amount of energy, and due to Einstein's $E = mc^2$, it also has an infinitely great mass. Something has got to be wrong! And if people tell you that quantum electrodynamics fixed the problem, don't believe it. Feynman, who got the Nobel Prize in 1965 for his role in developing quantum electrodynamics, says it does not."

(UnA) p. 132: A briefer history of quantum gravity
„*Since the Planck length contains the gravitational constant G and Planck's quantum h, it is the scale at which „quantum effects of gravity" are supposed to become important. Dear reader, this is all. No theory of quantum gravity exists, let alone any evidence of an observable effect*"

(UnA) p. 133: Does the gravitational constant cement the failure of quantum gravity?
„*While Niels Bohr's quantum theory marvelously derives energy levels for the atomic shell out of the constants of nature, nuclear physics has not achieved anything comparable yet*"

(UnA) p. 135: Quantum of solace: how to escape from black holes
„*Thus, Hawking concluded, there may be a net escape of particles from black holes through this quantum effect, which is forbidden by the classical laws of gravity.*
As neat as this thought might be, it is far cry from every observation, for a black hole with a solar mass would then need 10^{66} years to evaporate by ejecting particles"

(UnA) p. 144: Symmetries all over the place: where is this journey taking us?
„*The beta decay process, not fitting into common scheme of a force, is called „weak interaction". Why it occurs on average after 10 minutes but not to say, after 20 minutes is unknown. Even the very reason why neutrons don't live foreever is a mystery*"

(UnA) p. 145: The dance of electrons and light:

„Long before the symmetry fashion took over, Richard Feynman became famous for his intriguing interpretation of the interactions of electrons, positrons, and light. The basic idea is fairly easy to grasp. Thanks to Heisenberg's uncertainty principle, a traveling electron can borrow for a little time t an amount of energy $E = h/t$. Electrons may use this energy for juggling with photons. Like two people sitting on wheeled office chairs who are throwing heavy medicine balls to one another and rolling backward every time they pitch or catch the ball, two electrons that exchange photons knock each other back, too. Feynman managed to reformulate the laws of electrodynamics—two electrons feel a repulsive force—in these funny terms. The calculations based on this have led to predictions that have been precisely tested and are considered the best-measured results of all physics (The magnetic moment of an electron (its inherent magnetism) and the so-called Lamb shift in the spectral lines of a hydrogen atom). Richard Feynman, Julian Schwinger, and Sin-Itiro Tomonaga were justifiably awarded the Nobel Prize for this in 1965. The big insight of the theory is that light and the most basic particles, electrons and positrons, show such a puzzling similarity. Yet nobody knows the reason for it."

(UnA) p. 146: The colorful ornamentation of quantum electrodynamics

„In former times, classical physics upheld the picture that it was the electric and gravitational fields in space that caused the accelerations of charged particles. Quantum electrodynamics completely abandons this idea in favor of the exchange of borrowed photons. Feynman's theory worked so well that particle physicists decided to use it as a blueprint for all other interactions. Though the old wave-particle quantum theory of Bohr, Heisenberg, and Schrödinger should be a caveat against describing everything with particles, the idea entered the back door and seized hold of modern physics.

But unlike quantum electrodynamics, the results of its extension to nuclear physics, called quantum chromodynamics, are anything but precise [(*)]. It is therefore utter spaculation that imposing the concept of quantum electrodynamics on atomic nuclei is the right way to go. Nevertheless, theorists almost exclusively walk on this we—trodden path"

[(*)] The magnetic moment of an electron (its inherent magnetism) and the so-called Lamb shift in the spectral lines of a hydrogen atom.

(UnA) p. 146: *„Feyman's theory worked so well that particle physicists decided to use it as a blue print for all other interactions"*

(UnA) p. 151: *„The standard model of particle physics is unable to predict the observed masses of its particles. This is really quite embarrassing, given that mass is such a basic property of particles"*

(UnA) p. 212: *„R. D. Precht: „The sum of obvious little steps is not seldom a way in the wrong direction"*

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Unzicker A.
Einstein's Lost Key
E. Schrödinger's estimate of the gravitational potential
A. Einstein & R. Dicke's idea of a variable speed of light
P. Dirac's Large Number Hypothesis

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(UnA1) p. 117: Schrödinger's hour of glory

„There is a real gem of physical reasoning in a completely unknown article on cosmology published in 1925 by Erwin Schrödinger, who was later awarded the Nobel Prize. Today he is best known for his essential contribution to quantum mechanics; the wave equation that bears his name, which he fould incidentally, also in 1925 (during a skiing holiday in Switzerland with a lover who remained unidentified). Schrödinger's thoughts on cosmology are perhaps no less important, even though they are entirely forgotten. He, in fact, was the first to suspect the coincidence $G \approx c^2 \frac{R_U}{M_U}$, ($R_U$ radius of the universe; M_U mass of the universe).

Whereas the relation $G \approx c^2 \frac{R_U}{M_U}$ as such is only numerical, Schrödinger went a step further and realized that the concept of the gravitational potential φ was concealed in the formula. Potential is simply energy per mass, for which Newton had derived an expression in his theory of gravitation: $\varphi = -\frac{GM}{r}$, when a mass is at a distance r from the Sun (with mass M).

Let us point out for the moment the subtle difference from gravitational force $F = \frac{GMm}{r^2}$, where the distance is squared in the denominator. This means that the gravitational force for distant celestial bodies strongly decreases, and the gravitational force the Sun exerts on the Earth is thus hardly noticeable (apart from the tides, to which it contributes). The gravitational potential is quite a different matter: the value of the solar potential in which we find ourselves exceeds the effect of the Earth by a factor of ten – which is easy to see of one considers the two quotients $\frac{M}{r}$ (mass divided by distance).

Schrödinger noticed that too. It looked plausible to him that the influence of the even more distant masses in the Milky Way had to be larger, even though it was impossible to perceive a force. Schrödinger tried to estimate this potential and noticed, of course, that it had the same unit as the square of the speed of light, c^2. With amazing intuition he suspected that all the potentials in the universe might just add up to c^2. In Schrödinger's own words:

> *„This remarkable relationship states that the (negative) potential of all masses at the point of observation, calculated with the gravitational constant valid at the observation point, must be equal to half the square of the speed of light."*

In spite of the rudimentary astronomical data back then, he concluded that this indicated a far bigger universe that it was known at the time:

> *„Thus only a vanishingly small fraction of the inertial effect observed on Earth and in the solar system can originate from their interaction with the masses of the Milky Way."*

In a way Schrödinger had thus anticipated the discovery of the size of the cosmos in the 1930s. He further insisted hat Mach's principle had to be incorporated into the theory of relativity. In this respect, Schrödinger's intuition went beyond Einstein's. This makes it all the more bizarre that Schrödinger's work on cosmology is completely unknown even among physicists."

*(UnA1) p. 138 ff: „There are four so-called classical tests of the general relativity theory, called light defection, gravitational redshift, radar echo delay, and the perihelion advance of the planet Mercury. ….
These results were obtained quite naturally by Dicke, unlike the case of the perihelion advance.*

A particularly comprehensible presentation deserves to be mentioned here: …. Yet the article (DeH) does no less than explain all known tests of the theory with variable speed of light".

(UnA1) p. 150: „P. Dirac's Large Number Hypothesis concerns a connection between cosmology and particle physics."

(UnA1) p. 151: „In the 1930s, he started to think about the biggest structures in the universe, and this led him to the large number hypothesis.

Dirac had pondered for many years the question of why the electric force in the universe is so much stronger than the gravitational force, despite the fact that the laws of these forces are so similar in structure." ….

(UnA1) p. 152: „If we consider a hydrogen atom in which both forces are at work when a proton and an electron (with masses m_p and m_e) orbit one another, how big is the ratio of the two forces? … we get the value $\frac{F_e}{F_G} = \frac{e^2}{4\pi\varepsilon_0 m_p m_e} \approx 2{,}29 \cdot 10^{39}$."

(UnA1) p. 154: „Dirac now wondered how many particles there were in the universe. He divided Hubble's mass estimate by the mass of the proton and got about 10^{78}. The number of particles were obviously the square of that number 10^{39}.

(UnA1) p. 156: „Why are coincidences such as Dirac's considered exotics? Assuming that the number of hydrogen atoms in the universe is proportional to the square of its size indeed appears grotesque: as if the amount of matter in the universe had to do with its surface, rather then with its volume.

To round off the value of Dirac's observation, however, one should mention that it is in complete harmony with Ernst Mach's thoughts on gravity, though Dirac apparently never dealt with Mach. But probably he was convinced as well that the relation $\frac{M_U}{R_U} \approx \frac{c^2}{G}$ had a meaning. The fact that Dirac considered the size and the mass of the universe, the two quantities that Mach also related to the origin of gravity, constitutes another piece in this fascinating puzzle.

MACH'S PRINCIPLE 2.0

However, Dirac's observation goes beyond Mach's principle. Imagine the number of particles in the universe was a billion times larger, while simultaneously their mass was a billion times smaller. This would change nothing about Mach' s principle (or „flatness"). But it would alter Dirac's observation. In other words, Dirac was the first to insinuate that the size and the mass of elementary particles had a meaning, and that it is no coincidence that they are as large and heavy as they are. Who thought soothe same? You've guessed it – Albert Einstein":

> „The real laws of nature are much more restrictive than the ones we know. For instance would it not violate our known laws, if we found electrons of any size or iron of any specific weigth. Nature however only realizes electrons of a particular size and iron of very specific weigth."

(UnA1) p. 157: „Considering general relativity, i.e. gravity, in the most elementary quantum system, the hydrogen atom, yields the easily measurable yet enigmatic number $2,29 \cdot 10^{39}$. It is therefore cristal clear that any theory that hopes to unify quantum theory with relativity must calculate this number and explain it, if it does not want to end up in futile verbiage. …

(UnA1) p. 158: „Dirac took a risk and claimed that his hypothesis would force the gravitational constant to decrease with time"

(UnA1) p. 159: „Dirac's Large Number Hypothesis, which was touched only tentatively by his former colleagues, was forgotten over the years. He may even have moved away from it himself (from the second coincidence regarding mass). This was what Pascual Jordan claimed at least when, admiringly, he wrote in 1952:

> „I consider Dirac's ideas for one of the greatest insights of our time; the further study of these ideas has to be one of our principal tasks".

A. Unzicker
The Mathematical Reality
(UnA2)

(UnA) ix: „Applied physics has been terrific success to date, and the fundamental findings of theoretical physics in the early twentieth century were among the greatest accomplishments of humankind. But that was then. Today, the major part of theoretical physics has instead gotten lost in bizzare constructs that are completely disconnected from reality, in a mockery of the methods that grounded the success of physics for 400 years"

(UnA2) p. 4: „This book is about fundamental physics. It aspires to form a consistent picture of reality by observing nature from the cosmos to elementary particles. The new approach I present here is based on investigating constans of nature and questioning their origin. … From this analyis it also follows that current ideas in physics, especially the standard models of particle physics and cosmology, offer very little help for real understanding. … Consequently, tihs book is also aimed specifically at mathematicians. Although their activities are often misguided by current theoretical fashions, they nevertheless have a crucial contribution to make to the understanding of nature, especially by studying the three-dimensional unit sphere that plays an essential role in those considerations. … To get an even clearer picture, it will also be helpful to have a look at the cognitive mechanisms with which the species* Homo sapiens *has struggled so far to fathom the laws of nature"

(UnA2) p. 85 ff.: The paramount role of the proton in fundamental physics
„Planck's constant h is approximately equal to the product of the speed of light, the mass m_p of the proton and its radius r_p

$$h \sim \frac{\pi}{2} c \cdot m_p \cdot r_p \ .$$

The formula $h = \frac{\pi}{2} m_p r_p$ is even valid within the current measuring limits of about one percent (!). Of course, this formula displays the definition of the Compton wavelength

$$\lambda_C = \frac{h}{c \cdot m_p} \ .$$

However, according to current wisdom, the wavelength λ_C calculated from the mass alone does not reflect the actual size of a particle. … Accordingly, the proton is not given a prominent role among elementary particles. In reality, however, it is the only particle in the universe, that is massive and stable at the same time. The fact that its Compton wavelength approximately matches its real extension measured by experiments is a clear indication of the paramount role of the proton in fundamental physics. …. Since the formula contains fundamental constants of nature only, it would be important to derive it from a theory.

Dirac's observation regarding the size and mass of of particles in the universe is

$$\frac{M_U}{m_p} \sim \frac{R_U^2}{r_p^2} .$$

… without Dirac's conjecture, there cannot be no further progress at all in understanding elementrary particles. A thorough understanding would require a calculation of their masses, which is literally unthinkable in the current paradigm, because the (available nature) constants … cannot be combined in a way that the unit of a mass, kg, emerges. … Dirac's observed large numbers would automatically appear, a consequence of the fact that the very nature of mass can only be understood cosmologically, as E. Mach had suspected."

(UnA2) p. 96: Big simplicity at the big flash
„The hydrogen atom would then be similar to an object now called positrinium, consisting of an electron and its antiparticle positron that orbit each other. The definition of the fine structure constant implies that $\frac{1}{\alpha} \sim 137$ is the ratio of speed of light c to the electron's velocity on the innermost orbit of the hydrogen atom"

(UnA2) p. 183: „All in all, there are many indications that electrons, including their strange spin behavior, are described more simple by S^3. In any case, despite the elegant representation Dirac had developed, it cannot be claimed that this sheds light on the reason for the existence of spin,[*]"
[*] The spin matrices introduced by Pauli 1927 are also isomorphic to the unit quaternions and the simplest non-abelian Lie-group $SU(2)$

Vagt C.
Henri Bergson's Dauer und Gleichzeitigkeit,
Über Einsteins Relativitätstheorie, (BeH)

(BeH): Einführung
Beschäftigt sich Philosophie mit Physik, gilt ihr Engagement selten den Formeln, Diagrammen oder Experimentalapparaturen der Naturwissenschaft. Worauf sie sich in der Regel konzentriert, ist die Interpretation physikalischer Aussagen und Begriffe. Dauer und Gleichzeitigkeit verfolgt die genau gegenteilige Strategie: Das Buch, das 1922 in Paris erscheint, erhebt die Physikalischen Instrumente und mathematischen Verfahren der Relativitätstheorie sowohl zum Ausgangspunkt als auch zum Argument philosophischer Reflexion. … Größtenteils (…) spielen die mathematischen Ausdrücke mögliche Aussagen der immer gleichen Formeln und Diagramme durch, die das Gerüst der speziellen Relativitätstheorie bilden.

Vielleicht liegt (….) im Explizieren und Hinterfragen der Interpretationen mathematischer und experiementeller Verfahren durch den Philosophen die Möglichkeit eine viel allgemeinere Hürde zu nehmen, nämlich jene, die Gaston Bachelard ein „epistemologisches Hindernis" nennt; etwas, das als unbewusste Hemmung immer dort entsteht, wo die gewohnte Sicht der Dinge oder die tradierten Wege der wissenschaftlichen Erkenntnis nicht mehr in Frage gestellt werden.

(WeH2) S. 18: *„Ich bin fest davon überzeugt, daß die Substanz heute ihre Rolle in der Physik ausgespielt hat. …Die Physik muß sich ebenso der ausgedehnten Substanz entledigen"*

(WeH2) p. 51: *„The classical philosopher of a dynamic world presentation is Leibniz. … For him the real of movement does not lie in a pure change of the location, but in a moving force „La substance est un etre capable d'action – une force primitive – overspatial, immaterial. … The last element is the dynamic point, from which the force erupts as an otherworldly power, an indecomposable strechless unit: the monade"*

Weyl H.
Space, Time, Matter
Mie' Theory

(WeH) p. 171: *"On the basis of rather convincing general considerations G. Mie in 1912 pointed out a way of modifying the Maxwell equations in such a manner that they might possibly solve the problem of matter, by explaining why the field possesses a granular structure and why the knots of energy remain intact in spite of the back-and-forth flux of energy and momentum. The Maxwell equations will not do because they imply that negative charges compressed in an electron explode; to guarantee their coherence in spite of Coulomb's repulsive forces was the only service still required of the substance by H. A. Lorentz's theory of electrons. The preservation of the energy knots must result from the fact that the modified field laws admit only of one state of field equilibrium. …"*

(WeH1) p. 206 ff.: *„The theory of Maxwell and Lorentz cannot hold for the interior of the electron; therefore, from the point of view of ordinary theory of electrons we must treat the electron as something given <u>a priori</u>, as a foreign body in the field. A more general theory of electrodynamics has been proposed by Mie, by which it seems possible to derive the matter from the field.*

We shall sketch its outline briefly here – as an example of a physical theory fully conforming with the new idea of matter, and one that will be of good service later. It will give us an opportunity of formulating the problem of matter a little bit more clearly.

We shall retain the view that the following phase-quantities are of account: (1) the four-dimensional current vector s, the „electricity"; (2) the linear tensor of the second order F, the „field". Their properties are expressed in the equations

$$(1) \quad \frac{\partial s^i}{\partial x_i} = 0$$

$$(2) \quad \frac{\partial F_{kl}}{\partial x_i} + \frac{\partial F_{li}}{\partial x_k} + \frac{\partial F_{ik}}{\partial x_l} = 0.$$

Equations (2) hold if F is derivable from a vector Φ_i according to the formula

$$(3) \quad F_{ik} = \frac{\partial \Phi_i}{\partial x_k} - \frac{\partial \Phi_k}{\partial x_i}.$$

Conversely, it follows from (2) that a vector Φ must exist such that equations (3) hold.

In the same way (1) is fulfilled if s is derivable from a skew-symmetrical tensor H of the second order according to

$$(4) \quad s^i = \frac{\partial H^{ik}}{\partial x_k}.$$

Conversely, it follows from (1) that a tensor H satisfying these condititons must exist. Lorentz assumed generally, not only for the ether, but also for the domain of electrons, that $H = F$. Following Mie, we shall make

the more general assumption that H is not a mere number of calculation but has a real significance, and that its components are, therefore, universal functions of the primary phase-quantities s and F. To be logical we must then make the same assumptions about Φ. The resultant scheme of quantities

$$\begin{array}{c|c} \Phi & F \\ \hline s & H \end{array}$$

contains the quantities of intensity in the first row; they are connected with one another by the differential equations (3). In the second row we have the quantities of magnitude, for which the differential quantities (4) hold. If we perform the resolution into space and time and use the same terms as in §20 we arrive at the well-known equations

(1) $\frac{d\rho}{dt} + div(s) = 0$

(2) $\frac{dB}{dt} + curlE = 0$ $(divB = 0)$,

(3) $\frac{df}{dt} + grad\Phi = E$ $(-curlf = B)$,

(4) $\frac{dD}{dt} - curlH = -s$ $(divD = \rho)$.

If we know the universal functions, which express Φ and H in terms of s and F, then, excluding the equations in the brackets, and counting each component separately, we have ten „principal equations" before us, in which the derivatives of the ten phase-quantities with respect to the time are expressed in relation to themselves and their spacial derivatives; that is, we have physical laws in the form that is demanded by the principle of causality. The principle of relativity that here appears as an antithesis, in a certain sense, to the principle of causality, demands that the principle equations be accompanied by the bracketed „subsidiary equations," in which no time derivatives occur. The conflict is avoided by noticing that the subsidiary equations are superfluous. For it follows from the principle equations (2) and (3) that

$$\frac{\partial}{\partial t}(B + curlf) = 0 \,,$$

and from (1) and (4) that

$$\frac{\partial \rho}{\partial t} = \frac{\partial}{\partial t}(divD).$$

It is instructive to compare Mie's Theory with Lorentz's fundamental equations of the theory of electrons.

In the latter, (1), (2), and (4) occur, whilst the law by which H is determined from the primary phase-quantitites is simply expressed by $D = E$, $H = B$. On the other hand, in Mie's theory, Φ and f are defined in (3) as the result of a process of calculation, and there is no law that determines how these potentials depend on the phase-quantitities of the field and on the electricity.

In place of this we find the formula giving the density of the mechanical force and the law of mechanics, which governs the motion of electrons under the influence of this force.

Since, however, according to the new view which we have put forward, the mechanical law must follow from the field-equations, an addendum becomes necessary; for this purpose, Mie makes the assumption that, Φ and f aquire a physical meaning in the sense indicated.

We may, however, enunciate Mie's equation (3) in a form fully analogous to that of the fundamental law of mechanics. We contrast the ponderomotive force occurring in it with the „electrical force" E in this case.

In the statical case (3) states that

(*) $E - grad(\Phi) = 0$

that is, the electric force E is counterbalanced in the ether by an „electrical pressure" Φ.

In general, however, a resulting electrical force arises which, by (3), now belongs to the magnitude f as the „electrical momentum". It inspired us with wonder to see how, in Mie's Theory, the fundamental equation of electrostatics (*) which stands at the commencement of electrical theory, suddenly acquires a much more vivid meaning by the appearance of potential as an electrical pressure; this is the required cohesive pressure that keeps the electron together."

Weyl H.
Philosophy of Mathematics and Natural Science
Relationship of physics to chemistry & biology
Organic & inorganic matter

(WeH) p. 266: „*The current understanding of the relationship of physics and chemistry may be briefly sketched by the statement that*

> „the valence bonds are an abbreviated symbol for the actual quantum-physical forces acting between the atoms, which themselves are complex dynamical system""

(WeH) p. 276: „*The current understanding of the relationship of physics and biology may be briefly sketched by the statement that*

> „One of the profoundest enigmas of nature is the constrast of dead and living matter. …. Incidentally, the gap between organic and inorganic matter has been bridged to a certain extent by the discovery of virusses. Virusses are submiroscopic entities that behave like dead inert matter unless placed in certain living cells. …. Many virusses have the structure typical of inorganic matter; they are crystals""

(WeH) pp. 276-278: „*Incidentally, the gap between organic and inorganic matter has been bridged to a certain extent by the discovery of viruses. Viruses are submicroscopic entities that behave like dead inert matter unless placed in certain living cells. As parasites in these cells, however, they show the fundamental chracteristics of life – self-duplication and mutation. On the other hand many viruses have the structure typical of inorganic matter; they are crystals. In size they range from the more complex protein molecules tot he smaller bacteria. Chemically they consist of nucleo-protein, as the genus do. A virus is clearly something like a naked gene. The best studied virus, that of tobacco mosaic disease, is a nucleo-protein of high molecular weight consisting of 95 per cent protein and 5 per cent nucleic acid; it cristallizes in long thin needles*. …*

The specific properties of living matter will have to be studied within the general laws valid for all matter; the viewpoint of holism that the theory of life comes first and that one descends from there sort of deprivation to inorganic matter must be rejected. It is therefore significant that certain simple and clearcut traits of wholeness, organization, acausality, are ascribed by quantum mechanics to the elementary constituents of all matter. …*

The quantum physics of atomic processes will become relevant for biology wherever in the life cycle of an organism a moderate number of atoms exercises a steering effect upon the large scale happenings. …. On a broad empirical foundation, genetics furnishes the most convincing proof that organisms are controlled by processes of atomic range, where the acausality of quantum mechanics may make itself felt. … The mere fact of such X-rays induced mutations proves that the genes are physical structures. …*

By ingenious methods H. J. Muller, N. W. Timoféeff-Ressowsky, and others have succeeded in establishing simple quantitive laws concerning the rate of induced mutations. These results indicate that the mutation is brought about by a single hit, not by the concerted action of several hits, and that this hit consists of an ionization, and is not, as one might have thought, a process directly released by the X-ray photon or absorbing the whole energy of the secondary electron.

These facts suggest the hypothesis that a gene is a (nucleo-protein) molecule of highly complicated structure, that a mutation consists in a chemical change of this molecule brought about by the effect of an ionization on the bonding electrons, and that thus allele genes are essentially isometric molecules."

Weinberg S.
The First Three Minutes

„The first One-hundredth Second: Our account of the first three minutes in Chapter 5 did not begin at the beginning. Instead, we started at a „first frame" („ein erstes Bild") when the cosmic temperature has already cooled to 100000 *million degrees of Kelvin, and the only particles present in large numbers were photons, electrons, neutrinos and their corresponding antiparticles. If these really were the only types of particles in nature, we could perhaps extrapolate the expansion of the universe backward in time and infer that there must have been real beginning, a state of infinite temperature and density, which occurred* 0,0108 *seconds bevor our first frame (our „erstes Bild")"*

Wheeler J. A.
The boundary of the boundary principle and geometrodynamics

(CiI) p. 49: *Einstein's "general relativity" or ""geometric theory of gravitation" or "geometrodynamics", has two central ideas:*

> *(1) Spacetime geometry "tells" mass-energy how to move; and*
> *(2) mass-energy "tells" spacetime geometry how to curve.*

ad (1): We have just seen that the way spacetime tells mass-energy how to move, is automatically obtained from the Einstein field equations by using the identity of Riemannian geometry, known as the Bianchi identity, which tells us that the covariant divergence of the Einstein tensor is zero.
In other words, Einstein geometrodynamics has the important and beautiful property that the equations of motion are a direct mathematical consequence of the Bianchi identities

ad (2): According to an idea of extreme simplicity of the laws at the foundations of physics, what one of us has called „the principle of austerity" or „law without law at the basis of physics", in geometrodynamics it is possible to derive the dynamical equations for matter and fields from the extremely simple but central identity of algebraic topology: the principle that the boundary of the boundary of a manifold is zero.

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