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Refutation of the quantum theory principles: Theorem

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Abstract The theorem presented challenges the quantum mechanics and its relativistic theory generally posited as an ultimate unifying guideline of nature in fundamental and applied matters, refutes this theory, any bridges from it to the realm. We build the evidence on the rigorous statistical criteria and arguments of compatibility at the interfaces not adduced previously against the theory. It calls in question the Born rule, particle-wave doublethink, probability sense of the quantum theory, any bridges from the theory to both Lagrangian and nonholonomic mechanics. The argumentation given to the matter of ambient noise impact at the interfaces by meaningful statistical methods paves the way towards the correct principles of causality, connectedness, robustness.

Keywords Quantum mechanics · Quantum relativistic theory · Statistical mechanics · Vortex physics

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1. Introduction

"The history of science shows that the progress of science has constantly been hampered by the tyrannical influence of certain conceptions that finally came to be considered as dogma. For this reason, it is proper to submit periodically to a very searching examination, principles that we have come to assume without any more discussion." This Louis de Broglie's message [1] is up-to-date. The evidence against the quantum paradigm provided below is a case in point.

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No matter how the physical theory beauty may look, the true criterion of its tenability is the bridge to the realm. From this perspective we first consider the core quantum mechanics and then, in section 8, its relativistic extensions.

2. Critical deficiency inherent in the Borne rule

Let us agree on terms. By quantum mechanics, the behaviour of systems of canonically conjugated multi-component position-momentum variables x, p distils down to the constraint $\hat{x}\hat{p} - \hat{p}\hat{x} = i\hbar$ between the Hermitian operators $\hat{x}, \hat{p}$ which in x presentation reduces to $\hat{p} = -i\hbar\partial_x$ defined by a complex-valued wave-function $\Psi(x,t)$ of instant quantum states of the system. The wave-function is to comply with the Schroedinger's equation

$$i\hbar\frac{\partial\Psi}{\partial t} = \hat{H}\Psi, \tag{1}$$

its Cauchy problem with proper boundary conditions for x, with $i^2 = -1$ and $2\pi\hbar$ Plank's constant, and governed by a quantum Hamiltonian $\hat{H}$, a Ψ-independent Hermitian operator as a function of $x, \hat{p}$ in a complex Hilbert space, e.g. [2,3].

An observable property of the system is defined in this theory by a proper Hermitian operator $\hat{A}$ with its average determined in Dirac's notation as

$$\langle\hat{A}\rangle = \left\langle \Psi \middle| \hat{A} \middle| \Psi \right\rangle. \tag{2}$$

In so doing by (1) it is implied $\int ||\Psi||^2 d\Gamma = 1$, the integral is over the volume Γ of the x space, and the norm $||\Psi||^2$ is taken for the probability density distribution of real, in measurable terms, states of the system. This way the eigen-spectrum of $\hat{H}$ governing the behavior of Ψ is assigned the probability measure of total energy of the system.

The wave-function Ψ as solution to (1) by this construct called Born rule relates the states x of the system at instants 0 and t. So, the density distribution function $||\Psi||^2$ taken for the bridge to real trends is two-point. But it is the multi(> 2)-point density distributions that assign the meaning to the notion of real existing behaviours, of observable features, and by (1) and (2) such distributions appear to display non-compliance with the notion.

3. Discord with the principles of causality and connectedness

Indeed, since the solution to (1) presents the unitary transformation via $\exp(-i\hat{H}t/\hbar)$ or, if $\hat{H}$ is t-dependent, its form of Dyson time-ordering operator, one gets for a sequence of events $a \to b \to c$ in the space (x,t) some complex-valued amplitudes $\Psi_{ab}, \Psi_{bc}, \Psi_{ac}$ of corresponding transitions, and for the probabilities of the transitions by (1) and (2) the rules of quantum mechanics imply

$$P_{ab}^{(q)} = \|\Psi_{ab}\|^2,\ P_{bc}^{(q)} = \|\Psi_{bc}\|^2 \text{ and } \mathrm{P}_{\mathrm{ac}}^{(\mathrm{q})} = \|\Psi_{\mathrm{ac}}\|^2 \tag{3}$$

whatever the amplitudes of transitions $a \to b$ and $b \to c$ are. So, the theory admits only two-point distributions, as discussed, e.g., in Feynman [4]. But what we need important to add is that Eqs. (3) do not match the fact that, for the sequences of observable events under any laws of behaviours by the principles of causality and connectedness, whether it is particles or waves, in terms of probability density functions, it should be for any t_b

$$P_{ac}(x_a, t_a; x_c, t_c) = \sum P_{abc}(x_a, t_a; x_b, t_b; x_c, t_c), \tag{4}$$

with the sum of joint three-point density distribution P_{abc} over the states x_b at the intermediate moment, and with the function P_{abc} supposed to exist and be continuous at any intermediate instant t_b. Both the quantum $P_{ac}^{(q)}$ and the P_{ac} of (4) are non-negative and of same overall normalization to unity, but the difference $P_{ac}^{(q)} - P_{ac}$ can be of either sign and arbitrarily large magnitude.

The difference of $P_{ac}^{(q)}$ with the principle by (4) means that the probability sense of Born rule on the principles of causality and connectedness of motion is not the case. The approach by Heisenberg to quantum mechanics, including his quantum generalization of Ehrenfest theorem, and the quantum-classic approach back to Koopman and von Neumann, exhibit the same discordance of probability sense; and it applies to Feynman's path integral approach [4].

However, the discordance lies not only in the principles of causality and connectedness, it is complete in a more basic and objective manner, as shows the following.

4. The thing-in-itself problem of quantum theory

Does the quantum theory determine any general principle of physics that bases the claimed Born rule of averaging? In fact, it does not since any measurements of quantum states at intermediate instants between initial and final are posited as absolutely inadmissible no matter how subtly one tries to measure them and how long the sequence lasts. Whether the ban is referred to wave-function collapse, quantum entanglement, or any other particle-wave doublethink, one way or the other, everything is reduced to a principle that lacks materiality, which makes the theory merely a theory, a thing-in-itself.

The link postulated between the quantum Hamiltonian and the energy of systems is such theory. Indeed, whereas in Lagrangian mechanics the energy of system given by work it produces is a function of its states, beyond it the energy of system is a path-dependent functional irreducible to a function of x, p, e.g. [5,6]. But a path-dependent functional cannot be observed just by a one-time observation of an instant distribution of states of the system, so the bounds imposed on all degrees of freedom make the link of $\hat{H}$ to the energy of systems pointless as a guideline. Analogous fundamental problems are with the link to the behaviour of entropy, ergodicity, polarization features of systems.

The same flow of observation data about the system are at one's disposal on specifying the Hamiltonian as by the Borne rule as the principle by rule (4).

But the criterion (4) chops away of the data all its spooky irrelevant part that the Borne rule accounts for far and wide as the ban on the data of intermediate states admits that. The difference can be ample.

5. Incompatibility with Lagrangian mechanics

By the fact that the canonically conjugated variables of quantum systems are determined via Lagrangian mechanics and that the Born rule goes out to the limit $\hbar = 0$, it might seem, and is tacitly accepted, that the two mechanics are congruous there. But it is incorrect, the two are incompatible, their topologies on approaching the limit differ by the principle of causality and connectedness, as evident from the trends by rules (3) and (4).

And incompatible in relation to physics, its conditions, for the factor of noise disappears at $\hbar = 0$ by one mechanics, while it is vital to the other, so the two differ dramatically by the principle of robustness, see section 6.

6. Fathomless non-robustness

In physics, the principle, as it is, means robustness of observable trends of the process. In this respect it is essential that the relations to the eternal noise differ for the quantum and Lagrangian mechanics. One describes closed systems with the noise effect given in Eqs. (1),(2) by the operator uncertainty relation for $\hbar \neq 0$. The other describes open systems, where the Lagrangian mechanics corresponds to the conditions of *detailed balance* between the rates of diffusion and dissipation of system states. The difference is of principle in the sense of stability of trends.

Indeed, consider the behaviour of systems describable by canonical variables $z = (x, p)$ of particles (and/or normal wave modes of media deformations) in conditions of ambient chaos in terms of a smoothed distribution density function $\varrho(z, t)$ of system states. Smoothed so that we can apply the description in terms of continuity equation of a general form

$$\partial\varrho/\partial t = -div(\hat{v}\varrho) = [H, \varrho] + I, \tag{5}$$

its Cauchy problem for the boundary conditions taken natural for unlimited z for the normalization $\int \varrho(z, t) d\Gamma = 1$, with the integral over Γ of the phase space z. Here $div(\hat{v}\varrho)$ is divergence of phase flows $\hat{v}\varrho$ in z presented as the sum of two operator expressions, one is the Poisson bracket $[H, \varrho]$ and the other

$$I = -div[(\hat{v} - \bar{v})\varrho], \tag{6}$$

where $\bar{v} = [z, H]$ is the velocity of phase flows of zero divergence, governed by function H of z at instant t. Without loss of generality we take H for a whole (dressed) Hamilton function for *all* smooth non-divergent phase flows of the system at instant t. Then I is a non-anticipating functional of ϱ for all phase flows of non-zero divergence, caused by the ambient noise both of long and short correlation times. By the exact methods [7,8] or in the approximation close to diffusional, of short correlation times, e.g. [6,9-10], one gets

$$I = \frac{\partial}{\partial z_i}\left(f_i - d_{ik}\frac{\partial}{\partial z_k}\right)\varrho + (**) \tag{7}$$

(with summation over repeated $i, k = 1, \dots n$ for all n degrees of system freedom). $(**)$ stands for all cut-off terms of higher order diffusion; f and d are functions of z, $d = \{d_{ik}\}$ is the matrix of diffusion and $f = \{f_i\}$ the irreversible drift forces of friction and vorticity stemmed from finite correlations times of the noise. The matrix d is non-zero and all its non-zero eigenvalues are positive.

For the functions $H(z)$ limited from below, the conditions of system stable equilibrium states at rest correspond to $I = 0$ but on the account of compensation between the rates of diffusion and friction and providing vorticity-free drift. It means the detailed balance for all n degrees of freedom

$$f_i = d_{ik}\bar{v}_k, \quad i, k = 1, 2, \dots n \tag{8}$$

(with $\bar{v} = [z, H]$) and implies, because of the indicated feature of d matrix, the trend of systems relaxation in the asymptotic limit to the state of rest $\bar{v} = 0$ in minima of $H(z)$. The well-known fluctuation-dissipation theorem is a particular case of detailed balance (8).

The balance (8) provides physical rationale to the classics of variational principles: the stability and recurrence of trends of system states due to the relaxation trends of behaviours under the impact of eternal ambient noise. Things like this also happen for the non-stationary conditions, for the functions H, f and d depending on t. That's what takes place in thermodynamics with its first and second laws and entropy principle, being the case of detailed balance kinematics in the limit of utmost slow changes of external parameters; this provides robustness and stability of observed phenomena.

The irreversible drift forces of vortex type in f of (7) arise in conditions

$$\partial f_i/\partial x_k - \partial f_k/\partial x_i = \gamma_{ik} \tag{9}$$

with $\gamma_{ik} \neq 0$ for some forms of motion x. Such forces can be just linear, $f_i = \gamma_{ik}x_k$. The question of such torsion forces was raised by the author in [9-11] devoted to general features and theorems with an eye on applications and we called them vortical or vortex. They cause new features of resonances, including parametric and combinational, violate the conditions of second law and thermal death of universe and make possible the stable states of motion with vortex balance inside the system. The physics involved is not related to the ideology of quanta.

As for the systems of purely quantum theory construct, since they are subjected to a state collapse on the tiniest bit of detection, that exposes the trends absolutely unstable, elusive, of the immaterial world. Being unstable, they are also not determinable by series of independent observations.

7. Incompatibility with the non-holonomic mechanics

In the matter of a bridge from the quantum theory to the realm the account should be taken also of nonholonomic systems of analytical mechanics developed and used since 19th century, e.g.[12,13]. The equations of motion proceed then from the general D'alamber-Lagrange precept of energy conservation

$$\sum(\mathbf{F}_\nu - m_\nu \mathbf{a}_\nu)\delta \mathbf{r}_\nu = 0 \tag{10}$$

with $\mathbf{F}_\nu$ the total active force acting on the point of mass m_ν and acceleration $\mathbf{a}_\nu$, the sum is over all points of the system. The constraints of non-holonomy are ideal, their forces of reaction perform no work on virtual variations $\delta\mathbf{r}_\nu$ in summing. In terms of system's n-component space of canonical pairs $(x, \dot{x})$ it makes the variables x and $\dot{x}$ not on equal footing. In actual analytics this is presented by g, $g < n$, linearly independent equations in the velocities $\dot{x}$

$$A_{ij}\dot{x}_j + A_j = 0 \quad (j = 1, \dots g;\ i = 1, \dots n) \tag{11}$$

with A_{ij} and A_j functions of x and possibly t that are not integrable. Taking account of constraints (11) by the method of Lagrangian undetermined multipliers or other methods, one gets a complete system of differential equations for any preassigned given initial states in terms of $x, \dot{x}$. The set of possible motions $x(t)$ lies then in a hyperplane of dimension $n - g$, this is the actual number of degrees of freedom of the system, e.g.[12].

The energy of such systems given by work they produce is conserved, but the associated energies and behaviours are not given in terms of Hamilton functions. From the point of stability of trends and robustness the case presents a kind of *generalized* detailed balance being due to the nonlinear cumulative vortex effect of ambient noise, for the analytics in point emerges as the limit opposite to detailed balance, which is the utmost strong friction causing the nonholonomy constraints of zero-time relaxation.

The fact of conjugated variables not on equal footing somewhat resembles quantum mechanics. It comes into particular prominence since 19th century in widely used terms called quasi-coordinates and quasi-velocities, (φ, ν), with relation to $(x, \dot{x})$ by

$$\varphi = \int_0^t \nu dt \tag{12}$$

with $\nu = \dot{x}$ or $\nu = \Lambda(x,t)\dot{x}$ with $\Lambda(x,t)$ a function of x and t. This integral is path-dependent, not integrable by the condition (11). The analysis in terms of φ, ν is more instructive, brings in new presentations and used for perception unification with holonomic (i.e. Lagrangian) mechanics. In particular, the equations back to Appell [12-14] completely characterize the dynamics via the quasi-acceleration, its square $\dot{\nu}^2$, analogous to the square of velocity in $U = \sum m_\nu \dot{\mathbf{r}_\nu}^2/2$. The Appell's equations read

$$\frac{\partial U}{\partial \dot{v}_s} = F_s \quad (s = 1, \dots, g) \tag{13}$$

(with the function $U = U(t, x_i, \nu_i, \dot{\nu}_i)$ the potential and F_s the components of $\mathbf{F}$ in such terms) and together with the above constraints constitute a complete system of equations of kinematics under given initial conditions for the case.

By the fact that this and other forms of nonholonomic-systems kinematics are analytical extensions unified with the holonomic core shows their presentations, parameters and observables as rigorously obeying the principles of causality and connectedness. The same arguments, together with account of the robustness issue undertaken in sect. 6, carry conviction in regard to the factor of robustness for the case. So, the discordance of quantum theory with the robust principles of causality and connectedness inherent in the nonholonomic analytical mechanics makes the two mechanics incompatible and impossible any bridge from quantum theory to such realm.

8. Refutation of the quantum relativistic theory

The same kind of generic discordance is inherent in the quantum relativistic theory, for it should provide a smooth transition into quantum mechanics and be built in also for no more than two-point density distributions of systems states. Being rooted in so, it presents a kind of a theory-in-itself as well.

The essential grounds of its probability analysis is ill-logic, as evident proceeding already from the Klein-Gordon equation

$$\left(\frac{1}{c^2}\frac{\partial^2}{\partial t^2} - \nabla^2 + \frac{mc^2}{\hbar^2}\right)\Theta = 0 \qquad (14)$$

for the wave function $\Theta(\mathbf{r}, t)$ with $\mathbf{r} = (x, y, z)$, c is the speed of light, for describing the quantum relativistic behaviour of a free spin-0 particle of mass m from given initial conditions under the natural boundary conditions and normalized $\int ||\Theta|| dV = 1$ over the $\mathbf{r}$ space of system variables. With the complex conjugate of this equation, one obtains a kind of conservation law

$$\partial_t \rho + \nabla \cdot \mathbf{j} = 0 \qquad (15)$$

with $\rho = \Theta^* \Theta$ taken for the instant probability density distribution of systems states and $\mathbf{j} = i\frac{\hbar}{2m}\nabla \cdot (\Theta \nabla \Theta^* - \Theta^* \nabla \Theta)$ for their probability density current. Up to Θ replaced by Ψ the same follows from the Schroedinger equation (1).

Analogous conservation laws, with appropriate terms taken for ρ and $\mathbf{j}$ in (15), are regarded as inherent in both the non-relativistic and the relativistic motion of systems of many particles and more dimensions governed by Klein-Gordon and Dirac equations. This is a standard framework for the analysis of probability density distributions of system motion states in the current quantum relativistic theory. In its covariant notation, the divergence term $\nabla \cdot \mathbf{j}$ of (15) can appear even of positive sign, hence, cause a negative ρ, which is not possible for the probability and it is habitually treated giving the relativistic theory impetus for developments.

However, assigning to ρ and $\mathbf{j}$ the probability sense does not follow from (15); it is an additional assumption for bridging the theory with the realm. The probability sense implies statistical proportions of allowable events regardless of their kind of physics, including this not only in the limit of small velocities but how it looks in this or that frame. But, while the theory was thought of as in agreement with the rule (3) assigned for that limit, now, with revealing the discord with the statistical approach by criterion (4), it turns again into the contradiction.

What substance does then the law (15) conserve? It conserves nothing but the built-in construct as formally capable of even negative probabilities, while the strict criterion (4) is not in this construct. This makes the quantum relativistic theory to a higher degree far of having the bridge to the realm under the same general approach to various motion modelling dimensions.

Just as important, the discordance lies not only in the principles of causality and connectedness, it is complete in a more basic and objective manner regarding robustness of behaviours analogous to those we showed above for the quantum mechanics. It is especially true of the last paragraph of sect. 6.

9. The theorem and corollary

In all, it follows from the arguments detailed above the concluding theorem

Theorem *The quantum mechanics and its relativistic theory are untenable with regard to the principles of statistical averaging, causality, connectedness, robustness, compatibility with well-established classics. It makes the quantum guideline fundamentally incorrect for any observable trends of the systems motion in the realm.*

The theorem sets the record straight: each of the seven key elements inherent in the quantum theory revealed ill-logic in sections 2-8 via first determined strict criteria is critical, not a matter of cosmetic corrections, and all the more so as it causes all the difference with the classics at the heart of physics.

So the questions of coupling the theory with the basics of relativity, gravity and other theories, and search for new materials, electronics etc. lose significance. The statistical methods of physics brought in the argument pave the way towards a compelling case for the fall of quantum paradigm.

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