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AN ARGUMENTATION FOR EINSTEIN'S VIEW ON QUANTUM MECHANICS

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Abstract

In this Essay, we present our old ideas concerning foundations of Elementary Quantum Mechanics (EQM). These ideas were published at the first time in the local Journal "Acta Physica" in 1992 [1]. We shortly remind these ideas and finish with conclusion that they give an argumentation for Einstein's view on quantum theory: QM and Quantum Field Theory (QFT) are only trials of the description of the nonlinear reality by linear methods [2].

1. Introduction

In this Essay, we would like to remind our old ideas published at the first time in the local Journal "Acta Physica" in 1992 [1]. These ideas concern foundations of Elementary Quantum Mechanics (EQM). By these

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foundations we mean the wave-corpuscular duality for matter and Jordan rules of constructing of the wave equation (see, e.g., [3, 4]). To be precise, we give here these rules: In the expression $E = E(\vec{p}, \vec{x}) \equiv H(\vec{p}, \vec{x})$ for energy of an object having linear momentum, $\vec{p}$, and radius-vector, $\vec{x}$, one ought to substitute

$$E \to i\hbar \frac{\partial}{\partial t}, \quad \vec{p} \to \frac{\hbar}{i}\nabla, \quad \vec{x} \to \vec{x}, \tag{1}$$

where $\nabla = \left(\frac{\partial}{\partial x}, \frac{\partial}{\partial y}, \frac{\partial}{\partial z}\right)$, and then, form the wave equation

$$i\hbar \frac{\partial \psi}{\partial t} = H\left(\frac{\hbar}{i}\nabla, \vec{x}\right)\psi. \tag{2}$$

$\psi = \psi(\vec{x}, t)$ is the so-called *wave function* and the evolutional equation (2) is called *temporal Schrödinger's equation*. On the above foundations modern physics had built the great buildings of Quantum Mechanics (QM) and Quantum Field Theory (QFT). We will show in this Essay that these foundations follow from linearization of the gauge theory of gravity considered by the author [1, 5-8] and denoted by him MicGG. Linearization of the more general Poincaré Theory of Gravity denoted by PGT and considered, e.g., in [9-17] leads to analogical conclusion.

This, the considerations presented in next Sections can be interpreted as an argumentation for Einstein's view [2]: a nonlinear, deterministic field theory gives correct and complete description of reality. QM and QFT are only trials of the description by linear methods and, therefore cannot by complete.

2. Short information about MicGG

By MicGG we mean the model of gauge gravity considered by the author in [1, 5-8]. This model is based on the following gravitational Lagrangian

$$L_g = \alpha\left(\Omega^i{}_j \wedge \eta_i{}^j + \Theta^i \wedge *\Theta_j\right) + \beta\Omega^i{}_j \wedge *\Omega^j{}_i, \tag{3}$$

where

$$\alpha = \frac{c^4}{16\pi G}, \quad \beta = \alpha A = \alpha\frac{K^2 hG}{c^3} = \frac{K^2 hc}{16\pi}. \tag{4}$$

Constant $K \in \mathbb{R}^+$ is most probably equal to 1, (see [1, 5-8]).

$\Omega^i{}_j$ and Θ^i denote here the curvature 2-form and torsion 2-form of the Riemann-Cartan connection $\omega^i{}_k$, respectively, and $\eta_i{}^j = g^{jk}\eta_{ik}$ is a pseudotensorial 2-form introduced by Trautman [18]. $*$ means the Hodge-star-operator [19, 20].

The Latin indices run over 0, 1, 2, 3 and the metric signature is $(+, -, -, -)$. $h = 2\pi\hbar$ denotes Planck's constant, c is the value of the light velocity in vacuum and, G, denotes the Newtonian gravitational constant.

The Lagrangian (3) has very good physical and geometrical motivation (see [1, 5-8]). After performing standard calculation we get the following gravitational field equations:

$$D * \Omega^j{}_i \equiv (-)\frac{\alpha}{2\beta}\left(\vartheta^j \wedge *\Theta_i - \vartheta_i \wedge *\Theta^j\right) - \frac{\alpha}{2\beta}\Theta_k \wedge \eta_i{}^{jk} - \frac{S_i{}^j}{4\beta}, \tag{5}$$

$$D * \Theta_i = -\Omega^{jk} \wedge \eta_{ijk} + \left[Q^b{}_{ir}Q_b{}^{pr} - \frac{\delta_i^p}{4}Q^{btr}Q_{btr} + \frac{\beta}{\alpha}\left(\frac{\delta_i^p}{4}R^{ijrm}R_{ijrm} - R^{ij}{}_{it}R_{ij}{}^{pt}\right)\right]\eta_p - \frac{t_i}{2\alpha}. \tag{6}$$

Equations (5)-(6) have very similar form to equations of a gauge field with sources given by the right hand sides. Decomposing the equations

(5)-(6) in the basis formed by the 3-forms η_i (see, e.g., [18]), one gets the following tensorial equations:

$$\nabla_m R_{li}{}^{pm} + R_{li}{}^{pt} Q_t + \frac{1}{2} R_{li}{}^{tn} Q^p{}_{tn}$$

$$= (-)\frac{\alpha}{2\beta}\left(Q_i{}^p{}_l - Q_l{}^p{}_i + Q_l \delta^p_i - Q_i \delta^p_l + Q^p{}_{il}\right) - \frac{1}{4\beta} S^p{}_{il}, \tag{7}$$

$$\nabla_k Q_{bp}{}^k + Q_{bp}{}^k Q_k + \frac{1}{2} Q_b{}^{lk} Q_{plk}$$

$$= G_{pb} + Q^r{}_{br} Q_{ip}{}^r - \frac{g_{bp}}{4} Q^{itr} Q_{itr}$$

$$- \frac{\beta}{\alpha}\left(R^{ij}{}_{bt} R_{ijp}{}^t - \frac{g_{bp}}{4} R^{ijrt} R_{ijrt}\right) - \frac{t_{pb}}{2\alpha}. \tag{8}$$

In the above formulae D means the exterior covariant derivative, ϑ^i denotes the corepor and $R^i{}_{klm} = (-)R^i{}_{kml}$ and $Q^i{}_{kl} = (-)Q^i{}_{lk}$ are the curvature and torsion components, respectively; ∇ means the covariant derivative and $G_{pb} = R_{pb} - \frac{g_{pb}}{2} R$ are components of the Einstein tensor. t_i and $S_i{}^j$ denote the canonical energy-momentum and canonical spin 3-forms of matter, respectively.

The canonical tensors $t^p{}_i$ and $S^p{}_{il} = (-)S^p{}_{li}$ are defined by following decompositions:

$$t_i = \eta_p t^p{}_i, \quad S_i{}^j = \eta_p S^p{}_i{}^j. \tag{9}$$

Field equations of the theory are 2nd order differential equations w.r.t. corepor ϑ^i and connection $\omega^i{}_k$, and, simultaneously, they are 3rd order differential equations w.r.t. metric and torsion components (or w.r.t. metric and defect components).

In tensor notation and inside of matter one has the system of 40 nonlinear, 3rd order partial differential equations on 40 unknown functions: 6 intrinsic metric components, 24 intrinsic torsion (or defect) components and 10 functions describing matter.

From physical point of view, the theory based on the Lagrangian (3) is an example of classical, microscopic gravitational theory (like one-particle Dirac's theory from the point of view QFT).

In macroscopic limit $h \to 0$ in vacuum we obtain standard GR.

For the following, the linearization of the field equations (7)-(8) in vacuum $\left(t_{pb} = S^{i}{}_{kl} = 0\right)$ will be valid. It is because we want to have to deal with a free gravitational field only.

3. The Linearized Field Equations

Decomposing the torsion tensor $Q^{i}{}_{kl}$ onto irreducible parts w.r.t. proper orthochronous Lorentz group $L_{+}^{\uparrow}$ [9-17]:

$$Q_{ikl} = \frac{2}{3}\left(t_{ikl} - t_{ilk}\right) + \frac{1}{3}\left(\eta_{ik}v_{l} - \eta_{il}v_{k}\right) + \varepsilon_{iklm}a^{h}, \tag{10}$$

where

$$v_{i} := Q^{k}{}_{ki} = -Q_{i}, \quad a_{i} := (-)\frac{1}{6}\varepsilon_{iklm}Q^{klm}, \tag{11}$$

$$t_{ijk} := Q_{(ij)k} + \frac{1}{3}\eta_{k}\left({}_{i}v_{j}\right) - \frac{1}{3}\eta_{ij}v^{k} \tag{12}$$

are the vectorial, axial, and tensorial parts of torsion respectively, we obtain from (7)-(8) the following linearized dynamical equations:

$$\Box\phi_{ik} = 0, \quad \phi_{ik} = \phi_{ki}, \quad \partial_{i}\phi^{ik} = 0, \tag{13}$$

where

$$\phi_{ik} := \psi_{ik} - \frac{8\beta}{\alpha}\chi_{ik} - \frac{2\beta}{3\alpha}\left(\eta_{ik}\delta - \frac{\beta}{\alpha}\partial_i\partial_k\delta\right) \tag{14}$$

is a massless field with spin-parity $J^P = 2^+$.

$\Box := \frac{\partial^2}{c^2\partial t^2} - \nabla^2$ and $\psi^{ik} = \psi^{ki}$ are small corrections to the flat Minkowskian metric $\eta_{ik} = \eta_{ki} = \eta^{ik}$.

$$\left(\Box - \frac{\alpha}{\beta}\right)\delta = 0, \tag{15}$$

where $\delta := \partial_a v^a$ is the field having mass $m^2 = (-)\frac{\alpha}{\beta}\frac{\hbar^2}{c^2}$ and $J^P = 0^+$;

$$\left(\Box + \frac{\alpha}{\beta}\right)B = 0, \tag{16}$$

where $B := \partial_i a^i$ is the field with mass $m^2 = \frac{\alpha\hbar^2}{\beta c^2}$ and $J^P = 0^-$;

$$\left(\Box + \frac{\alpha}{\beta}\right)\tilde{a}_b = 0, \tag{17}$$

where $\tilde{a}_b := a_b + \frac{\beta}{\alpha}\partial_b B$ is the field with mass $m^2 = \frac{\alpha\hbar^2}{\beta c^2}$ and $J^P = 1^+$;

$$\left(\Box - \frac{\alpha}{\beta}\right)\chi_{ik} = 0, \tag{18}$$

where $\chi_{ik} := \partial^l t_{l(ik)} - \frac{1}{12}\partial_{(i}\tilde{v}_{k)}$ is the field having mass $m^2 = (-)\frac{\alpha}{\beta}\frac{\hbar^2}{c^2}$ and $J^P = 2^+$;

$$\left(\Box - \frac{\alpha}{\beta}\right)\tilde{v}^i = 0, \tag{19}$$

where $\widetilde{v}^i := v^i - \frac{\beta}{\alpha}\partial^i\delta$ is the field with mass $m^2 = (-)\frac{\alpha\hbar^2}{\beta c^2}$ and $J^P = 1^-$.

$$\left(\Box + \frac{\alpha}{\beta}\right)\widetilde{t}_{ikl} = 0, \tag{20}$$

where

$$\begin{aligned}\widetilde{t}_{ikl} := t_{ikl} &+ \frac{\beta}{\alpha}\left(X_{il,k} + X_{kl,i} - 2X_{ik,l}\right) \\ &+ \frac{1}{4}\left\{\frac{1}{6}\left(\eta_{il}\widetilde{v}_k + \eta_{kl}\widetilde{v}_i - 2\eta_{ik}\widetilde{v}_l\right) - \frac{\beta}{\alpha}\left(\widetilde{v}_{l,ik} - \widetilde{v}_{(i,k)l}\right)\right\} \\ &- \frac{g}{8}\frac{\beta}{\alpha}\left(\varepsilon_{ilmn}\partial_k + \varepsilon_{klmn}\partial_i\right)\partial^m\widetilde{a}^n\end{aligned} \tag{21}$$

is the field having mass $m^2 = \frac{\alpha\hbar^2}{\beta c^2}$ and $J^P = 2^-$.

The linearized fields $\phi_{ik} = \phi_{ki}$, δ, B, $\widetilde{v}_i$, $\widetilde{a}_i$, $X_{ik} = X_{ki}$, $\widetilde{t}_{ikl}$ are irreducible in the following sense: they are traceless and divergenceless in vacuum, thus describing particles with definite spin-parity.

We see that all these fields satisfy the relativistic linear Schrödinger equations $(\equiv$ Klein-Gordon equations$)$ with positive, imaginary, or negative mass. Other important observation is: linearization introduces tachyons despite the fact that the exact theory is casual and deterministic (see, [1, 5-8]).

4. The Wave - Corpuscular Duality and Jordan's rules

Let us consider Schrödinger equation given by (16)

$$\left(\Box + \frac{\alpha}{\beta}\right)\Psi = 0; \quad \Psi := B. \tag{22}$$

For convenience we will restrict ourselves to analysis of this equation. However, an analogous analysis is also possible to the rest of the linear Schrödinger equations (13)-(21).

It is easy to check that the complex plane wave

$$\Psi = \Psi_0 e^{\frac{i}{\hbar}(Et \pm \vec{p}\cdot\vec{x})}, \quad \Psi_0 = \text{const.}, \quad E > 0 \tag{23}$$

satisfies equation (22) if and only if

$$\frac{E^2}{c^2} - \vec{p}^2 = \frac{\alpha}{\beta}\hbar^2 \left(= m^2 c^2 \right), \quad m > 0, \tag{24}$$

i.e, if and only if , E, is the energy and, $\vec{p}$ is linear momentum of the particle having mass

$$m^2 = \frac{\alpha \hbar^2}{\beta c^2} \to m = \frac{1}{2\pi}\sqrt{\frac{hc}{G}} \quad (\text{if } K = 1). \tag{25}$$

The solution (23)-(24) is, in some sense, fundamental one because one can construct more general solutions to the equation (22) from it by superposition.

It is seen that the fundamental solution (23)-(24) describes dynamically a free particle having mass $m = \frac{1}{2\pi}\sqrt{\frac{hc}{G}}$ $(\text{if } K = 1)$, linear momentum $\vec{p}$, energy $E^2 = c^2(\vec{p}^2 + m^2c^2)$, and spin-parity $J^P = 0^-$, which is *piloting* by the wave (23).

We propose to interpret the wave (23) following M. Born proposition [3, 4], i.e., we propose the wave as piloting the point like particle in such way that probability of its finding at the point, p, is proportional to square of moduli of this wave at this point.

This particle is not localized. A free and localized particle is described by the so-called *wave packed* formed from the waves (23).

It is reasonable to call the solution (23)-(24) the *wave-like* particle because it propagates as wave and interacts as particle having energy, E, and linear momentum, $\vec{p}$, both satisfying the famous de Broglie's relations

$$E = \hbar\omega, \quad \vec{p} = \hbar\vec{k}. \tag{26}$$

From the above facts one can conclude that we have here the wave-corpuscular duality for the solution (23)-(24) to the equation (22) (and for corresponding solutions to remaining Schrödinger's equations (13)-21))

This, one of the foundations of the EQM - the wave-corpuscular duality - is immediately obtained by linearization of MicGG.

We propose to interpret the wave (23) following M. Born proposition [3, 4], i.e., we propose the wave as piloting the point-like particle in such a way that probability of finding the particle at point, p, is proportional to square of moduli of this wave at this point (Interpretation of Ψ by de Broglie or, Bohm, is also possible).

It is very interesting that one can obtain the equation (22) as one-particle Schrödinger's equation if and only if by applying Jordan's rules (1)-(2) to a free realistic particle satisfying

$$\frac{E^2}{c^2} - \vec{p}^2 = m^2c^2\left(\frac{\alpha}{\beta}\hbar^2\right). \tag{27}$$

So, one can say that the elementary quantum-mechanical Jordan rules (1)-(2) follow from (22)-(23)-(24), i.e., that they follow linearized MicGG.

5. Hypothesis

From Sections 1-4, we see that the free gravitational field has the following properties:

1. Exact theory of the field is a nonlinear and deterministic gauge field theory.

2. Linearization of this theory leads us to Schrödinger equations, wave-corpuscular duality for gravitons and to Jordan rules, i.e., it leads us to foundations of the elementary quantum theory of gravitons.

If we treat gravitational field as typical gauge field and gravitons as typical micro-objects, then we will end up with the following Hypothesis.

The exact and complete theory of matter is a deterministic and nonlinear field theory, NFT (maybe a gauge field theory). The free fundamental particles, defined as irreducible representations of the Poincaré group P, emerge in linear approximation of the theory.

To every particle, a suitable linear Ψ is joined (the field of matter wave piloting the particle). The field Ψ satisfies the linear wave equation obtained from the relation

$$E^2 = c^2\vec{p}^2 + m^2c^4 \tag{28}$$

for integer spin and, most probably, from the relation

$$E = c\hat{\alpha} \cdot p + mc^2\hat{\beta} \tag{29}$$

for half-integer spin by means of the Jordan rules.

$$E = c\hat{\alpha} \cdot p + mc^2\hat{\beta} \tag{30}$$

is here the "Dirac's square-root" of $E^2 = c^2\vec{p}^2 + m^2c^4$, i.e.,

$$\left(c\hat{\alpha} \cdot p + mc^2\hat{\beta}\right)\left(c\hat{\alpha} \cdot p + mc^2\hat{\beta}\right) = c^2\vec{p}^2 + m^2c^4. \tag{31}$$

(See, e.g., [3]).

$\hat{\alpha}$, $\hat{\beta}$ mean Dirac's matrices and, p, is 4-momentum.

The obtained equation is, of course, linear Schrödinger's equation.

The above Hypothesis generalizes properties of the gravitational field to the whole matter.

From the point of view of the Hypothesis the standard quantum-mechanical formalism is only description by linear methods of the relations which are, in fact, nonlinear. Therefore, this formalism cannot be complete.

References

[1] J. Garecki, Acta Physica 2 (1992), 88.

[2] A. Einstein, The Meaning of Relativity, Princeton University Press, fifth edition, 1953.

[3] Bronisław Średniawa, Quantum Mechanics (in Polish), Wydawnictwo Naukowe PWN, 1 edition, 1978.

[4] Leonard I. Schiff, Quantum Mechanics, International Series in Pure and Applied Physics, McGraw-Hill, New York, 3rd ed., 1968.

[5] J. Garecki, New physical interpretation of the Bell-Robinson tensor, Classical and Quantum Gravity 2 (1985), 403.

[6] J. Garecki, Gauge Theory of Gravitation with Quadratic Lagrangian, On Relativity Theory, World Scientific, Singapore, 1985, p. 232.

[7] J. Garecki, Acta Physica Polonica B 20 (1989), 997.

[8] J. Garecki, General Relativity and Gravitation 22 (1990), 111.

[9] K. Hayashi and T. Shirafuji, Progress of Theoretical Physics 64 (1980), 866.

[10] Kenji Hayashi and Takeshi Shirafuji, Gravity from Poincaré gauge theory of the fundamental particles. II: Equations of motion for test bodies and various limits, Progress of Theoretical Physics 64(3) (1980), 883-896.

[11] Kenji Hayashi and Takeshi Shirafuji, Gravity from Poincaré gauge theory of the fundamental particles. III: Weak field approximation, Progress of Theoretical Physics 64(4) (1980), 1435-1452.

[12] Kenji Hayashi and Takeshi Shirafuji, Gravity from Poincaré gauge theory of the fundamental particles. IV: Mass and energy of particle spectrum, Progress of Theoretical Physics 64(6) (1980), 2222-2241.

[13] Kenji Hayashi and Takeshi Shirafuji, Gravity from Poincaré gauge theory of the

fundamental particles. V: The extended Bach-Lanczos identity, Progress of Theoretical Physics 65(2) (1981), 525-532.

[14] Kenji Hayashi and Takeshi Shirafuji, Gravity from Poincaré gauge theory of the fundamental particles. VI, Progress of Theoretical Physics 66(1) (1981), 318-336.

[15] Kenji Hayashi and Takeshi Shirafuji, Gravity from Poincaré gauge theory of the fundamental particles. VII, Progress of Theoretical Physics 66(6) (1981), 2258-2273.

[16] Kenji Hayashi and Takeshi Shirafuji, Energy, momentum and angular momentum in Poincaré gauge theory, Progress of Theoretical Physics 73(1) (1985), 54-74.

[17] Masayasu Fukui, Kenji Hayashi and Takeshi Shirafuji, Conformal rescalings applied to Poincaré gauge theory, Progress of Theoretical Physics 74(4) (1985), 852-865.

[18] A. Trautman, Symposia Mathematica 12 (1973), 139.

[19] W. Thirring, Acta Physica Austriaca XIX (1978), 439, Suppl.

[20] W. Thirring, Use of differential forms in general relativity, Vienna preprint, 1978.