

# SPACE STRUCTURE AND QUANTUM MECHANICS

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A new concept of the constitution of Nature is considered. The constructed submicroscopic quantum mechanics is deterministic and is characterised by elementary excitations of the space net that is treated as the tessellation of balls, or superparticles. Said excitations called "inertons" accompany any canonical particle when it moves. It is shown theoretically that the introduction of inertons obviates all conceptual difficulties of orthodox quantum mechanics. The theory has been verified experimentally. It is argued that just inertons play the role of real carriers of the gravitational interaction.

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03.75.-b Matter waves. 04.60.-m Quantum gravity

## 1 Introduction

Sometimes this or that science one may treat from not typical standpoints. For instance, in the mid-20th century Arnold Toynbee [1] investigated historical studies considering people history as a circulation of local civilizations, which replace one another. 120 years ago Polish linguist Michal Krasuski [2] was interested in the origin of numerals: one, two, three, ..., ten, hundred, thousand, etc. The study came him to the unexpected deduction: names of numerals were associated with the every day fingers activity and names of fingers in Ukrainian language. Thus he concluded that names of numerals could be understood only from Ukrainian which, therefore, is the most ancient language among all Aryan ones including Sanskrit, Greek, Latin, etc.

Such kinds of studies are rather cognitive. But may quantum physics be explored in a similar way? Probably it may since quantum physics is based on some initial notions (mass, particle, quantization, particle energy  $E = h\nu$ , de Broglie wavelength  $\lambda = h/p$  and the matter waves, wave  $\psi$ -function and long-range action, Compton wavelength  $\lambda_{\text{Com}} = h/mc$ , spin, fundamental constants, and so on), which all together have never been treated in detail so far. A viewpoint of this type has something in common with Louis de Broglie's, who used to say that it is useful to reconsider the foundations of physics from time to time. It is obvious that conducting such an analysis

one will touch both the foundations of quantum mechanics and the foundations of quantum gravity since these two to be descent from the same submicroscopic scale [3].

## 2 The theory and results

We would start from the Dirac's remark [4] that the objections to an aether posed by relativity were removed by quantum mechanics. This means that a vague vacuum, or an empty space of general relativity should make way for a substrate. The substrate cannot directly be associated with an uncertain Higgs condensate of models of grand unification of interactions (the condensate is not constructed in a real 3D space). None the less the models of grand unification basing on experimental results allow the calculation of evolution of three constants  $\alpha_{\text{el.-magn.}}$ ,  $\alpha_{\text{weak}}$ , and  $\alpha_{\text{strong}}$  as functions of distance  $r$ . All the constants come together at  $r \approx 10^{-28}$  cm (Fig. 1).

At the same time modern concepts of gravitational interaction do not permit any similar analysis in principle. But why? It is apparent that the main reason of such a difference of gravitational interaction from the other fundamental ones is caused by its initial phenomenological basis while the detailed behaviour of the three other interactions were constructed many years later resting on already well-developed quantum mechanics. Those three interactions, electromagnetic, weak, and strong are characterised by their own carriers, namely photons,  $W^{\pm}$

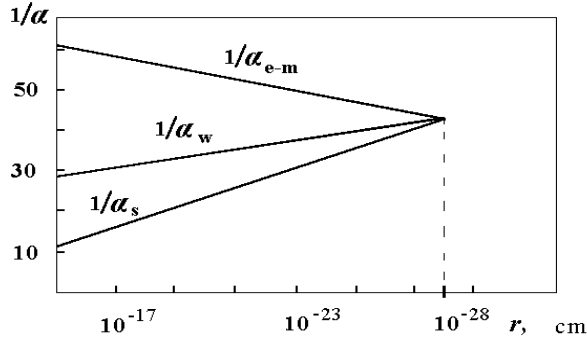


Figure 1: Evolutional lines describing changes of the interaction constants with distance.

and Z bosons, and gluons, respectively. Hence we may conclude that if someone tries to construct the gravitational interaction starting from quantum mechanics, he may also come to certain carriers, which will effect the direct interaction between massive objects. High energy physics has greatly advanced our knowledge about the microstructure of real space and the structure of particles. Specifically, unified models have proposed an abstract "superparticle" whose different states are quarks, electron, muon, neutrino, and others. Taking into account the facts mentioned above a researcher whose specialty is condensed matter physics may suggest that just those superparticles form a world substrate, which shares discrete and continual properties. The introduction of such a substrate in fundamental physics automatically implies that both the relativity and the concept of unification of interactions require a radical revision: 1) the gravitational interaction will immediately be endowed by carriers, i.e., special elementary excitations of the substrate; 2) the three other interactions may not be elementary, particularly the weak and strong ones – they might result from the renormalization of some kinds of more fundamental excitations of the substrate (such as photons and inertons introduced below).

Let us construct a real space packing of superparticles leaning on concepts and ideas used in condensed media physics. Such a construction is in agreement with requirements of a mathematical space [5]. The

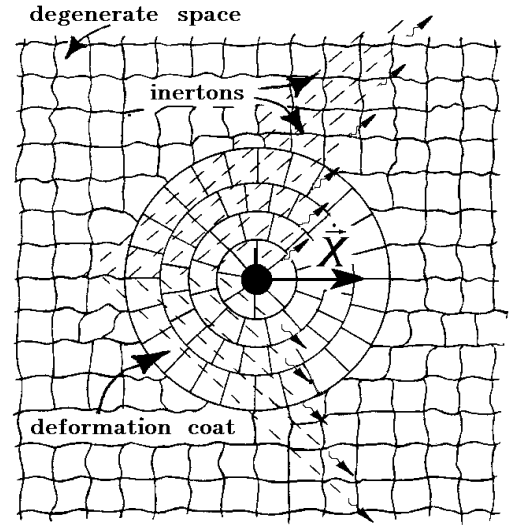


Figure 2: The moving particle in the degenerate space net.

conceivable size of a superparticle may be equal to  $10^{-28}$  cm. Let superparticles being elastic densely put to each other forming an entire substrate (quantum aether). The substrate may be thought of as the degenerate space net. In the theory proposed in papers [6-8] a local deformation of the space net, i.e., a stable change of the initial volume of a superparticle in the degenerate space net is associated with the creation of a particle in it (Fig. 2). Unstable deformations constitute spatial excitations, or quasi-particles, called "inertons" [6]. Any particle created in the space net features its deformation coat (or singularity region, or aether/space crystallite) which plays the role of a screen shielding the particle from the degenerate space. The size of the crystallite is equal to the Compton wavelength  $\lambda_{Com} = h/Mc$  of the particle. Superparticles are characterised by mass within this region and therefore possess some properties typical for a solid crystal, for instance such as collective vibrations. When the particle begins to move it experiences friction striking superparticles. As a result of the interaction with coming superparticles, the particle should emit and then absorb elementary excitations, i.e. inertons [6-8]. Once the particle moves running between fluctuating superparticles, inertons migrate as typical quasi-particles, i.e., they carry bits of space deformation hopping from superparticle to superparticle by relay mechanism. The moving particle pulls its deformation coat, or crystallite, since superparticles surrounding the particle along all its path have time to be adjusted to the particle organizing the coat.

The Lagrangian that characterises the motion of a particle is the following [6]

$$\begin{aligned}
L &= \frac{1}{2}g_{ij}\dot{X}^i(t)\dot{X}^j(t) + \frac{1}{2}\sum_{l=0}^{N-1}\tilde{g}_{ij}^{(l)}\dot{x}_{(l)}^i(t_{(l)})\dot{x}_{(l)}^j(t_{(l)}) \\
&- \sum_l^N[X^i\dot{x}_{(l)}^j + v_0\delta_{ij}x_{(l)}^j]\delta_{t-\Delta t_{(l)},t_{(l)}}\frac{\pi}{T_l} \quad (1)
\end{aligned}$$

Here, the first term describes the particle, the second term describes the ensemble of inertons and the third one depicts the interaction between the particle and inertons.  $v_0$  is the initial velocity of the particle,  $\pi/T_l$  is the frequency of collisions of the particle with inertons.

In the relativistic case we start from the Lagrangian

$$L_{\text{rel.}} = -M_0c^2\sqrt{1 - v_0^2/c^2} \quad (2)$$

in which the following transformation is made [7]

$$v_0^2 \longrightarrow [g_{ij}\dot{X}^i\dot{X}^j + U(X, x, \dot{x})]/g. \quad (3)$$

where the function  $U$  is similar to the second and third terms in expression (1).

The solution of the equations of motion has shown that the particle oscillates along the trajectory: the particle velocity changes periodically from  $v_0$  to 0 and then from 0 to  $v_0$  in the interval of de Broglie wavelength  $\lambda$ . So from the submicroscopic viewpoint the value  $\lambda = h/Mv_0$  may be remolded as the spatial period of the oscillatory moving particle. The time period of the particle oscillations is  $T = \lambda/v_0$ . A similar relation is true for the inerton cloud enclosing the particle. The cloud oscillations are specified by amplitude  $\Lambda = cT$  where  $c$  is the velocity of inertons in the degenerate space net, which might be equal to the velocity of light. The amplitude  $\Lambda$  is connected with the de Broglie wavelength by the relationship [6]

$$\Lambda = \lambda c/v_0. \quad (4)$$

It is proved that the motion of the particle is deterministic and features the relationships

$$E = h\nu, \quad \lambda = h/Mv_0 \quad (5)$$

where  $E = Mv_0^2/2$  and  $M = M_0/\sqrt{1 - v_0^2/c^2}$ . As known [9] just the availability of relationships (5) allows the introduction of the Schrödinger formalism, which due to relationship (4) is correct in the region covered by the distance  $\Lambda$  from the particle. Thus the introduction of inertons automatically removes long-range action from any quantum system restricting the effect of the Schrödinger formalism by the value of amplitude  $\Lambda$ .

The problem of spin is solved [8] by the introduction of one more degree of freedom in expression (3),

i.e., we add a new matrix form function  $U_\alpha$  (where  $\alpha = \uparrow, \downarrow$ ) to the function  $U$ . The matrix describes two possible pulsations of the particle: ahead ( $\uparrow$ ) and back ( $\downarrow$ ) in relation to the vector of particle's motion velocity. This sheds light [8] on the inner reason of transformation of the total Hamiltonian of a particle

$$H^{\text{part.tot}} = \sqrt{c^2\vec{p}^2 + c^2\vec{\pi}_{\uparrow(\downarrow)}^2} + M_0^2c^4 \quad (6)$$

to the Dirac Hamiltonian operator

$$\hat{H}_{\text{Dirac}} = c\hat{\alpha}\vec{p} + \hat{\rho}_3M_0c^2. \quad (7)$$

The theory developed yields the very interesting relationship [8], namely it groups together the amplitude of inerton cloud with the Compton wavelength

$$\Lambda = \tilde{\lambda}_{\text{Com}}c^2/v_0^2. \quad (8)$$

With  $v_0^2/c^2 \ll 1$ , the inerton cloud amplitude  $\Lambda \gg \lambda_{\text{Com}}$  and the inerton cloud governs the motion of the particle, as already at a distance of  $\Lambda$  from the particle the cloud undergoes obstacles and passes the corresponding information to the particle. This is the de Broglie "motion by guidance" and the utilization of the Schrödinger formalism is quite correct in this case.

In the approximation  $v_0 \rightarrow c$ ,  $\Lambda \approx \lambda_{\text{Com}}$  and therefore the cloud of inertons completely closed in the crystallite surrounding the particle. This case falls under the Dirac formalism.

Thus inertons surrounding a moving particle make up a substructure of the matter waves, which so far have been treated only in the framework of the wave  $\psi$ -function probabilistic formalism and any physical interpretation has not been taken into account.

### 3 Experimental corroboration

The theory of submicroscopic quantum mechanics has been verified. Paper [10] demonstrates how inerton clouds expanded around moving electrons manifest themselves in numerous experiments. The paper deals with experimental and theoretical results available when laser-induced gas ionisation phenomena and photoemission from a laser-irradiated metal take place.

In work [11] the impact of inertons on the collective behaviour of atoms in a solid has theoretically been treated and then experimentally approved in metal specimens. It has been derived that the force matrix  $W_{\alpha\beta}$  that determines three branches of acoustic vibrations in the crystal lattice consists of two components

$$W_{\alpha\beta}(\vec{k}) = \tilde{V}_{\alpha\beta}(\vec{k}) + \tilde{\tau}_{\alpha\beta}^{-1} \sum_{\alpha'} \tilde{\tau}_{\alpha'\beta}^{-1}(\vec{k}) \frac{e_{\alpha'}}{e_{\beta}} \quad (9)$$

Here,  $\tilde{V}_{\alpha\beta}$  is the usual term caused by the elastic electromagnetic interaction of atoms and the second term is originated from the overlapping of inerton clouds of adjacent atoms. The availability of the second term means that an outside inerton field is able to influence the crystal lattice increasing amplitudes of vibrating atoms. The experiment which assumes the presence of the hypothetical inerton field has been performed. The terrestrial globe has been considered as a source of inertons. The expected changes in the structure of test metal specimens caused by the Earth inerton field in fact have been convincingly fixed in electron micrographs [11].

Moreover just recently the theory has been tested for truth in the experiment on the hydrogen atoms clustering in the  $\delta$ -KIO<sub>3</sub>·HIO<sub>3</sub> crystal [12]. We have considered the cluster formation of atoms in a model when the potentials of attraction and repulsion are parted from one another. Proceeding from submicroscopic quantum mechanics we come to the following form of two parts of the Lennard-Jones potential

$$V_{\text{att}}(r) = -\epsilon\left(\frac{g}{r}\right)^6 + \frac{1}{2}\gamma r^2; \quad V_{\text{rep}}(r) = \epsilon\left(\frac{g}{r}\right)^{12}. \quad (10)$$

Here, the small correction  $\gamma r^2/2$  is stipulated by an elastic response of the space net on the motion of acoustic excitations, i.e. phonons, in the crystal lattice. The calculated number of hydrogen atoms in a cluster equals

$$\mathcal{N} \simeq \left(\frac{3\epsilon}{\gamma g^2}\right)^{3/5} \quad (11)$$

where  $\epsilon$  and  $g$  are the bound energy and the length of O–H bond respectively and  $\gamma$  is the inerton elasticity constant of the cluster. The IR spectra obtained yield the reliable evidence of the cluster formation in the crystal studied ( $\mathcal{N} = 24$ , the number of cooperated hydrogen atoms [12]).

## 4 Conclusion

Summarizing we can infer that just the inerton field, **a new physical field**, whose carriers – inertons – make a substructure of the matter waves, generates the quantum mechanics formalism in the region from  $10^{-28}$  cm to the atom size. The radius of action of the field of a particle is limited by the amplitude  $\Lambda$  (4) of particle's inerton cloud. This also signifies that the gravitational radius of a particle is restricted by the same distance  $\Lambda$  since any piece of information about the particle cannot be found beyond the bounds of its inerton cloud. Thus the dynamic inerton field becomes a real candidate for the understanding the gravitation phenomenon and yet the research conducted denies an option of the existence

of gravitons of general relativity without any doubt. The inerton field is capable also to account for macroscopic phenomena trespassing upon the range traditionally describing by general relativity. This means that general relativity loses its monopole rights of the all-embracing theory: the static relativity should be replaced for a dynamic theory based on the inerton field that realizes the direct interaction between massive objects. However this is the other problem which is still waiting for the solution.

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