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ON THE MASS OF ELEMENTARY CARRIERS OF GRAVITATIONAL INTERACTION

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Abstract: Based on the theory of submicroscopic quantum mechanics recently constructed by the author the mass of elementary spatial excitations called inertons, which accompany a moving particle, is estimated herein. These excitations are treated as carriers of both inertial and gravitational properties of the particle.

Key words: space, inertons, mass, gravitation

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

In a series of recent papers by the author [1-4] submicroscopic quantum mechanics has been constructed. It easily results in the Schrödinger and Dirac formalisms on the atom scale. The theory has predicted the existence of peculiar spatial excitations around a moving particle. Those excitations have been identified with a substructure of the matter waves and been called "inertons". The theory has successfully been verified experimentally, namely, it has been demonstrated how inertons manifest themselves in numerous experiments [5] and, moreover, inertons have been recorded in our experiments as well [6-8].

Detailed theoretical consideration [1-5] of the motion of a canonical elementary particle in the real space that is characterized by a submicroscopic structure (and the particle is an element of the space as well), allows an evaluation of the value of mass of elementary excitations – inertons – of a space substrate (i.e. quantum aether).

Elementary excitations of the space substrate are created due to collisions of a moving particle by superparticles – primary cells of the structure of the real space. The excitations were called inertons [1] because, in essence, they reflex inert properties of the particle, i.e. inertons appear owing to the resistance which the particle experiences at its motion on the side of the space substrate that in turns is specified by quantum properties. Amplitude Λ of the particle's inerton cloud that surrounds the moving particle obeys the relationship [1]

$$\Lambda = \lambda c / v_0 \qquad (1)$$

where λ is the de Broglie wavelength of the particle, v_0 is its initial velocity, and c is the velocity of light.

According to the author's concept [1-5], a particle is created from a degenerate superparticle. Therefore a particle should be treated as a local curvature of the space. The notion of the mass is associated with the alteration of an initial volume of the mother superparticle. Around a particle, a deformation coat, or crystallite, is formed that consists of superparticles which possess mass. Beyond the crystallite superparticles are massless. Thus the crystallite plays the role of a screen that shields the particle from the degenerate space substrate. The total mass of massive superparticles of the crystallite is equal to the mass m_{v_0} of the particle [4], which is found in the center of the crystallite. The size of the crystallite is estimated by the length of the Compton wavelength $\tilde{\lambda}_{v_0} = h/m_{v_0}c$. As the solid state physics teaches, the availability of the crystal structure automatically implies the appearance of elementary vibrational excitations in the crystallite [4].

Inertons should be considered as a substructure of the matter waves [3-5]. In papers [1,2,4] it has been noted that the kinetic energy of an emitted inerton is directly proportional to the energy of the particle that the particle had had at the moment of the collision with the vibrating mode of the crystallite. Both the energy of the particle and that of the mode decrease from collision to collision. Therefore the same should occur for emitted inertons: the energy of the $(i+1)$th inerton is less than the energy of the $i$the one. Since we assume that the initial velocity of emitted inertons has an order of the velocity of light c, we should conclude that the mass of emitted inertons gradually decreases as well, i.e. $m_{i+1} < m_i$.

For instance, if the velocity of the particle $v_0 \ll c$, then the inequality $m_i > m_{\rm cr}$ holds in the beginning, where $m_{\rm cr}$ is the averaged mass of the crystallite's superparticle. In other words the inequality is correct at a small value of i (we recall that $i = \overline{1, N}$ where N is the total number of collisions of the particle along its half de Broglie wavelength $\lambda/2$. In this case amplitude Λ_i of the ith emitted inerton prevails the crystallite size, $\Lambda_i \gg \tilde{\lambda}_{v_0}$.

However, as the index i increases, the inerton mass diminishes and reaches values less than the mass of crystallite's superparticles, $m_i < m_{\rm cr}$. In this case the amplitude of the inerton has a magnitude under the crystallite size, $\Lambda_i < \tilde{\lambda}_{v_0}$.

The averaged mass $m_{\rm cr}$ of a superparticle in the crystallite can be estimated. For example, in the case of a nonrelativistic electron the Compton wavelength $\tilde{\lambda}_0 = 2.42 \times 10^{-10}$ cm. If we divide the crystallite volume $\tilde{\lambda}_0^3$ by the volume of a superparticle $\mathcal{V} \sim (10^{-28})^3$ cm^3, we will get the number of superparticles in the crystallite $N_{\rm in\ crys.} \sim 10^{55}$. Since the mass of the crystallite is taken to be the mass of the particle, we will obtain the following value for the mass of a crystallite's superparticle: $m_{\rm cr} = M_0^{\rm electron}/N_{\rm in\ crys.} \sim 10^{-85}$ kg.

We can also evaluate the mean mass $\bar{m}_{\rm in}$ of an emitted inerton. For this purpose we should divide the total mass $\Delta M = (M_0/\sqrt{1 - v_0^2/c^2} - M_0)$ of the emitted inerton cloud by the number of emitted inertons $N = \lambda/\mathcal{V}^{1/3}$ (we recall that the cloud is emitted along the first half de Broglie wavelength $\lambda/2$, then it is absorbed in the next section $\lambda/2$ of the particle path, and so on).

Setting v_0 equals $0.01c$ to $0.999c$, we obtain:

$$\bar{m}_{\rm in} = \frac{M_0/\sqrt{1 - v_0^2/c^2} - M_0}{\lambda/\mathcal{V}^{1/3}} = 10^{-57} \text{ to } 10^{-45} \text{ kg}. \quad (2)$$

In the case of inertons emitted by atoms which vibrate in a solid, $\bar{m}_{\rm in}$ falls in the broad range between values (2) and about $\sim 10^{-70}$ kg (at the extremely low atom velocity $v_0 \sim 1$ μm/s).

The value of mass of carriers of a peculiar interaction between objects was estimated also by other researchers. For instance, Kolpakov [9] studying experimentally a nonelectromagnetic interaction between both extrasensitive participants and objects of abiotic environment proposed a pure classical mechanism of the propagation of excitations of an aether substance; his model yielded evaluation $\sim 10^{-73}$ kg for the mass of carriers of the revealed interaction.

Starting from the field formulation of the general theory of relativity Zhuk [10] obtained for his "gravitons", carriers of the gravitational interaction, mass $\sim 10^{-69}$ kg. It is interesting that this magnitude is approximately equal to an average value between mentioned inerton masses $m_{\rm cr}$ and $\bar{m}_{\rm in}$.

Thus, it can be concluded based on submicroscopic quantum mechanics that the value of mass of carriers of the inertial/garvitational interaction is not strongly fixed. Masses of inertons emitted and then absorbed by a moving particle is distributed in a wide spectral range. Note that a similar situation occurs in the case of the electromagnetic radiation: the photon frequency can vary from practically zero to the frequency of high-level γ-photon.

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