

On The Proper System of Coordinates and the Meaning of The Wave Function

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The presented line of arguments is focused on finding the basic reason why non-quantum mechanics, and, in particular, special relativity theory (SRT), fail for a free non-zero mass entity (a particle) – the case for which they might seem best suited. As suggested, the cardinal point causing the insufficiency of the SRT consists in the contradictory way of how a system of coordinates is introduced for a free entity. While SRT introduces an object as essentially related to some external property, such as transformation under a change in the (external) system of coordinates, quantum mechanics (QM) introduces an object as essentially defined by its proper feature – the wave function. It might be therefore assumed that the basic novelty of QM consists in postulating that an object is described by (or in) its *own*, that is, *proper* system of reference. As shown, a consistent application of a proper system of coordinates may provide a common background from which QM and SRT originate.

In the presented approach, a proper system of coordinates for a free, non-zero mass entity (particle) is introduced based on de Broglie's periodic phenomenon [1], which provides the natural unit of the entity's proper time, entirely determined by the entity's proper mass m_0 , and enabling the entity's functioning as a 'proper clock' [2, 3]. Based on the strategy 'everything from proper time', an interval of the entity's proper time enables one to introduce a related set of intervals of proper space and straightforwardly provides a set of 'proper velocities'. Such an approach possesses a correspondence to the basics of arithmetic, starting from natural numbers for proper time. Maintenance of strict consistency in applying a proper reference frame approach would require introducing dimensionless coordinates of a particle's proper time and space; this becomes possible by including, along with h and c , also the constant of gravity G .

As follows, the connection between intervals of proper time and proper space inevitably appears in a wave-like form, yielding an entity's free wave. A conjunction of particle-like and wave-like properties of m_0 -entity acquires a numerical description that discloses the meaning of the entity's 'proper velocity'.

Besides the necessity of wave-like properties, it will be shown that recognizable basic phenomena such as the expression for relativistic energy-momentum, the one-half spin idea, as well as some pre-condition for Pauli-Dirac's prohibition principle, indistinguishability of particles, nonlocality and some others emerge from and acquire a different meaning in the course of consistent application of the proper reference frame concept to a free, non-zero mass particle.

[1] Louis de Broglie, *Recherches sur la théorie des quanta*, Ann. Phys. **3** (1925), 22.

[2] R. Penrose, *Structure of Space-Time* (Benjamin, New York, 1968).

[3] R. Ferber, *A Missing Link: What is Behind de Broglie's "Periodic Phenomenon"?*, Foundations of Physics Letters **9** (1996), 575.