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Hypercomplex medium as a storage of physical equations

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In a brief review, we draw attention to the “hypercomplex medium” with the accent on quaternion (Q) algebra and contiguous areas: biquaternion (BQ) numbers, Q-spinors, and related groups. Due to Heaviside- & Gibbs’ vector algebra, this “Q-set” was nearly abandoned in XX century rarely emerging as a math tool [1]. However, it turns out to contain many geometric images and equations related to physics, thus appearing no less fruitful for current physics than differential geometry. By 1980 we knew three main “Q-physical coincidences”: imaginary Q-units geometrically form a 3D Cartesian frame (Hamilton), Pauli matrices are BQ-units’ representations, Cauchy-Riemann-type conditions for a Q-variable function are Maxwell equations of electrodynamics (Fueter [2]). Within the last 40 years, new non-trivial observations were made. There are pure math facts, among them the existence of 3D Q-space’s fractal 2D sub-structure (real unit being its metric) and an original geometric image of a complex number as a conic-gearing-type mechanism. There are also new Q-physical findings. A Q-vector version of SO(3,C)-invariant relativity theory emerges as a Q-square-root from special relativity [3]; formulated on a tangent plane over a curved manifold, it admits a further fractalization into Q-spinors [4]. A stability condition for Q-algebra under distortions of fractal space becomes the Schrodinger equation (in physical units), in a more complicated case, it precisely becomes the Pauli equation [5]. This helps to show that the Bohr model of H-atom is an exact stationary solution of the Schrodinger equation [6]. Consequent “reduction” of obtained equations leads to classical mechanics (with a geometric image of the action function) and to relativistic mechanics; in sum, a “general theory of mechanics” can be formulated [7]. Other aspects concerning links of the Q-curvature with Yang-Mills field strength and use of 2C fractal instruments in the spacecraft control [8] are considered.

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