Physical systems in a noncommutative space with preserved time-reversal and rotational symmetries

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We consider a space with noncommutativity of coordinates and momenta with preserved time-reversal and rotational symmetries [1]. The noncommutative algebra is constructed by generalizing the parameters of coordinate and momentum noncommutativity to tensors, defined with the help of additional coordinates and momenta. They are governed by a rotationally invariant system. The resulting algebra is equivalent to a canonical-type noncommutative algebra and does not violate rotational or time-reversal symmetries [1].

We examine one- and many-particle systems in this space, including free particles, systems of harmonic oscillators, and exotic atoms. We derive corrections to the energy levels of these systems caused by space quantization [2]. Additionally, we discuss the problem of describing the motion of a macroscopic body in such a space. We propose conditions on the parameters of the noncommutative algebra that provide a resolution to the soccer-ball problem in noncommutative space.

Motion of a particle and a macroscopic body in gravitational field is examined in the noncommutative phase space. The problem of the violation of the weak equivalence principle is discussed [3,4]. On the basis of comparison of the results of theoretical studies with the experimental ones the upper bound on the minimal length and the minimal momentum are found [1].

[1] Kh. P. Gnatenko Minimal momentum estimation in noncommutative phase space of canonical type with preserved rotational and time reversal symmetries  
Eur. Phys. J. Plus 135(8), 652 [12 p.] (2020)

[2]Kh. P. Gnatenko System of interacting harmonic oscillators in rotationally invariant noncommutative phase space Phys. Lett. A 382(46), 3317 (2018)

[3] [Kh. P. Gnatenko](http://ktf.lnu.edu.ua/users/khrystya/index.html), [M. I. Samar](http://ktf.lnu.edu.ua/users/samar/index.html), [V. M. Tkachuk](http://ktf.lnu.edu.ua/users/tkachuk/index.html), [Kepler problem in quantized space](http://ktf.lnu.edu.ua/books/Gnatenko_Samar_Tkachuk-monogr.pdf). Lviv: Lviv University Press, 2024. 136 pages.

[4] Kh. P. Gnatenko, [V. M. Tkachuk](http://ktf.lnu.edu.ua/users/tkachuk/index.html) Deformed Heisenberg algebras of different types with preserved weak equivalence principle J. Phys. Stud. 27(1), 1001 [19 p.] (2023)