Physical systems in a space with noncommutativity of coordinates

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In recent years noncommutativity has received much attention due to development of String Theory and Quantum Gravity. We have considered canonical version of noncommutative space characterized by the following commutation relations for the coordinate and momentum operators $[X_i, X_j] = i\hbar\theta_{ij}$, $[X_i, P_j] = i\hbar\delta_{ij}$, $[P_i, P_j] = 0$, where θ_{ij} is a constant antisymmetric matrix. We have examined the motion of a macroscopic body in gravitational field in this space [1]. The problem of violation of the equivalence principle in noncommutative space has been studied. We have found the way to solve this problem. It has been shown that the equivalence principle is recovered in the case when the parameter of noncommutativity is determined by the mass of a particle [1]. We have also studied the problem of rotational symmetry breaking in noncommutative space. To preserve the rotational symmetry we have considered the generalization of the constant antisymmetric matrix θ_{ij} to a tensor, which is defined with the help of additional coordinates governed by the harmonic oscillator [2]. The hydrogen atom has been studied in noncommutative space, which is rotationally invariant. We have found the perturbation of the energy levels of this atom caused by the noncommutativity of coordinates [2,3]. Using experimental results for the $1s - 2s$ transition frequency, we have estimated the upper bound of the parameter of noncommutativity [2].

References

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