Effects of dark matter, variation of the fundamental constants and violation of the fundamental symmetries in nuclei, atoms and molecules

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Low-mass boson dark matter particles form classical field and produce effects linear in the interaction strength. This may give an enormous advantage since in a traditional experiments effects are of the fourth or second power. Interaction with dark matter produces cosmological evolution and oscillating variation of the fundamental constants (fine structure constant, electron, proton and qurk masses) and oscillating effects of apparent violation of symmetries (parity, time reversal, Lorentz invariance, Einstein equivalence principle). Atomic spectroscopy measurements, the primordial helium abundance data and electric dipole moment (EDM) measurements allowed us to improve limits on the interaction of dark matter with photon, gluon, electron, quarks, Z, W and Higgs bosons up to 15 orders of magnitude [1-3]. The effects are strongly enhanced in nuclear [4,5] and highly charged ion clocks [6].

Using ^{21}Ne spectroscopy we improved limits on the anisotropy of the speed of light by 7 orders of magnitude [7]. Thousand times enhanced effects of parity and time reversal invariance (EDM) in ^{229}Th-containing molecules have been suggested [8]. New theorem about dynamical screening of the external oscillating field on atomic nucleus has been derived and effects of such field as well as new effects of oscillating dark matter field in atoms, molecules and nuclei have been considered [9-11].

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