Effects of variation of fundamental constants and violation of fundamental symmetries (P,T) in atoms

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Theories unifying gravity with other interactions suggest temporal and spatial variation of the fundamental "constants" in expanding Universe. I discuss effects of variation of the fine structure constant alpha which are linked to the relativistic corrections in atomic and molecular spectra, also effects of strong interaction and fundamental masses. The measurements of these variations cover lifespan of the Universe from few minutes after Big Bang to present time and give controversial results. There are some hints for the variation in Big Bang nucleosynthesis and quasar absorption spectra data. A very promising method to search for the variation consists in comparison of different atomic clocks. Huge enhancement of the relative variation effects happens in transitions between accidentally degenerate energy levels in nuclei, atoms and molecules.

Measurements of Cs weak charge by Wieman's group indicated possible deviation from the Standard Model predictions. We performed new calculations of parity violation in Cs including all-orders summation of dominating diagrams in many-body theory and strong Coulomb field radiative corrections. Conclusions for the Standard Model and possible "new physics" will be discussed. Atomic and molecular experiments can also be used to detect nuclear anapole moment - magnetic multipole which violates parity.

I explain the origin of atomic and molecular electric dipole moments (EDM) violating time reversal symmetry and parity. Calculations and measurements of EDM in atoms and molecules are used to test modern unification theories describing CP violation, for example, supersymmetric models.