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Isotope shift and atomic parity violation in the search for new physics

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Isotope-shift-related phenomena are an important way of probing nuclear physics models and they can assist the search for new physics. It has been recently suggested to use measurements of King plot nonlinearity in a search for hypothetical new light bosons, namely for long-range force carriers with couplings not proportional to the electric charge [1]. However, one can find nonlinear corrections to the King plot appearing already in the standard model framework. We investigate contributions to the nonlinearity arising from relativistic effects in the isotope field shift, the nuclear polarizability, and many-body effects. Our predictions place theoretical sensitivity limits on the search for new interaction [2].

Another way of precisely testing the standard model are parity-nonconserving (PNC) effects in low-energy atomic experiments. These effects are notably sensitive to hypothetical extra Z'bosons and dark photons [3]. We estimate the relative contribution of nuclear structure effects and new physics couplings to the PNC spin-independent effects in atomic systems [4]. We present general expressions to assess the sensitivity of isotopic ratios to neutron skins and to couplings beyond standard model at tree level. The evaluation of related parameters is carried out for atoms of current experimental interest.

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Authors: VIATKINA, Anna (Johannes-Gutenberg-Universität Mainz); FLAMBAUM, Victor (University of New South Wales and Johannes-Gutenberg-Universität Mainz); GEDDES, Amy J. (School of Physics, University of New South Wales, Sydney, New South Wales 2052, Australia); ANTYPAS, Dionysis (Helmholtz Institut Mainz); KOZLOV, Mikhail (Petersburg Nuclear Physics Institute); BUDKER, Dmitry (Helmholtz Institute Mainz and UC Berkeley)

Presenter: VIATKINA, Anna (Johannes-Gutenberg-Universität Mainz)

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