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Isotope shift in the search for the nuclear island of stability and new physics[1] ANNA VIATKINA, Johannes Gutenberg University Mainz, 55099 Mainz, Germany, VICTOR FLAMBAUM, School of Physics, University of New South Wales, Sydney 2052, Australia, Johannes Gutenberg University Mainz, 55099 Mainz, Germany, AMY GEDDES, School of Physics, University of New South Wales, Sydney 2052, Australia — We derive a mean-field relativistic formula for the isotope shift of an electronic energy level with arbitrary angular momentum. We use this formula to predict the spectra of superheavy metastable neutron-rich isotopes belonging to the hypothetical island of stability. These results may be applied to the search for such superheavy atoms in astrophysical spectra. In addition, it has been recently suggested to use measurements of King plot nonlinearity in a search for hypothetical new light bosons. 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. It is found that the nuclear-polarizability term can lead to significant deviation of the King plot from linearity. We then proceed with a rough analytical estimate of the nonlinearity arising solely from the effect of a hypothetical scalar boson. Our predictions place theoretical sensitivity limits on the search for new interactions and should help to identify the most suitable atoms for corresponding experiments.

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