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Ab initio nuclear structure calculations for new physics searches in ytterbium isotope shifts

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Ab initio nuclear structure theory aims to predict the structure of atomic nuclei from "first principles," employing systematically improvable approximations for nuclear forces and many-body wave functions. This ab initio paradigm has been established as a consistent, precise framework for predicting the structure of medium-mass nuclei with the ability to fully quantify uncertainties. In particular, ab initio calculations can give controlled predictions for nuclear structure effects in searches for physics beyond the standard model in atoms and nuclei. Recent developments have extended ab initio calculations on two frontiers: towards higher precision and towards heavier nuclei. These developments allow us to provide fully uncertainty quantified nuclear structure input for a search for a new boson in ytterbium isotope shifts. Based on our input, we identify the leading signal in ytterbium isotope shifts to be due to the structure of ytterbium isotopes, not the new possible boson, and extract new information on higher-order nuclear structure from high-precision mass and frequency measurements. We conclude with an outlook on ongoing studies of nuclear structure effects in neutrinoless double-beta decay and muon-to-electron conversion.

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