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Tabletop experiments using atomic dysprosium and ytterbium for tests of fundamental physics.

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Atomic dysprosium (Dy) and ytterbium (Yb) have proved to be valuable systems to study fundamental problems in modern physics. Their high atomic mass and their rich energy-level structure, which results in accidental degeneracies of opposite-parity energy states, make them ideal candidates for investigating parity-violating (PV) interactions. Dysprosium is particularly well-suited for searches of time variation of fundamental constants. In addition, atomic PV experiments offer the opportunity to study the weak interaction at low energy scales, providing valuable information about the Standard Model and nuclear physics. Most notably, the broad isotope distribution of both systems brings within reach the possibility of measuring neutron-skin variation among different isotopes, as well as detecting nuclear anapole moments.

We provide an overview of our group's experimental work on testing fundamental symmetries, searching for variations of fundamental constants, and measuring PV interactions using atomic Yb and Dy. The emphasis is on our newly revised PV experimental setups and current efforts, with a discussion of the present statistical sensitivities and future plans. Furthermore, we discuss two recent developments: (1) analysis of the Yb and Dy measurements that has been used to constrain possible PV interactions of cosmic fields with atomic electrons, and (2) precise radio-frequency spectroscopy in Dy that has provided strict limits on very-low-mass dark-matter particles.

Summary

Atomic dysprosium (Dy) and ytterbium (Yb) have proved to be valuable systems to study parity violating interactions at low energy scales, search for possible time variations of fundamental constants and violations of fundamental symmetries, and constraint light dark matter particles. We provide an overview of our experimental work on tests of fundamental physics using atomic Dy and Yb, and we discuss further recent developments.

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