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Improved differential charge radii of heavy alkali metals using isotope shift

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Isotope shift spectroscopy has repeatedly demonstrated its efficacy in high-precision tests of fundamental physics and the Standard Model. Its ability to benchmark atomic models and determine sizes of atomic nuclei has been well established, and in recent years, it has also been identified as one method for searching for potential dark matter particles.

The isotopic shift in transition frequencies between pairs of isotopes follows a linear ‘King’ relation, and deviations from this linear relation may indicate new physics. However, the prevailing belief now is that these arise due to non-linear Standard Model contributions including nuclear deformation.

In this work, we consider the isotope shifts in heavy atomic systems using state-of-the-art atomic many-body methods. We present significantly improved theoretical calculations of the field isotope shift and deduced differential nuclear charge radii for heavy alkali metals and alkali-metal-like ions of interest to fundamental physics studies. Our results resolve the discrepancies between previous calculations using isotope shift spectra and other experimental methods.

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