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High-precision atomic calculations for fundamental physics applications and the development of atomic clocks

Recent advances in atomic spectroscopy techniques have created a new era of unprecedented precision in the study of atomic phenomena. Atomic physics plays an ever-growing role in fundamental physics studies, including through atomic parity violation and searches for permanent electric dipole moments, as well as for tests of the CPT theorem and Lorentz symmetry, searches for variation of fundamental constants, and detection of dark matter and dark energy.
High precision atomic theory is required both to interpret experimental data in terms of fundamental physics parameters, and to direct experiment by identifying ideal systems for study.
We perform a detailed study of electric dipole (E1) transition amplitudes in K, Ca+, Rb, Sr+, Cs, Ba+, Fr, and Ra+, which are of interest for studies of atomic parity violation, electric dipole moments, polarisabilities, the development of atomic clocks, and for testing atomic structure theory.
We demonstrate extraordinary accuracy, and present a robust method for determining theoretical uncertainty.

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Track Classification: Precision Tests on Fundamental Physics