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Ab Initio Nuclear Theory for Tests of Fundamental Symmetries

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First principles, or ab initio, nuclear theory describes atomic nuclei as systems of nucleons interacting by QCD-based chiral effective field theory (EFT) nucleon-nucleon and three-nucleon forces. In combination with chiral EFT electroweak currents, ab initio nuclear calculations can provide model-independent results with quantifiable uncertainties relevant for tests of fundamental symmetries involving atomic nuclei. I will review recent and new results obtained within the ab initio no-core shell model (NCSM) [1] for parity violating anapole [2], electric dipole [3], and nuclear Schiff moments in atomic nuclei with the nuclear Green's function obtained using the Lanczos strength algorithm [4]. I will discuss ongoing effort to compute nuclear structure corrections for the extraction of the Vud matrix element from the superallowed Fermi transition measurements in 10C [5] and 14O. Finally, I will highlight NCSM calculations of the β-decay electron spectrum of the Gamow-Teller transition 6He(0+) ⟶ 6Li(1+) [6] and the unique first-forbidden β-transition 16N(2-) ⟶ 16O(0+). This work was supported by the NSERC Grant No. SAPIN-2022-00019. TRIUMF receives federal funding via a contribution agreement with the National Research Council of Canada. Computing support came from an INCITE Award on the Frontier supercomputers of the Oak Ridge Leadership Computing Facility (OLCF) at ORNL, form Livermore Computing, and from the Digital Research Alliance of Canada.

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