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Nuclear-recoils for New Physics Searches and Vud Determination

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Precise determinations of the energy distribution of recoil ions emerging from nuclear β-decay enables the determination of branching fractions to various excited states and angular correlations between the decay products. In this talk I will review ongoing and planned experiments in this field, and expand on two opportunities to make a significant impact with recoil measurements. The first is to search for, or exclude, new tensor interactions coupled to right-handed neutrinos. The second is to extract the Vud CKM matrix element from the Ft values of mirror and Fermi transitions. For measurements in isotopes decaying to a stable or long-lived daughter, it is necessary to deduce the energy distributions from the kinematics of the recoil daughter nuclei, requiring the use of ion or atom traps. A major systematic uncertainty in such experiments is caused by discrepancies in the determination of the trap position and size. I will show how a new imaging technique, the nuclear microscope [1], maximizes the sensitivity of a kinematic measurement to the underlying energy distributions, and reduces the systematic uncertainty contributions. This technique was demonstrated by measuring branching ratios and recoil-ion energy distributions for ionization processes in optical collisions of cold metastable neon [2]. [1] Physical Review C 101.3 (2020): 035501 [2] Physical Review Letters 123.6 (2019): 063401