β decay and the electric dipole moment: Searches for Time-Reversal Violation in radioactive nuclei and atoms

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One of the great successes of the Standard Model of particle physics is the explanation of Time-Reversal Violation (TRV) in heavy mesons. The TRV mechanism implies that it is immeasurably small in normal nuclear matter. However, unifying models beyond the Standard Model predict TRV that may be large enough to be within reach of measurement in nuclei and atoms, thus opening an important window to search for new physics. We will discuss two experiments sensitive to TRV: Correlations in β decay of ^{21}Na and the search for an Electric Dipole Moment (EDM) in Radium. The two experiments are sensitive to different types of models and therefore they are complementary.

Mirror nuclei such as ^{21}Na have well defined mixed Fermi - Gamow-Teller β transitions, which make them suitable to search for TRV. Current methods to study $\beta - \nu$ correlations involve trapping of the parent nucleus and observing the recoiling nucleus in a reaction microscope. By measuring the recoil momentum the kinematical information of the missing ν can be obtained. If the trapped sample can be accurately polarized the TRV in the quantity $\vec{J} \cdot (\vec{p}_e \times \vec{p}_\nu)$ can be measured.

There are several advantages to search for an EDM in the radium atom, associated with both nuclear and atomic structure. A first step in the measurement is to slow and trap Ra in an optical trap. However, Ra is difficult to trap due to leaking from the main cooling cycle. Recently we showed for the first time the trapping of the chemical homologue Ba. The trapping and cooling scheme allowed capturing 1% of the atomic beam into a magneto-optical trap. Currently the necessary atomic spectroscopy of Ra is being done.

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