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Developing a Plunger Device for Precise Magnetic-Moment Measurements

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Comparison between large-basis shell-model calculations and experimental data gives insights into the emergence of nuclear collectivity. One experimental observable that can be examined is the g factor, which gives a sensitive test of the proton versus neutron character of the nuclear states. There are extensive data on the first-excited states of even-even nuclei measured by the transient-field technique [1]. However, these data have a large uncertainty due to the difficulty of calibrating the transient-field strength, and there are no suitably precise known g factors for nuclei with atomic numbers $14 < Z < 40$.

One way to provide applicable calibration g -factor values is the recoil-in-vacuum method using a plunger device [2]. The device consists of two parallel foils, with a mechanism to adjust the distance between them precisely. Once the nuclei of interest have been created via a suitable nuclear reaction in the first ‘target’ foil, they recoil through the vacuum towards the second ‘stopper’ foil. The hyperfine fields from the recoiling ion’s electron configuration will couple with the nuclear spin, causing the nucleus to precess about the coupled spin with a frequency proportional to the g factor of the state, until the ion is stopped. This precession can be observed via the angular distribution of the emitted γ rays. Varying the distance between the foils allows the observation of the time-dependence of the nuclear precession, which in turn allows the measurement of the g factor, as the hyperfine fields can be calculated precisely [3].

This talk reports on recent progress in the development of a new plunger device. This new capability will allow precise reference measurements to be performed for a wide range of nuclei, providing crucial calibration values for a large set of both past and future g -factors measurements.

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