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Laser spectroscopy of aluminium isotopes at the limits of existence at FRIB

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Investigating the properties of atomic nuclei through measuring their influence upon bound electrons is a powerful and well-established approach in modern nuclear physics [Yan23]. By measuring the hyperfine structure and isotope shift in the atomic structure of radioactive nuclei, nuclear spins, magnetic dipole and electric quadrupole moments and changes in mean-square charge radii can be determined in a nuclear model-independent manner. These observables offer critical and complementary insights into the electromagnetic structure of the ground- and isomeric states of atomic nuclei, enabling state-of-the-art models of nuclear theory to be tested.

There is evidence for the existence of a proton halo in the neutron-deficient isotope ^{22}Al. Decay studies suggest that the unbound excited 1+ state possesses a proton halo based on the asymmetry of decays populating it from ^{22}Si compared to its mirror nucleus, ^{22}O [Lee20]. Reaction experiments measure an increased reaction cross-section in ^{23}Al compared to other N=10 isotones, suggesting an increase in nuclear size (both protons and neutrons) near the dripline [Cai02]. Additional experiments measuring the ground-state mass of ^{22}Al reveals an exceptionally low proton-separation energy of around 100 keV, a prerequisite for halo formation [Cam24]. Furthermore, ab initio nuclear theory calculations employing three different nuclear interactions predict an increase in the proton distribution size for the dripline nucleus ^{22}Al, compared to its heavier neighbours [Miy24].

To investigate the charge distribution of ^{22}Al, it was recently studied with laser spectroscopy using the new Resonance Ionization Spectroscopy Experiment, at the Facility for Rare Isotope Beams. This contribution will present the results from this campaign, where the changes in mean-square charge radii were measured all the way the proton dripline nucleus ^{22}Al (N=9).

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