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Laser spectroscopy of Al and Ni as probes of the transitional regions of deformation at $N = 20$ and $N = 40$

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The neutron-rich regions of $N = 20$ and $N = 40$ provide excellent testing grounds to investigate the evolution of nuclear structure and the rapid onset of deformation in radioactive isotopes lying close to shell closures and sub-shell closures. In these regions, effects such as islands of inversion (IoI), the onset of deformation and the collapse of the conventional shell model can be investigated using laser spectroscopy.

The Al isotopic chain forms the northern border of the $N = 20$ island of inversion, presenting an ideal candidate to probe the transition from spherical Si [1] into deformed Mg [2], whereby ^{32}Mg is considered the heart of the IoI. Before this work, charge-radii measurements in this region were limited up to $N = 20$ for Mg [2] and Na [3], and $N = 19$ for Al [4]. The CRIS collaboration recently measured $^{26-34}\text{Al}$ using laser spectroscopy, crossing the $N = 20$ shell closure.

The neutron-rich chain of Ni is of particular interest, with a magic proton number ($Z = 28$) and spanning across two main shell closures ($N = 28, 50$) and one sub-shell closure ($N = 40$). However, the neutron-rich region of Ni marks a challenging area experimentally, due to the refractive nature of Ni and the large contamination in this region (Ga), resulting in the current laser spectroscopy studies being limited up to ^{70}Ni (excluding ^{69}Ni). However, this region, yet to be explored thoroughly with laser spectroscopy, marks an area of high interest. Measurements of the $E(2^+)$ in Ni [5] indicate the re-emergence of the $N = 40$ shell closure, which appears to collapse in neighbouring elements ($Z < 28$) such as Cr [6], forming the $N = 40$ IoI. Furthermore, the enhancement of collectivity between $N = 40 - 50$ induced by the weakening of the $Z = 28$ shell closure [7] is not indicative of a semi-magic nucleus. The PI-LIST collaboration is actively working on the measurement of the neutron-rich chain of Ni using in-source laser spectroscopy, extending measurements into this mid-shell region between $N = 40 - 50$.

In the first half of this talk, a brief overview of the CRIS technique will be presented along with recent measurements of the change in mean-square charge-radii of $^{33,34}\text{Al}$, crossing $N = 20$. In the second half, the PI-LIST technique will be introduced, followed with a presentation of the recent measurements on neutron-rich Ni, extending the measurements of the nuclear spin, charge-radii and electromagnetic moments into the $N = 40 - 50$ mid-shell region. All result will be discussed in relation to the region and neighbouring isotopic chains.

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