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High-sensitivity and high-resolution laser spectroscopy of 76,77,78Cu at CRIS

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The Collinear Resonance Ionization Spectroscopy experiment (CRIS) at ISOLDE combines the high sensitivity of resonance ionization spectroscopy with the high resolution offered by collinear laser spectroscopy. The first experiments at CRIS demonstrated the ability to reach exotic isotopes, normally out of reach for collinear laser spectroscopy methods based on photon detection, with an intermediate resolution [1]. Further developments have focused on improving the resolving power, to the point where it now matches the resolution of other collinear laser spectroscopy methods [2]. With this performance, the CRIS experiment is ideally suited to study the evolution of nuclear structure in regions far from stability.

Several ISOLDE experiments have been working towards the region around the doubly magic 78Ni. Previous laser spectroscopy work [3-7] clearly demonstrated the inversion of the πf5/2 and the πp3/2 orbitals between 73Cu and 75Cu as the νg9/2 orbital is filled. This inversion is currently understood in terms of the tensor interaction between the neutrons and protons [8] which could potentially result in a quenching of the Z=28 shell gap towards N=50 [9].

This contribution will focus on the application of the high-resolution CRIS technique to the study of neutron-rich copper isotopes in the vicinity of N=50. The g-factors, quadrupole moments and charge radii of these neutron rich copper isotopes will provide additional information to gauge the robustness of the Z=28 shell in 78Ni. During the last campaign in April 2016, measurements have been performed on 15 Cu isotopes, including for the first time high resolution measurements of the very exotic isotopes 76,77,78Cu. These measurements, where 78Cu was produced at a rate of only 20 ions/s, provide information on the spin, magnetic moment, quadrupole moment and charge radius. The obtained data will be compared to large scale shell model calculations.

A brief discussion of the required technical developments for future work on even more exotic isotopes, including the doubly-magic+1p isotope 79Cu, will also be presented.

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[4] P. Vingerhoets, PRC 82, 064311 (2010)

[5] P. Vingerhoets, PLB 703, 1 (2013)

[6] K. T. Flanagan, PRC 82, 041302(R) (2010)

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[8] T. Otsuka et al, PRL 95, 232502 (2005)

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[10] J. Hakala et al., PRL 101, 052502 (2008)

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