RAPTOR - a novel collinear laser ionization spectroscopy experiment at the IGISOL facility

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The Resonance ionization spectroscopy And Purification Traps for Optimized spectRoscopy (RAPTOR) [1] project is a new experimental setup located at the Ion Guide Separator On-Line (IGISOL) [2] laboratory in the Department of Physics of the University of Jyväskylä, Finland. RAPTOR combines the two most common methods for laser spectroscopy in use at radioactive ion beam facilities: collinear laser spectroscopy and in-source laser-resonance ionization spectroscopy. This results in perhaps the most promising approach for optical spectroscopy by exploiting the high selectivity of resonance laser ionization, the high efficiency of ion detection, and the high resolution achieved by the use of fast beams. This technique, collinear resonance ionization spectroscopy (CRIS) [3], was pioneered in the past decade at the Isotope Separator On-Line Device (ISOLDE) at the European Organization for Nuclear Research (CERN). While the conventional collinear laser spectroscopy and CRIS methods exploit the kinematic compression of Doppler-broadening effects with beam energies of 30-60 keV, the RAPTOR device uniquely employs beam energies of 2-10 keV. Although the lower beam energy leads to somewhat lower spectral resolution, it improves the efficiency and selectivity of the charge-exchange process. Thus measurements requiring high efficiency are uniquely suitable for RAPTOR, especially complex d and f shell systems and refractory isotopes. In addition to laser spectroscopic studies, RAPTOR will be used to provide isomerically purified ion beams to JYFLTRAP double Penning trap - allowing for high-precision mass measurements of states independent of energy separation, as well as purified beams for post-trap assisted spectroscopy.

This contribution will present the current status of RAPTOR and the first offline commissioning results using stable isotopes of silver. In parallel, CRIS on exotic silver isotopes has been performed at ISOLDE. I will present some preliminary analysis of that experiment, with a focus on the overlap with RAPTOR, e.g., comparing the resulting spectral linewidths and efficiencies.

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[1] S. Kujanpää, et al., "RAPTOR: a new collinear laser ionization spectroscopy and laser-radiofrequency double-resonance experiment at the IGISOL facility", Nuclear Instruments and Methods in Physics Research B (accepted, preprint at arXiv:2302.14637) (2023).
[2] I. Moore, et al., "Towards commissioning the new IGISOL-4 facility", Nuclear Instruments and Methods in Physics Research B 317 (2013) 208–213.
[3] A. Vernon, et al., "Optimising the Collinear Resonance Ionisation Spectroscopy (CRIS) experiment at CERN-ISOLDE", Nuclear Instruments and Methods in Physics Research B 463 (2019).