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Molecular laser spectroscopy of RaF at CRIS

In the past few years, the spectroscopy of radioactive molecules has been performed at ISOLDE (CERN) using the Collinear Resonance Ionization Spectroscopy (CRIS) experiment [1]. Given their structure and chemical properties, molecules are a promising candidate for studies in different fields [2] and for extracting elements with low production yields due to their refractory or reactive properties.
Among them, diatomic polar molecules are at the center of theoretical and experimental investigations in search of the electron's electric dipole moment (eEDM) and nuclear Schiff moments [3-4]. Due to the strong electric field and the rich electronic, vibrational, and rotational structure inherent in molecules, the sensitivity to Schiff moments and eEDM is expected to be enhanced in radioactive polar molecules, such as RaF [5]. The sensitivity to these moments depends on non-measurable molecular constants, making the benchmark of ab initio molecular theory with experimental observations a crucial step towards eEDM studies.
After three experimental campaigns at CRIS (2018, 2021, 2023), all predicted electronic levels in RaF have been studied with broadband laser spectroscopy [6] and one optical transition in high resolution on 223,225,226RaF, yielding sensitivity to magnetic dipole and electric quadrupole interactions, as well as a laser cooling scheme [7-8].
This poster will present the study of eEDM's on molecules, the basic principles of molecular spectroscopy at CRIS, and some results obtained in the last experimental campaign.
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[3] Kudashov, A. D., et al. "Ab initio study of radium monofluoride (RaF) as a candidate to search for parity- and time-and-parity–violation effects." Physical Review A 90.5 (2014): 052513.
[4] Osika, Y., & Shundalau, M. (2022). Fock-space relativistic coupled cluster study on the RaF molecule promising for the laser cooling. Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy, 264, 120274.
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[7] S.-M. Udrescu, et al., Precision spectroscopy and laser-cooling scheme of a radium-containing molecule", Nature Physics (2024) online January 9, https://doi.org/10.1038/s41567-023-02296-w
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Abstracts

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