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Collinear resonant ionization spectroscopy of RaF

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The use of table-top high-precision measurements for studying physics beyond the standard model has become an alternative window to physical phenomena that are currently probed only by large-scale colliders like the LHC [1]. Among them, studies on diatomic molecules have become a promising quatum systems for diverse fields [2]. Even though most of these studies have been primarily with stable species, the advances in laser spectroscopy techniques have allowed the study of radioactive species at ISOLDE (CERN) using the Collinear Resonance Ionization Spectroscopy (CRIS) experiment [3].
Due to the rich electronic, vibrational, and rotational structure inherent in molecules, the sensitivity to different observables, such as the electron's electric dipole moment (eEDM) and nuclear Schiff moments, is expected to be enhanced in radioactive polar molecules [4]. However, their molecular structure is poorly known, requiring preparatory spectroscopic studies of their electronic structure.
So far, RaF and AcF are the only short-lived radioactive polar molecules whose structure has been studied. After two experimental campaigns at CRIS (2018, 2021), many electronic levels in RaF have been studied with broadband laser spectroscopy [5], as well as one optical transition in high resolution [6]. This has shown the capacity of collinear laser spectroscopy at radioactive ion beam facilities for the study of radioactive molecules, as well as benchmarking the predictive power of state-of-the-art quantum chemistry.
This poster will present why molecules are ideal probes for eEDM studies, along with the basic principles of molecular spectroscopy. An overview of the CRIS technique and results from RaF [7], revealing most of the predicted electronic excited states up to 30.000 cm-1, will also be presented.
[1] Agostini, Matteo, et al. "Toward the discovery of matter creation with neutrinoless β β decay." Reviews of Modern Physics 95.2 (2023): 025002.
[2] Athanasakis-Kaklamanakis, Michail, et al. "Opportunities for Fundamental Physics Research with Radioactive Molecules." (2023).
[3] Garcia Ruiz, R.F., et al. "Spectroscopy of short-lived radioactive molecules." Nature 581.7809 (2020): 396-400.
[4] Safronova, M. S., et al. "Search for new physics with atoms and molecules." Reviews of Modern Physics 90.2 (2018): 025008.
[5] Athanasakis-Kaklamanakis M., Wilkins S.G., et al, "Pinning down electron correlations in RaF via spectroscopy of excited states.", in preparation (2023).
[6] Udrescu S.M., Wilkins S.G. et al., "Precision spectroscopy and laser cooling scheme of a radium-containing molecule." Nature Physics (2023), accepted.
[7] Fajardo-Zambrano C.M., "Broadband laser spectroscopy of RaF." Master thesis, KU Leuven. June 2023.

Author: FAJARDO ZAMBRANO, Carlos Mario (KU Leuven (BE))

Co-authors: BREIER, Alexander Axel (University of Kassel (DE)); DORNE, Anais (KU Leuven (BE)); BORSCHEVSKY, Anastasia; VAN DEN BORNE, Bram (KU Leuven (BE)); ZUELCH, Carsten (Philipps Universitaet Marburg (DE)); HANSTORP, Dag (University of Gothenburg); NEYENS, Gerda (KU Leuven); PERRETT, Holly Anne (University of Manchester (GB)); BELOSEVIC, Ivana; REILLY, Jordan R (University of Manchester); WESSOLEK, Julius Wilhelm (University of Manchester (GB)); CHRYSALIDIS, Katerina (CERN); FLANAGAN, Kieran T (University of Manchester); GAUL, Konstantin (Philipps Universitaet Marburg (DE)); SKRIPNIKOV, Leonid (PNPI); LALANNE, Louis (KU Leuven

(BE)); BISSELL, Mark (CERN); AU, Mia (CERN); ATHANASAKIS-KAKLAMANAKIS, Michail (CERN); NICHOLS, Miranda (Gothenburg University (SE)); WANG, Quanjun (Lanzhou University (CN)); HEINKE, Reinhard (CERN); BERGER, Robert (Philipps Universitaet Marburg (DE)); GARCIA RUIZ, Ronald Fernando (Massachusetts Inst. of Technology (US)); DE GROOTE, Ruben Pieter (KU Leuven (BE)); GELDHOF, Sarina (Centre National de la Recherche Scientifique (FR)); FRANCHOO, Serge (Université Paris-Saclay (FR)); WILKINS, Shane (Massachusetts Institute of Technology); Mr UDRESCU, Silviu Marian (Massachusetts Institute of Technology); KUJANPÄÄ, Sonja Pirita; Prof. COCOLIOS, Thomas Elias (KU Leuven - IKS); Prof. GIESEN, Thomas (Universität Kassel); ISAEV, Timur; YANG, Xiaofei (Peking University (CN)); KOSZOŕUS, Ágota (KU Leuven)

Presenter: FAJARDO ZAMBRANO, Carlos Mario (KU Leuven (BE))

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