Contribution ID: **20** Type: **Submitted oral (In person)**

New results from the laser spectroscopy of RaF at CRIS towards searches for new physics

Friday 2 December 2022 11:45 (12 minutes)

More than a decade ago, radium monofluoride (RaF) was proposed as a highly promising system for the search of new physics with ultra-high-precision laser spectroscopy [1]. In addition to its predicted sensitivity to the electric dipole moment of the electron and nuclear P,T-odd effects [2], the molecular structure of RaF was also predicted to be laser-coolable [1,3], promising an improvement in ultra-high-precision spectroscopy of more than an order of magnitude.

In 2018, the collinear resonance ionization spectroscopy (CRIS) experiment at ISOLDE performed the first-ever laser spectroscopy of RaF, confirming its laser-coolability [3], measuring the excitation energies of low-lying electronic states, and measuring isotope shifts for several transitions in 223-226,228RaF [4]. In 2021, the CRIS collaboration revisited RaF, successfully performing a large number of new measurements with both broadband and narrowband collinear laser spectroscopy.

This contribution will firstly briefly present RaF as a future probe for the search for new physics, and the role of quantum chemistry in such searches. Afterwards, new measurements of the excitation energies of high-lying electronic states, isotope shifts in 210,212-214,223-228,230RaF, and high-resolution spectroscopy of the hyperfine structure of 225RaF will be presented. These measurements can be used to understand the role of electron correlations and higher-order effects (e.g. QED corrections) in the electronic-state energies, and to study signatures of the Bohr-Weisskopf effect in 225Ra in the spectra of RaF. Comparisons with state-of-the-art quantum chemistry are thus used to assess theoretical treatments of RaF across a large range of electronic energies, whose accuracy and precision is necessary for the ultimate extraction of new physics from experimental searches.

[1] Isaev, Hoekstra, and Berger, Physical Review A 82, 052521 (2010)
[2] Kudashov et al., Physical Review A 90, 052513 (2014)
[3] Garcia Ruiz et al., Nature 581, 396-400 (2020)
[4] Udrescu et al., Physical Review Letters 127, 033001 (2021)

Primary authors: Dr KOSZORUS, Agota (CERN); BREIER, Alexander Axel (University of Kassel (DE)); HANSTORP, Dag (Gothenburg University (SE)); NEYENS, Gerda (KU Leuven (BE)); REILLY, Jordan Ray (University of Manchester (GB)); FLANAGAN, Kieran (University of Manchester (GB)); SKRIPNIKOV, Leonid (PNPI); LALANNE, Louis-Alexandre (KU Leuven (BE)); ATHANASAKIS-KAKLAMANAKIS, Michail (CERN); NICHOLS, Miranda (Gothenburg University (SE)); WANG, Quanjun (Lanzhou University (CN)); GARCIA RUIZ, Ronald Fernando; DE GROOTE, Ruben Pieter (KU Leuven (BE)); GELDHOF, Sarina (Centre National de la Recherche Scientifique (FR)); WILKINS, Shane (Massachusetts Institute of Technology); Mr UDRESCU, Silviu Marian (Massachusetts Institute of Technology); Prof. COCOLIOS, Thomas Elias (KU Leuven - IKS); YANG, Xiaofei (Peking University (CN))

Presenter: ATHANASAKIS-KAKLAMANAKIS, Michail (CERN)

Session Classification: Atomic Techniques for Fundamental Physics