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Precision spectroscopy of RaF molecules for fundamental physics

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Molecular spectroscopy represents a unique tool in the search for physics beyond the Standard Model and exploration of the fundamental forces of nature. Compared to atoms, molecules can offer more than five orders of magnitude enhanced sensitivity to violations of fundamental symmetries, testing energy scales beyond hundreds of TeV. These effects are further enhanced in radioactive molecules, which are particularly sensitive to nuclear parity violating (P-odd) and time-reversal violating (T-odd) effects. A promising candidate for this kind of studies is radium monofluoride (RaF). Containing octupole-deformed nuclei, this molecule is expected to show a high sensitivity for the electron interaction with the P-odd nuclear anapole moment as well as with the P- and T-odd nuclear Schiff and magnetic quadrupole moments. In addition, being laser coolable, RaF is suitable for high-precision studies. In this talk I will present the latest results obtained from a series of laser spectroscopy experiments performed on short-lived RaF isotopologues, at ISOLDE facility at CERN. I will first describe a measurement of the isotope shift of five RaF isotopologues, $^{223-226,228}$RaF. This shows the particularly high sensitivity of radium monofluoride to nuclear size effects, offering a stringent test of models describing the electronic density within the radium nucleus. I will then show preliminary results from a high-resolution laser spectroscopy of ^{223}RaF and ^{226}RaF. Rotational and hyperfine constants of these two isotopologues will be presented. These results represent the first of their kind performed on radioactive, short-lived molecules, opening the way for precision studies and new physics searches in these systems.

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