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Probing the nuclear magnetic octupole moment of trapped Sr ions

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At the Institute for Nuclear and Radiation Physics of KU Leuven (IKS) we started a project to measure data on the magnetic octupole moment (Ω) of single valence radioactive nuclei. While currently this observable has only scarcely been measured, and is thus poorly understood, preliminary shell model and Density functional theory (DFT) calculations indicate Ω may display a strong sensitivity to nuclear shell effects, even stronger than the dipole moment. It may also be well suited to probe the distribution of neutrons within the nucleus, and study fundamental properties of nucleons of stable and radioactive isotopes. This objective presents several challenges, both technical and scientific, as there are presently no methods that reach the precision required to measure Ω for short-lived isotopes of any element. In this context, the first study will be performed on the stable $^{87}Sr^{+}$. With 49 neutrons, $^{87}Sr^{+}$ is characterized by a single hole in the N=50 closed shell, which makes it more easily compared with a variety of theoretical calculations. Once measurements with ^{87}Sr are demonstrated, it could be possible to extend them to the long-lived $^{83,85,89}Sr^{+}$ here at IKS. A non-zero Ω leads to small energy shift of the hyperfine structure. We aim to measure these splitting with a precision of the order of 1-10 Hz on the hyperfine intervals, which should result in a measurement of Ω with a precision of 10$\%$. This has been demonstrated feasible with stable
$^{137}Ba^{+}$, homologue of Sr^{+}, inside ion traps [1]. This contribution aims to offer a broad understanding of the project and present the latest developments in the laboratory.

References
[1] N. C. Lewty, B. L. Chuah, R. Cazan, B. K. Sahoo, and M. D. Barrett, "Spectroscopy on a single trapped 137ba+ ion for nuclear magnetic octupole moment determination," Optics Express, Sep. 10, 2012. doi: 10.1364/OE.20.021379.

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