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Towards Optical Frequency Standard based on Lutetium Ion[1]

TING REI TAN, RATTAKORN KAEWUAM, KYLE ARNOLD, JAREN GAN, GLEB MASLENNIKOV, KO-WEI TSENG, DZMITRY MATSUKEVICH, MURRAY BARRETT, National University of Singapore, CENTRE FOR QUANTUM TECHNOLOGIES TEAM, PHYSICS DEPARTMENT TEAM — A lutetium (^{176}Lu^{+}) ion offers multiple advantageous as a promising candidate as an optical frequency standard, these include (i) multiple optical clock transitions, (ii) long excited state lifetimes (up to $\sim$ 1 week), (iii) low sensitivity to magnetic field, (iv) low blackbody-radiation shift, (v) low second-order Doppler shift. Furthermore, it has the prospect of a multi-ion operation working at a "magic" radio-frequency (RF) where the two important shifts (i.e. second-order Doppler shift and AC Stark shift) due to micromotion are exactly canceled. Here, we report progress on establishing clock operation on a small linear Coulomb crystal of ^{176}Lu^{+}. We also present high-accuracy measurements of the 577 nm $^1S_0 \leftrightarrow {}^1D_2$ clock transition from which we extract hyperfine splittings. Hyperfine structure constants associated with the nuclear magnetic octupole and electric hexadecapole (16) moments are considered. An often-overlooked systematic shift due to a transverse AC Zeeman effect associated with the trapping RF is also discussed; an evaluation method based on Autler-Townes splitting is experimentally demonstrated.

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