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High-precision laser spectroscopy of helium-like carbon

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The nuclear charge radius is a key observable in nuclear structure studies. Using the Collinear Apparatus for Laser Spectroscopy and Applied Physics (COALA) at the Institute of Nuclear Physics of TU Darmstadt, an all-optical approach for the nuclear charge radius determination was tested with the well-known nucleus of ^{12}C. Here, the nuclear charge radius of ^{12}C was extracted purely from laser spectroscopy measurements that were combined with non-relativistic QED calculations. Laser excitation of helium-like $^{12}C^{4+}$ started from the metastable $2\,^3S_1$ state with a lifetime of 21 ms to reach the $2\,^3P_J$ states. The precision of the corresponding transition frequencies was improved by more than 3 orders of magnitude. Furthermore, this work represents the starting point for the necessary improvement of charge radii of the light-mass nuclei and it will be the corner stone for investigations of the carbon isotope chain. This contribution will give an overview of the project, present the measured transition frequencies along with the extracted all-optical nuclear charge radius of ^{12}C and give an outlook on upcoming measurements. This project was supported by DFG (Project-ID 279384907 - SFB 1245) and by BMBF (05P21RDFN1).

Author: IMGRAM, Phillip (KU Leuven (BE))

Co-authors: MAASS, Bernhard (Argonne National Laboratory (US)); KOENIG, Kristian; MULLER, Patrick Matthias (Technische Universitaet Darmstadt (DE)); NOERTERSHAEUSER, Wilfried (Technische Universitaet Darmstadt (DE))

Presenter: IMGRAM, Phillip (KU Leuven (BE))

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