HIGH-PRECISION MASS MEASUREMENT OF ^{48}Ca AND g-FACTORS OF LITHIUM-LIKE CALCIUM IONS

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The mass of a nuclide is one of the most important properties which gives insight into atomic and nuclear structure. High precision mass values of nuclides, reached with Penning traps, can be used for different tasks in fundamental physics. The atomic mass of ^{48}Ca has been directly measured in this work [1] with the Penning-trap mass spectrometer SHIPTRAP, located at GSI, Darmstadt. A novel method based on the projection of the Penning-trap radial ion motion onto a position-sensitive detector [2, 3] allowed to obtain $4\cdot10^{-10}$ level of atomic mass accuracy for ^{48}Ca The measured atomic mass of ^{48}Ca is in a good agreement with the literature mass value [4] and a factor of seven more precise. The measured mass of ^{48}Ca and the mass of ^{40}Ca [4] were used to derive the most precise g-factor values for lithium-like ions $^{48}Ca^{17+}$ and $^{40}Ca^{17+}$ from the Larmor-to-cyclotron frequency ratio measurements which were performed with a triple Penning trap setup at the University of Mainz. The investigation of one of the most interesting contribution to the g-factor, the relativistic interaction between electron and nucleus, is limited by our knowledge of bound-state quantum electrodynamic effects. By comparing the g-factors of two isotopes, it is possible to cancel most of these contributions and sensitively probe nuclear effects. The theoretical predictions and the high-precision g-factor measurements for $^{48}Ca^{17+}$ and $^{40}Ca^{17+}$ ions showed a good agreement. The comparison of the measured value of the g-factor difference with the theoretical prediction of this work allows for the first time a direct test of the relativistic interaction of the electron spin with the motile nucleus.

[1] F. Kohler et al., Nature Communications, January 18, 2016, doi:10.1038/ncomms10246.
[2] S. Eliseev et al., Phys. Rev. Lett. 110, 082501 (2013).
[3] S. Eliseev et al., Appl. Phys. B 114, 107–128 (2014).
[4] M. Wang et al., Chin. Phys. C 36, 1603 (2012).