The high-precision Penning trap mass spectrometer PENTATRAP

A. Dörr[1,2], H. Bekker[1,2], K.Blaum[1,2], Ch. Böhm[1,2,3], J.R. Crespo López-Urrutia[1], S. Eliseev[1], M. Goncharov[1,2], C. Hökel-Schmöger[1,2], Yu.N. Novikov[4], J. Repp[1], C. Roux[1], S. Sturm[1], S. Ulmer[1,5]

[1]*Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg, Germany*
[2]*Fakultät für Physik und Astronomie, Im Neuenheimer Feld 226, 69120 Heidelberg, Germany*
[3]*Extreme Matter Institute EMMI, Helmholtz Gemeinschaft, Planckstraße 1, 64291 Darmstadt, Germany*
[4]*Petersburg Nuclear Physics Institute, Gatchina, Leningrad district 188300, Russia*
[5]*RIKEN Advanced Science Institute, 2-1 Hirosawa, Wako, Saitama 351-0198, Japan*
adoerr@mpi-hd.mpg.de

Currently, the high-precision Penning trap mass spectrometer PENTATRAP [1] is being built up at the Max-Planck-Institut für Kernphysik, Heidelberg, Germany. It aims at mass-ratio measurements of highly charged medium- to high-Z ions with uncertainties of a few parts in 10^{12}, a precision so far only achieved for relatively light elements [2].

Mass-ratio measurements at this precision are of interest for fundamental studies in various fields of physics. As one example, mass-differences between mother and daughter nuclei in e.g. the β-transitions ^{187}Re → ^{187}Os and ^{163}Ho → ^{163}Dy are important input parameters for neutrino mass determinations [3,4]. As another example, “weighing” the binding energy of the last remaining electron in hydrogen-like ^{208}Pb with a precision of 1 eV would be an improvement over current X-ray spectroscopy results [5] and constitute a stringent test of QED in the regime of extreme electromagnetic fields.

At PENTATRAP, mass-ratios will be determined by the measurement of cyclotron frequency-ratios in the strong magnetic field of the trap. The experiment will host five identical cylindrical Penning traps [6]. Dedicated image current detection systems [7] with single-ion sensitivity will allow for simultaneous cyclotron frequency determinations in all measurement traps. This, together with the five-trap setup, enables measurement schemes ensuring cancellation of magnetic field fluctuations in the determination of mass-ratios to first order. Electron Beam Ion Traps [8] will provide access to highly charged ions. The housing of the traps will be immersed in a bath of liquid helium, so that proper vacuum conditions for the trapping of highly charged ions for hours or even days will be achieved by means of cryogenic pumping.

Further details as well as the current status of the experiment will be presented in the poster.

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