A test of the Isobaric Multiplet Mass Equation: High precision mass measurement on ^{35}K with the ISOLTRAP mass spectrometer

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The tandem Penning trap experiment ISOLTRAP is a mass spectrometer installed at the on-line separator ISOLDE [1] at CERN (Geneva). It is dedicated to high-precision mass measurements of short-lived nuclides. The measurement principle is based on the determination of the cyclotron frequency of the stored ions:

$$\nu_{\mathrm{c}} = \frac{1}{2\pi} \cdot \frac{q}{m} \cdot B, \tag{1}$$

where q/m is the charge to mass ratio of the ion of interest and B the magnetic field strength in the trap region. The ISOLTRAP mass spectrometer achieves a resolving power of up to $\mathrm{R} = 10^7$ used for the separation of contaminating ions or isomers and a relative mass uncertainty of $\delta m/m = 10^{-8}$ for most measured nuclides, some of them with less than 100 ms half-lives.
Mass measurements for unstable nuclei are important in order to considerably improve the understanding of the nucleus by revealing nuclear fine structure effects as well as locating shell and subshell closures. They also serve as a stringent test of nuclear models and may challenge in mass prediction theories as, *e.g.* , the Isobaric Multiplet Mass Equation (IMME) [2].

Under the isospin formalism which considers that protons and neutrons are alike, the isobaric analog states in different nuclei (same mass number A and isospin T) should have the same mass in a first approximation. Under the assumption of a perturbative two body Coulomb force, the mass of those nuclides can be predicted by the quadratic Isobaric Multiplet Mass Equation [3]:

$$ME(T_{\mathrm{z}}) = a + bT_{\mathrm{z}} + cT_{\mathrm{z}}^2, \tag{2}$$

where $ME(T_{\mathrm{z}})$ is the mass excess, $T_{\mathrm{z}} = (N - Z)/2$ is the projection of the isospin T and $\{a, b, c\}$ is a set of parameters mainly depending on the mass number A and isospin T of the multiplet.

The potassium region has been addressed because of the importance of ^{35}K in the $A = 35$ ground state quartet system of the IMME. The former literature values [4] for this quartet have shown a deviation from the IMME with a strong cubic term of $d = -4.8(35)$. However, the uncertainties are too big to conclude a breakdown of the IMME. The mass measurement performed at ISOLTRAP reduced the mass uncertainty for ^{35}K and neighboring nuclei by a factor of up to 40. The results of the high-precision mass measurement of the respective potassium isotopes and their discussion in the light of the IMME will be presented.

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