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Fundamental Symmetries Probed by Precision Nuclear Mass Measurements at ISOLTRAP

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Mass measurements on rare isotopes can play an important role in testing the nature of fundamental interactions. Precise mass values together with decay data are required for critical tests of the conserved vector current (CVC) hypothesis and the standard model. Substantial progress in Penning trap mass spectrometry has made this technique the best choice for precision measurements on rare isotopes, by providing high accuracy and sensitivity even for short-lived nuclides. The pioneering facility in this field is ISOLTRAP at ISOLDE/CERN. ISOLTRAP is a mass spectrometer capable to determine nuclear binding energies with an uncertainty of 10^{-8} on nuclides that are produced with yields as low as a few 100 ions/s and at half-lives well below 100 ms. It is used for mass measurements relevant for a better understanding of nuclear structure and the nucleosynthesis of the elements. It is also used for the determination of masses that are important for the test of CVC, the unitary of the Cabibbo-Kobayashi-Maskawa (CKM) matrix, and for putting constrains on the existence of scalars currents. Measurements along this line include ^{74}Rb ($T_{1/2}$=65 ms), which is the shortest-lived nuclide studied in a Penning trap. The Q_{EC} values of ^{74}Rb, determined with a precision of $6{\cdot}10^{-8}$, serves as a test of CVC or of related theoretical corrections [1]. Masses of ^{32}Ar and ^{33}Ar have been determined with uncertainties of $6.0 \cdot 10^{8}$ and $1.4 \cdot 10^{-8}$ [2]. The improved mass for ^{32}Ar helps to provide a better constraint on scalar contributions to the weak interaction and both argon data serve as the most stringent test of isobaric multiplet mass equation IMME. ^{34}Ar, another CVC test candidate, has been studied with an uncertainty of $1.1{\cdot}10^{8}$ (δm = 0.41 keV). Similar precision has been achieved for ^{22}Mg and neighboring ^{21}Na and ^{22}Na [4]. The importance of these results is twofold: First, an Ft value has been obtained for the super-allowed β decay of ^{22}Mg to further test the CVC hypothesis. Second, the resonance energy for the astrophysically relevant ^{21}Na proton-capture reaction has been independently determined. [1] A. Kellerbauer et al., Phys. Rev. Lett. 93 (2004) 072502 [2] K. Blaum et al., Phys. Rev. Lett. 91 (2003) 260801 [3] F. Herfurth et al, Eur. Phys. J. A15 (2002) 17 [4] M. Mukherjee et al., Phys. Rev. Lett. 93 (2004) 150801