Precision and accuracy of the experimental data on Atomic Masses

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Introduction

The atomic masses are important input data as well for fundamental as applied sciences. Compilations/ evaluations of these quantities are indispensable tools for research and applications. The most recent evaluation had been presented back in 2003[1]. In the last decade, the field has evolved rapidly with the advent of new measuring techniques resulting in substantial ameliorations concerning the precision of the data. Therefore we have prepared a new compilation of atomic masses comprising as well the data from the evaluation of 2003 as well as results of measurements performed since then.

The literature relevant for atomic mass measurements, refereed journals and reports as far as available, was scanned for the period beginning 2000 up to mid-2012. Recommended values for the relative atomic masses have been derived and a comparison with results available in literature [1] was performed. The adopted values are the weighted averages of the experimental data as per the prescription of the Nuclear Data Tables[2]:

If $x_1 \pm \Delta x_1, x_2 \pm \Delta x_2, \ldots\ldots\ .. \ .x_n \pm \Delta x_n$ are n independent measurements, Δx_iΔx_i being the uncertainty in x_i, then the weighted average (weighted by the inverse square of the uncertainty) is given by $\bar{x} \pm \Delta\bar{x}$ where

$$\bar{x} = W \sum_1^n \frac{x_i}{(\Delta x_i)^2}$$

with $$W = \left(\textstyle\sum_1^n (\Delta x_i)^{-2}\right)^{-1}$$

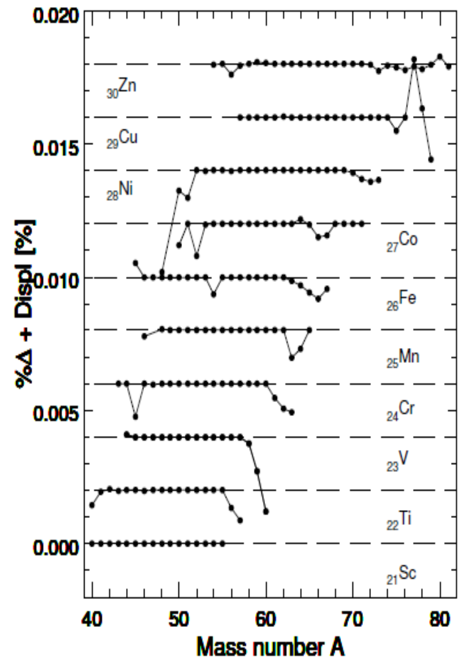
and $\Delta\bar{x}$ is the larger of $W^{1/2}$ and

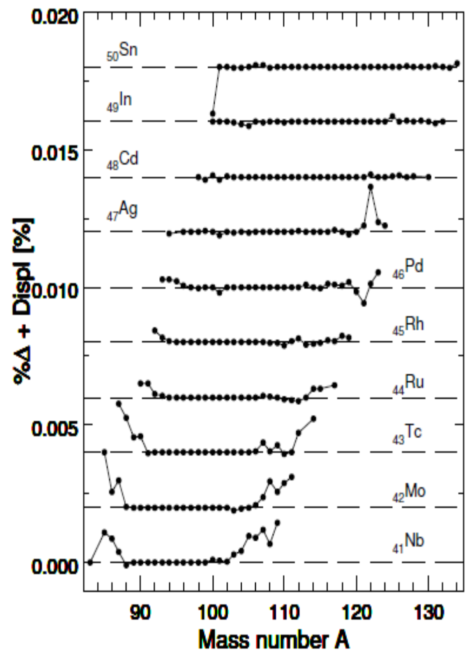
$$\left[W \sum_1^n (\Delta x_i)^{-2} (\bar{x} - x_i)^2 / (n-1)\right]^{1/2}$$

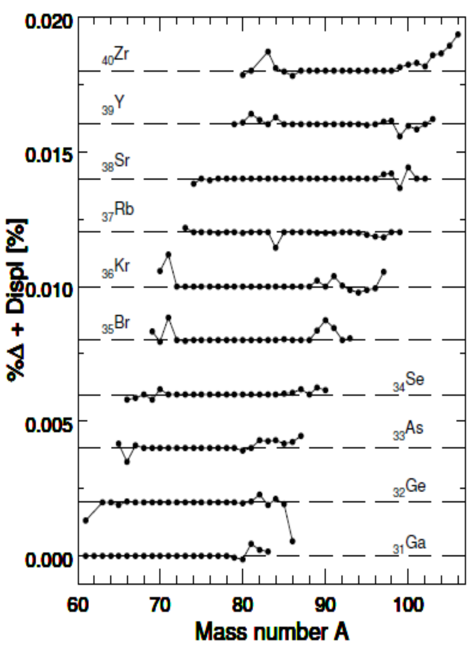
In order to compare the data of this work with the AME03, we have split the whole data sets in bins according to the relative mass uncertainty ΔM/M. The relative percentage deviations of adopted Atomic mass values of the present compilation (AMC12)[3] and the Atomic mass values from AME03 have been calculated for each of the isotopic chains using the definition

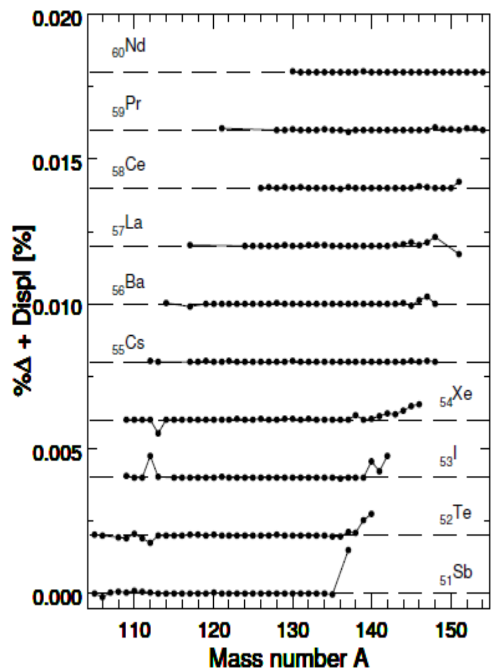
$$\%\Delta = \frac{mass(AMC11) - mass(AME03)}{mass(AME03)}\ x\ 100$$

For nuclides where no evaluated data was available in AME03, the extrapolated values of AME03 have been used for the calculation of percentage deviations. We present the analyses plotted as Mass number Versus %Δ for different isotopic chains from Sc through Sn up to Sb for the mass region 40 to 150 in the Figure 1. The elements are displayed in the graph by adding displ.=(Z-31)*0.002%. It can be seen that in most of the cases while the accuracy of the mass measurements almost seems to be maintained, the precision of masses of many nuclei has been improved. The main deviations from the AME03data are clearly visible with the newly measured masses of proton-rich and neutron-rich nuclides. In these cases the extrapolated mass values of AME03 have been used for comparison. This suggests the need for a more plausible way of extrapolations using the changed mass surfaces as these masses will impact future calculations through their influence on the extrapolation of masses toward the drip lines and future mass models.









References:

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