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Comment on "Atomic mass compilation 2012" by B. Pfeiffer, K. Venkataramaniah, U. Czok, C. Scheidenberger

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For more than half a century the Atomic Mass Evaluation (AME) has striven to provide a consistent and comprehensive set of atomic masses (see Ref. [1–4] and references therein). Masses are measured directly by mass spectrometry techniques or deduced from energy measurements in nuclear decays and reactions. In all cases, mass relations are established between two or more nuclides, thus resulting in a large number of links that are meticulously evaluated to ultimately obtain the masses for all known nuclei using a least-squares-fit approach to all available experimental data. Those carefully recommended values play a seminal role in fundamental research in many areas of natural sciences (chemistry, physics, astrophysics, material physics, etc) and in an increasingly large number of applications. For example, the 2003 edition AME2003 [1, 2] has been cited more than 2150 times according to Web of Science. The most recent evaluation, AME2012 [3, 4], and the associated evaluation of nuclear properties, NUBASE2012 [5], were published in the December 2012 issue of the journal Chinese Physics C by a collaboration of scientists from Europe, China and the USA.

The AME approach and its long history are in contrast with the recent publication of the so-called Atomic Mass Compilation (AMC12) [6], which came to our knowledge only with its online publication on September 6, 2013. We, as regular users of, or contributors to, the AME mass tables, wish to high-

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light several major differences between AMC12 and the traditional AME series, by presenting below a few illustrative examples. It is not the purpose of this "Comment" to present an extensive list of all discrepancies between the AMC12 and the AME2012 mass values nor to provide detailed comments about all observed deviations. The reader might want to explore the original AME2012 publication [3] where detailed comments are given on how each of the recommended atomic mass values was derived. The consistency of the AME2012 approach is also largely demonstrated there, which is definitely not the case for the AMC12 compilation [6].

As a general rule, any credible evaluation must contain an extensive compilation of all available experimental data. Indeed such a compilation is a prerequisite of the AME process and it has already been published in the latest AME2012 [3, 4]. In this respect AMC12 does not add anything new to what has already been published. Furthermore, although it is certainly necessary, a compilation is not sufficient to provide a consistent set of values and this is exactly where the AMC12 falls well short of AME2012. In the AME process, each piece of data is expressed as a linear relation where the masses are treated as unknown parameters. The ensemble of relations is solved by the least-squares method, which requires inversion of the associated normal matrix. One obvious advantage of the AME matrix approach over the simple averages used in AMC12 is that it employs an overdetermined data set, which allows for the evaluation of consistencies (or conflicts).

By contrast, the method used in AMC12 is to combine any new result with the mass values from the previous AME2003, independent of any other new result, even if it is reported in the same paper. Given that many data have changed - and been improved - since 2003, this procedure can only yield results that are less precise and, even worse, less accurate. Correlations are ignored in AMC12, even though the AME has proven that they are essential, given the strong entanglement of much of the input data. Furthermore, in AMC12 the individual pieces of experimental data (decay and/or reaction energies, etc.) are not given, but instead they have been converted into mass-excesses, preventing easy access to the originally published values.

As a final remark, we urge the readers and users of mass tables not to be misled by the similarity of the titles of "The AME2012 atomic mass evaluation" [3, 4] with the AMC12 presented as "Atomic mass compilation 2012" [6]. We would like to stress that the AMC12 is by no means the continuation or an update of the work initiated by A.H. Wapstra in the 1950's. The methods used in the AME series have consistently proved themselves and have led to useful and reliable tables of atomic masses from the ensemble of experimental data obtained since 1934, and from all laboratories around the world. The AME2012 and the past AME evaluations were all endorsed by the C2 Commission on Symbols, Units, Nomenclature, Atomic Masses and Fundamental Constants of the International Union of Pure and Applied Physics (IUPAP) whose aim is to promote international agreements on the use of symbols, units, nomenclature and standards.

The AME is a coordinated effort that involves collaboration among several scientists from around the world. They make no claim to a monopoly on the world's mass data. However, because of the comprehensive approach used by the AME collaboration, we consider the AME of superior accuracy to the more simplistic AMC12 compilation. We hope that any confusion between the AME and the so-called AMC12 will not interfere with the increasing use of mass data for improving mass models and in critical applications in the area of nuclear energy, and elsewhere.

illustrative examples

(1) the unit for eV used in AMC12 is not the eV_{90} for which full explanation is given in the AME. This results in slight differences for many very precise masses.
(2) ^{45}Cr : AMC12 missed the isomer at 100 keV.
(3) ^{47}Ar : AMC12's mass is –25910(100) keV compared to –25210(90) keV (AME2012). Apparently the authors of the AMC12 missed the noteworthy result obtained in 2006 by Gaudefroy et al., [7].
(4) ^{65}As : AMC12 averages a theoretically estimated (via calculated Coulomb Displacement Energy) value with an experimental result. Similarly ^{66}Se and ^{69}Br are given as being measured, which is not true.
(5) ^{73}Ge : AMC12 gives a precision of 1.6 keV, whereas it is known now with a precision of 0.06 keV, i.e. 27 times better. The reason is that the AMC12 method is not able to combine the new very precise mass of ^{74}Ge with the *Q*-value for the (n,γ) reaction on ^{73}Ge.
(6) ^{100}Sn : its value has changed significantly due to a very important experiment at GSI [8] published in Nature in June 2012, but submitted already in October 2011, and accepted in April 2012. Since one author's name is common to both the Nature article and AMC12, the authors of the latter must have been aware of this result in time to include it in AMC12, something they should have done in light of its importance and the significant impact it has on the mass of ^{100}Sn. Obviously, the authors of AMC12 could not include this important result since it is not directly a mass but requires the combination of Q-values! As a result AMC12's value for the mass of ^{100}Sn is –56780(710) keV instead of –57280(300) keV.
(7) ^{286}Ed with $Z = 113$ (called ^{286}Uut in AMC12) : mass excess is 168202(896) keV in AMC12 and 169730#(670#) in AME2012. The difference is thus 1520 keV. Even worse, the Q_α value deduced from the AMC12 table is 10012 keV, whereas it is known from experiment to be 9770(100) keV. Strangely enough, since the mass of ^{270}Db is not listed in the AMC12, one can naively wonder how the mass of ^{286}Ed, its precursor in the α-decay chain, could be determined.

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