Atomic Mass Wallet Cards: A new Atomic Mass Database

K. Venkataramaniah[1,2], C. Scheidenberger[2], Timo Dickel[2], A. Srinivasa Pradeep[3], K. Madhusudhana Rao[4], Deepa Seetharaman[1], K Vijay Sai[1*]

[1]*Dept. of Physics, Sri Sathya Sai Institute of Higher Learning, Prasanthi Nilayam 515134, India*
[2]*GSI Helmholtzzentrum fur Schwerionenforschung GmbH, 64291 Darmstadt, Germany*
[3]*Dept. of Physics, School of Sciences, Malla Reddy University, Hyderabad, India*
[4]*Vignan's Institute of Information Technology, Visakhapatnam, India*
** email: kvijaysai@sssih.edu.in*

Introduction

The ground state binding energy, and thus the mass of a nucleus, is one of its characteristic properties, revealing deep insight into the nuclear structure. Total binding energies and derived quantities, such as proton or neutron separation energies or Q-values, are needed for a basic understanding of the nuclear many- body problem, reaction kinematics and also applications in medicine, energy generation, nuclear waste transmutation and nuclear astrophysics. There have been activities leading to international collaborations on the compilations and evaluations leading to Atomic Mass Tables [1-3] and the related NUBASE evaluation of nuclear properties such as $T_{1/2}$, spin-parity (I^{π}) as well as decay modes for ground and isomeric states. The Atomic Mass Evaluation 2020 [4], the 2012 Atomic Mass Compilation [5] are the most recent published compilation and evaluations. These are extensive data bases which run into hundreds of pages. However, for an experimentalist while planning an experiment on a selected nucleus or performing the measurements or for quick analysis of the experimental data, vital literature values of the parameters like atomic mass, half-life, binding energy, Q-values, neutron and proton separation energies and details on isomers if available at one place would be of great use and help.

Method

Nuclear Wallet Cards present properties for ground and isomeric states of all known nuclides. The Nuclear Wallet Cards booklet is published by the National Nuclear Data Center (BNL) and its electronic version is periodically updated by Dr. Jagdish K. Tuli [6]. Properties given are: spin and parity assignments, nuclear mass excess, half-life, isotopic abundances, decay modes. Following the popularity of the Nuclear Wallet Cards, an effort is being taken up to bring out the Atomic Mass Wallet Cards initially based on the most recent AME20 and its supplement NUBASE and the Atomic Mass Compilation, AMC12 and its extension on extrapolations for nuclei far from the valley of stability [7]. Exhaustive original literature data on the experimental mass measurements on each of the 1000 nuclides starting from its initial measurement and up to date are presented in chronological order along with their references. The adopted values which are obtained from the weighted average of the available experimental data on the nuclide is also included along with the most recent Atomic Mass Evaluators' evaluated value. The mass-derivatives like S_n, S_{2n}, S_p, Q_{alpha}, binding energy/nucleon and beta decay energy are calculated using the weighted average mass data. Other most recent data included in the AMWCs are: half-life, ground state spin and details of any isomers associated with each nuclide. A sample sheet is shown in Table 1. There would be as many pages (cards) as the number of known nuclides.

References

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Table1: Sample sheet of the proposed Atomic Mass Wallet card.
(The references are as per the NSR format)

64 Gallium: $^{64}_{31}Ga_{33}$

Half-life: 2.627(12) min
Ground state spin: 0^+

Mass Data

Method	Mass excess (keV/c^2)	Uncertainty (keV/c^2)	Atomic mass (u)	Uncertainty	Reference (NSR)
^{64}Zn(P, nγ)^{64}Ga	-58836	6	63.936836926	6.44 E-6	1972DaYU
^{64}Zn(3He,t)^{64}Ga	-58819	8	63.936855176	8.59 E-6	1974Ro16
TOF	-58716	120	63.936965751	1.29 E-4	2005Ch60
ISOLTRAP	-58716	120	63.936965751	1.29 E-4	2007Gu09
LEBIT	-58832.6	2.5	63.936840576	2.68 E-6	2007Sc24
CPT	-58832.5	3.9	63.936840684	4.19 E-6	2007Cl01
TOF	-58720	115	63.936961457	1.24 E-4	2008Go23
Weighted average	-58833.6	1.2	63.936839503	1.29 E-6	Adopted
Atomic Mass Evaluation	-58832.8	1.4	63.936840362	1.5 E-6	AME20
KUTY	-57930		63.937809589		2005Ko07
HFB21	-58020		63.977129707		2010Go23
WS4+RBF	-58370		63.937337230		2014WaxX
FRDM12	-57648		63.938112329		2016Mo08

Mass Derivatives:

	S_n	S_p	S_{2n}	Q_α	Binding energy /nucleon (keV)	Beta decay energy (keV)
Adopted	10357.9 0.4	3909.57 0.5	22989.7 0.8	-2914.4 1.57	8611.639 0.017	β^+ 7170.4 1.4
AME20	10357.0 1.9	3908.4 2.1	22988.4 1.5	-2912.5 2.1	8611.632 0.022	β^+ 7171.2 1.5

Isomer:

Excitation energy (keV)	E_γ (keV)	$T_{1/2\gamma}$	J^π	λ	Decay mode
42.85 8	42.89 10	21.9 7 μs	(2^+)	E2	%IT = 100