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N U B A S E:
A Database of Nuclear and Decay Properties

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Abstract: A database (NUBASE) containing the main nuclear and decay properties of nuclides in their ground- and isomeric-states is being setup. This database has mainly been derived from ENSDF and the Atomic Mass Evaluation but also includes information from recent literature and is meant to cover all experimental data along with their references. When no experimental data are available, trends in the sytematics of neighboring nuclides have been used if possible to derive values (labeled in the database as non-experimental).

The nuclear physics community from basic physics to applied nuclear sciences would greatly benefit from a database for the main basic nuclear properties such as masses, excitation energies for the isomers, half-lives, spins and parities, decay modes and intensities, and main decay lines. All the information should be properly referenced in such a database to check their validity, if desired.

Most of the data are already present in two evaluated files: the Evaluated Nuclear Structure Data Files (ENSDF) [1] and the Atomic Mass Evaluation (AME) [2]. For some of our applications it was useful to combine them in a 'horizontal' structure (which does not exist in ENSDF) and to have as much as possible all the available experimental data included. One of the applications is the mass evaluation itself which requires clear identification of the states involved in a decay or a reaction. Furthermore, calculations requiring parameters for nuclear applications (e.g., reactors, waste management, nuclear astrophysics), need access to these basic nuclear properties. Therefore, a 'horizontal' nuclear experimental database, called NUBASE, is being generated. It can be considered as a critical compilation of the two evaluations mentioned above (AME and ENSDF). The guidelines used in setting up this database were: to cover as completely as possible all the experimental data, and to provide a proper reference for those used in NUBASE and not already included in ENSDF. This traceability allows any user to check the recommended data and, if necessary, undertake a re-evaluation. When no experimental data exist for a nuclide, values can be estimated from observed trends in the systematics of experimental data; such values are clearly labeled with a special symbol.

NUBASE contains experimentally known nuclear properties for 2923 nuclides including some values estimated by extrapolation of experimental data. NUBASE also contains data to describe isomeric states with half-lives greater than 1 millisecond; there are 631 such nuclides of which 60 have more than one isomeric state.

The following quantities have been compiled for each nuclide (A,Z) and for each state (ground or isomeric): mass excess, excitation energy of the isomeric states, half-life, spin and parity, decay modes and intensities for each mode, isotopic abundances of the stable nuclei, and references for all experimental values of the above items. Other properties such as the main α, EC, γ, and X-lines and the mean decay energies may be added in the future. As a result of this 'horizontal' work, a greater homogeneity in data handling and presentation has been obtained for all of the nuclides.

The mass excesses used in NUBASE are those of the most recent evaluation [2]. By the time the database is published, these data will be replaced by the values from the 1995 update [3]. For nuclides not in [3] but considered in NUBASE, values for masses have been estimated from trends in systematics (and flagged '#'). In some cases masses give information on nucleon-stability, thus yielding an upper or a lower limit on the half-life.

Data on isomeric assignments and excitation energies are taken from ENSDF when they result from gamma-ray energy measurements, otherwise they are taken from the AME. They have been reconsidered on a firmer basis and their data improved. As a result, the ordering of the ground- and isomeric-states have been reversed for the following nuclides compared to ENSDF: ^{58}Mn, ^{87}Nb, ^{108}Rh, ^{119}Ag, ^{138}Pm, ^{156}Tb, ^{147}Er, ^{152}Tm, ^{187}Hg, ^{187}Pb, and ^{188,198}Bi, and we found evidence for a state below the adopted ENSDF ground-state for the following nuclides: ^{94}Ag, ^{127}La, ^{151,153}Lu, ^{181,189}Pb, ^{184}Au, and ^{257}Db. Whereas, compared to AME [2], the following cases have been reversed: ^{84}Y, ^{99}Rh, ^{130}Sb, ^{148}Pr, and ^{248}Bk, as also done in the AME-95 update [3]. A flag (*) is added in NUBASE in case where the assignment of ground state and isomeric state is uncertain.

If no experimental spin and parity data exist they are estimated wherever possible (mostly for odd-A nuclides) from systematic trends in neighboring nuclides with the same odd-N or odd-Z numbers, and flagged (with '#').

NUBASE is updated via two routes: from ENSDF after each new A-chain evaluation and directly from the literature. ENSDF files are retrieved from NNDC using the on-line service [1]. Programs have been developed [4] to extract from these files the required physical quantities, which will be used to update the previous version of NUBASE. This latter step is done separately by the four authors and cross-checked until full agreement is reached. Similarly, literature (including annual reports, conference proceedings, and theses) is scanned independently and the updatings are inter-compared and added to the database. Most often these new data are included in the next ENSDF evaluation, and the corresponding references can be removed from the NUBASE database. At the present time NUBASE has been updated from literature by some 492 half-life values, 96 spins and parities and 113 decay modes and intensities.

NUBASE may be used in conjunction with a PC-program called NUCLEUS [5], whose main purpose is to display the nuclear properties contained in various databases, and also to draw a chart of nuclides according to the considered database.

NUBASE will be published in full and made available through the electronic highways, but not before completion of the AME-95 update [3]. An electronic mailing list is being set-up (e-mail: audi@frcpn11.in2p3.fr) to distribute information about NUBASE's availability.

References

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