Progress Report by Budapest Group

DISCRETE LEVEL SCHEMES SUBLIBRARY

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1. A new discrete level schemes data library

An entirely new discrete levels file has been created by the Budapest group according to the recommended principles, using the Evaluated Nuclear Structure Data File, ENSDF [1] as a source. The data set "Adopted levels and gammas" (as of 23 February 1996) has been retrieved and processed as outlined below.

- The 106,234 discrete nuclear levels and 148,129 gamma-ray transitions adopted by the ENSDF evaluators for 2,807 nuclei have been retrieved on line, using the program NUDAT. [2]

- The retrieved ENSDF data have been filtered for errors and converted into a library file in the extended Bologna format, as described in ref. [3].
- The cutoff energy, U_{max}, and the cumulative number, N_{max}, of levels up to this energy have been determined as described in the next chapter and has been included in the file as a cutoff value up to which the discrete level scheme is complete.
- A second energy cutoff, U_c, corresponding to the upper energy limit of levels characterized by an unique spin and parity has been determined for all nuclei on the basis of ENSDF data alone.

The resulting library [3] contains 96,834 levels and 105,423 gamma rays for 2,585 nuclei, with their characteristics such as energy, spin, parity, half-life as well as gamma-ray energy and branching percentage. Isomer flags for half-lives longer than 1 s have been introduced. For those 1,277 nuclei having at least ten known levels the cutoff level numbers N_{max} are also included. The cumulative level numbers N_c for the cutoff energies U_c, corresponding to the upper energy limit of levels characterised by an unique spin and parity, have been included for each nuclide in the library. The file is available in ASCII format, following the extended ENEA Bologna convention, from the IAEA Nuclear Data Section.

2. Level density histograms and nuclear temperatures

The same data set has been used for plotting the cumulative number of levels of nuclei in the form of histograms.(staircase plots). In the generation of level density plots at least ten known levels have been required, including the ground state. This constraint has left us with 1,277 cases out of the set of 2,585 nuclei described above. The histograms were then fitted with the back-shifted exponential formula:

$$N(E) = \exp\left(\frac{E - U_0}{T}\right)$$

where T is the nuclear temperature, and U_0 is the backshift energy. The excitation energy has been used as a weighting factor, in order to minimize the influence of $N(E)$ values at the high-energy end where our knowledge becomes incomplete. Based on these fits T, U_0 and the U_{max} cutoff parameters have been determined for 1,277 nuclei. It is noteworthy that in 111 cases this cutoff value is larger than the lowest of the two single-nucleon separation energies [4]. In other words, these fits include unbound states as well. A detailed description, including the set of plots, may be found in a separate publication [5].

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References

1. Evaluated Nuclear Structure Data File (ENSDF), produced by members of the International Nuclear Structure and Decay Data Network, and maintained by the National Nuclear Data Center, BNL, USA. Also available online from IAEA Nuclear Data Section, Vienna.
2. NUDAT database, version (23 February 1996), maintained by the National Nuclear Data Center, BNL, USA. Also available online from IAEA Nuclear Data Section, Vienna.
3. Chapter 2, in: Draft of Handbook on Reference Input Parameter Library for Nuclear Model Calculations of Nuclear Data.
4. G. Audi and A.H. Wapstra, "The 1995 update to the atomic mass evaluation," Nucl. Phys. A595 (1995) 409.
5. T. Belgya, G. L. Molnár, B. Fazekas and J. Östör, Histogram plots and cutoff energies for nuclear discrete levels, INDC(NDS)-367 (IAEA Vienna, 1997)