Abstract

The knowledge of nuclear reaction rates is important for studying energy production and nucleosynthesis, especially in reactions including nuclei far from stability line, which are not accessible experimentally so far and thus it is necessary to be able to predict reaction cross sections in low excitation energies. Nuclear level density is one of the important key quantities in many nuclear physics fields for both evaluations of reactions cross sections and statistical calculations. Statistical properties of atomic nuclei can be described by considering the excited nuclei as a Fermi gas with non-interacting particles consisting of two kinds of particles, protons and neutrons. Back shifted Fermi gas model is a modified form of the original Bethe analytical formula that both the energy shifted parameter $E_1$ and the level density parameter $a$ are considered as adjustable parameters, which yield a reasonable fit to the experimental level densities over a wide range of excitation energies. In this article, the results of $a$ and $E_1$ from fitting the number of levels versus energy with the corresponding experimental values for 468 nuclei are reported. The dependence of nuclear level density parameter $a$ on the mass number $A$ for even-even, odd-$A$ and odd-odd nuclei is given by $\frac{A}{13.5}$, $\frac{A}{15.5}$ and $\frac{A}{16}$, respectively. Large variations of this parameter in $Z=82$ and $N=126$ indicate its strong dependence on shell effects.

General behavior of this parameter versus mass number $A$ obeys the relation $a = A^2(0.105e^{-A^{0.4}/19.11} + 0.015)^2$. These relations are reliable facilities for extrapolating the nuclei far from stability which are not accessible experimentally.

Keywords: nuclear level density, nuclear reaction rates, cross section

For full article, refer to the Persian section