MICROSCOPIC LEVEL DENSITY FOR NUCLEONS AND DEFORMED CORE

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Realistic models of nuclear level densities (see e.g. ref. [1]) are usually based on some type of counting of many-particle-many-hole excitations of nucleons in a mean field. In addition, one must consider pairing, and also collective degrees of freedom, such as rotations and vibrations.

A key point in evaluations of the level density is the choice between the spherical or the deformed coupling scheme for the angular momentum, applying, respectively, the Bethe formula or the Ericsson formula [2]. We show that the two schemes can be related more directly to each other than previously described: For deformed nuclei the phase space is extended by the degrees of freedom of a deformed core, which can contribute to the level density at a very modest expense in energy. For small deformations it will cost much energy to bring the angular momentum of the core into play, and the density of states becomes considerably smaller.

One should have a gradual transition from one scheme to the other as function of deformation, and this we investigate in two ways:

a) Comparing data to theory. For all nuclei with calculated deformation larger than $\epsilon_2 \geq 0.05$ we have evaluated the level density at the neutron separation energy. Our results indicate that it requires a deformation of size about 0.2 to fully develop the deformed coupling scheme.

b) A schematic model with exact treatment of the angular momentum, which continuously evolves from the Bethe coupling scheme to the Ericsson scheme. That is a many-particles plus rotor model. A number of nucleons in specific shell levels are combined with, and interacting with, a deformed core carrying a realistic moment of inertia scaling with the deformation. For example, for angular momentum I=2 and with 4 particles in the sd shell, the coupling of particle angular momenta allows for a total of 21 states, while the addition of the core enhances the space to 180 states. We show how this enhancement of level density smoothly sets in with increasing deformation.

These considerations of nucleons and core shed new light on the so-called "rotational enhancement of level densities" [3].

References

[1] H. Uhrenholt, *et al.*, subm. to Nucl. Phys. **A** (2012).

[2] H. Bethe, Rev. Mod. Phys. **9** (1937) 69, T. Ericsson, Adv. Phys. **9** (1960) 425.

[3] G. Hansen and A. S. Jensen, Nucl. Phys. **A406** (1983) 236.