Calculating the nuclear binding energy at finite angular momenta

Gillis Carlsson, Ingemar Ragnarsson
Division of Mathematical Physics, Lund Institute of Technology, P.O. Box 118,
SE-221 00 Lund, Sweden.

A fundamental property of nuclei is their mass or equivalently, their binding energies, $\mathcal{B}$. The variation of the nuclear mass with proton and neutron number will reveal the shell effects which are closely related to the magic numbers and the extra binding associated with these numbers. It will also give some general idea about which regions of nuclei are deformed and if some specific particle numbers gives rise to extra binding for deformed nuclear shapes. In recent years, it has become possible to study a large number of nuclei up to very high angular momenta. A natural extension is then to study the variation of the total nuclear energy as a function of the angular momentum, I, i.e. to extend the investigations of the binding energy to three dimensions, $\mathcal{B}(Z, N, I)$.

Mean field methods to calculate the nuclear mass are therefore extended into the high-spin regime to calculate the nuclear binding energy as a function of proton number, neutron number and angular momentum. Good agreement between calculations and experiment is obtained using a standard liquid drop expression with an $A^{1/3}$ curvature term, an average moment of inertia calculated from a diffuse surface mass distribution and shell corrections based on the modified oscillator potential. For high-spin states in the mass range $A = 20 - 200$, the discrepancies appear comparable to those obtained in state of the art mass calculations, as exemplified in Fig. 1. The consequences of using different models when calculating the rotating liquid drop energy are investigated.

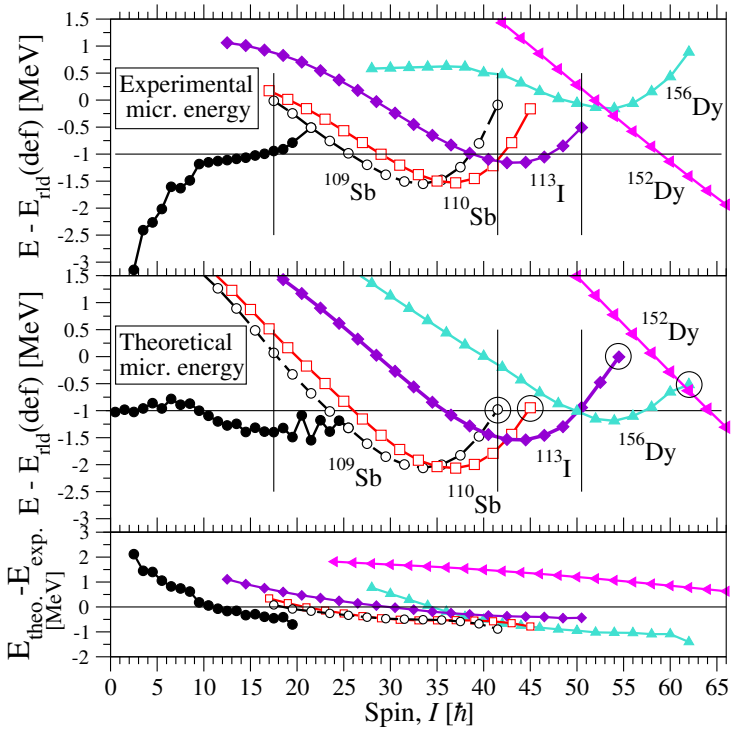

Figure 1: *Experimental (top panel) and theoretical (middle panel) microscopic energies and their difference (lower panel) for some well-established high-spin bands in* $A = 109 - 156$ *with the level scheme of* ^{109}Sb *extended down to the ground state. No pairing is included in the calculations so the increasing differences between calculations and experiment towards* $I = 0$ *should be a measure of the pairing energy.*