

Statistical Spectroscopy for Neutron-rich Light Nuclei

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A statistical framework for nuclear spectroscopy and strength distributions of nuclear excitation and decay processes has been developed over the years built on the original prescriptions of the use of random matrix ensembles in shell model spaces [1]. In these methods, often called the spectral distribution methods, statistically averaged forms for the nuclear level density and excitation strength distributions are obtained using arguments of random matrix ensembles and utilising the group theoretical structure of the shell model spaces, the averaged quantities are evaluated. They have the advantage of avoiding explicit diagonalisation of the Hamiltonian in many particle spaces and need to calculate traces of powers of Hamiltonian as well as their products with the excitation operators. Though these methods are suited for nuclei at excitations of a few MeV for a transition to chaos they are seen to work well even in the ground state region but for shell model spaces with not too small number of valence nucleons to satisfy a statistical description. For transition strengths the detailed comparison of the spectral distribution methods with shell model have been carried out for specific *sd*-shell and *fp*-shell examples using the same two body interactions for both methods for electromagnetic and beta decay transitions [1]. To recover the energy spectra one can go back to a discrete set of energy levels from the predicted averaged density of states which is continuous in energy and evaluate the binding energies of nuclei by the Ratcliff prescription adding a phenomenological global correction term for better accuracy.

In this work we revisit the issue of statistical spectroscopy by spectral distribution methods in the more challenging region of very neutron-rich nuclei. We describe the calculation of the binding energies of neutron-rich nuclei in the *sd* and *fp* shells and the evaluation of occupancies and sum rule strengths of excitation operators. Detailed comparison of the binding energies going upto the drip line are made and the isospin dependence of sum rule strengths explored. These studies are useful for astrophysical applications.

References

- [1] J.M.G. Gomez, K.Kar, V.K.B. Kota, R.A. Molina, A. Relano and J. Retamosa, *Phys. Rep.* **499** (2011) 103-226.