Nuclear Structure at the Limits of Proton Stability

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The production of exotic nuclei at the extremes of stability and the determination of their properties, is an active field of research in Nuclear Physics. The extremes of stability were reached for many regions of the nuclear chart. This offers an open window to probe nuclear structure at the limits of charge and mass, crucial to our understanding of different phenomena.

The nucleosynthesis processes, for example, evolve from reactions between elements very far from stability. In the case of the rapid proton capture rp process, that lead to the nucleosynthesis of medium heavy elements in explosive astrophysical scenarios, it involves nuclei at the proton drip line, and in order to understand the p-capture trajectory, time scale, and ending point of the process, the nuclear structure of these nuclei has to be known.

However, nuclei at the extremes of stability cannot be used in direct experiments due to their very unstable nature. An indirect way to probe them might be required, and can be provided by the interpretation of proton radioactivity observables. Ground state proton emission has been observed in nuclei with charges $50 < Z < 83$, with the exception of promethium, mapping the proton drip-line in this region. Below $Z = 50$, few cases of direct proton emission have been observed. We have developed theoretical models that describe the decay data by proton emission, and by the consistent interpretation of the experimental half lives, branching ratios and spectrum, we were able to predict the nuclear shape parameters and quantum numbers of the decaying states, for axial and non-axial deformation in odd-even and odd-odd nuclei. The breaking of axial symmetry for example, hinted in some experimental data, was confirmed by the theory.

It is the purpose of this talk to discuss results obtained in our studies of these exotic decays, and its implication to the assignment of the nuclear structure involved.