Theoretical description of proton decay

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The latest research activity in nuclear radioactivity, aims to produce exotic nuclei with proton or neutron excess and reach the limits of stability of matter, beyond which a nucleon is no more bound. Whereas the neutron drip–line will still be unaccessible for some time, since it is still impossible to produce in the lab the heavy elements that by fragmentation could reach the limit of neutron excess, the same is not true for protons. The recent studies [1, 2] of proton radioactivity from spherical and deformed nuclei, have almost completely defined the proton drip–line for $50 < Z < 82$.

We have developed a model [3, 4] to describe decay from odd-even and extended it [5] to odd–odd nuclei. The Nilsson resonance states and their corresponding half–lives for decay are evaluated exactly in a deformed nucleus described by realistic interactions. All available experimental data on even–odd and odd–odd deformed proton emitters from the ground and isomeric states, as well as the data on fine structure, were accurately and consistently reproduced, identifying the decay level and deformation of the decaying nucleus, and also supporting previous predictions made by other models on nuclear structure properties of the decaying nucleus. For decay from odd–odd nuclei, we have shown how the final decay width depends on the quantum numbers of the unpaired neutron state which cannot be considered only a spectator, but contributes significantly with its angular momentum to the decay. The Coriolis coupling and the pairing residual interaction were also exactly taken into account [6].

The present studies provided new tools to analise data, and to explore the structure of exotic nuclei in the region of the proton drip line.

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