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Nuclear structure at the limits relevant to nuclear astrophysics

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Nuclear structure far from stability plays a crucial role in the formation of heavy elements, during stellar evolution. In explosive scenarios, the density and temperature are so high, that rapid proton capture can occur, generating unstable nuclei up to the proton drip-line. Starting as a break out of the hot CNO cycle, and through many possible paths all proton rich nuclei up to the Sn region are generated, from p capture or photo disintegration of some seed nuclei, but there are many uncertainties about their origin, since most of these reactions proceed through resonances, in very unstable drip-line nuclei. In this region, the proton drip line also evolves almost along the N=Z line, relevant for the study of fundamental symmetries.

Therefore, the experimental and theoretical study of radioactive proton capture (p,γ) reactions in light and intermediate nuclei, are an important input to nucleosynthesis scenarios, along with the identification of the resonances, and their parameters which highly influence the reaction rates,

However, direct measurements on unstable nuclei are still a major challenge in nuclear physics.
At the proton drip line, the observation and theoretical interpretation of proton emission has been the only possibility to access the nuclear structure properties in this region[1,2]. Since the
emission of a proton from an excited state is just the inverse of the (p,γ) reaction, the information obtained from the interpretation of decay and structure properties of theses nuclei far from stability, can help to constraint astrophysical models.

An example of this procedure was given by our analysis of sequential two proton emission from ^{18}Ne[3]. We were able to identify very narrow high energy states of negative parity in ^{18}Ne, which prefer to decay by one proton emission to the excited states of the daughter ^{17}F, than to the ground state, thus becoming possible candidates for the emission of a second proton in the sequential decay process. Some of these resonances have been confirmed in experimental studies[4]. Decay to Fluorine is just the inverse of ^{17}F(p,γ)^{18}Ne, very important within the context described above.

With most recent developments in production and detection techniques[5], new proton emitters are being produced and their spectrum was also observed, along with the γ´s from some electromagnetic transitions.

It is the purpose of this talk to discuss other exotic nuclei in the region N~Z ~30, relevant in the nuclear astrophysics, and for the study of fundamental symmetries, where from the interpretation of their decay data by proton emission, one can identify properties of their spectra and shape.

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