Thesis abstract Emile Cantacuzène

"Nuclear structure beyond the neutron threshold in the N=50 region using neutron detection techniques at ALTO"

For nuclei far from the valley of stability, as the number of neutrons increases, the energy available for beta-decay (Qbeta) also increases. At the same time, the energy required to remove a neutron, also called the neutron separation threshold (Sn) decreases. Thus, for sufficiently large N/Z ratios, it becomes possible to populate excited states localized above the neutron emission threshold in the daughter nucleus, a region consisting a priori of a continuum of states (by definition unbound states, with very short lifetimes) decaying by emission of a neutron. This phenomenon is called beta-delayed neutron emission. For very exotic nuclei the decay can even occur beyond the threshold of emission of two neutrons or even three in exceptional cases. The probability that the beta-n sequence occurs during radioactive decay, often noted as P1n (in the case of beta-2n, P2n etc) is a quantity whose prediction defies the best theoretical descriptions currently available. This is related to our poor knowledge of the structure of the states localized beyond the neutron emission threshold for nuclei far from stability, which itself originates from the very great difficulty of their direct experimental study requiring the implementation of complex means of neutron detection. As a consequence, this region of very high nucleus excitation energy has recently revealed some major surprises, such as an unusually large competition between neutron and gamma de-excitation for some exotic nuclei. The precise experimental knowledge of beta-delayed neutron emission probabilities is crucial for the management of nuclear reactors or for the study of nucleosynthesis processes of elements heavier than iron by rapid neutron capture (r-process) in supernova explosions or, as recently discovered, during the fusion of two neutron stars. The goal of this thesis is to contribute to the study of these mysterious regions of the excitation spectrum of exotic nuclei, the neutron emission threshold region and beyond, in mass regions of interest for the r-process, i.e. not far from the magic neutron numbers N=50 and 82. These studies will be performed at the ALTO radioactive beam facility using two complementary techniques, one based on counting with a He-3 detector and the other based on time-of-flight spectroscopy with a liquid scintillator multidetector.