Nuclear Astrophysics with radioactive beams at GANIL

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Recently, several experiments using radioactive beams were performed at GANIL in order to progress in our understanding of certain astrophysical phenomena. A first direct measurement of reaction cross section was performed at quite low energy [1]. This experiment, the simultaneous measurement of the $H(^{18}F,\alpha)^{15}O$ and $H(^{18}F,p)^{18}F$ reactions, is related to the cosmic γ-ray emitter ^{18}F and Novae phenomena. Recent publications suggest that several important states located just above the proton emission threshold may have uncorrect spin assignments. In another experiment, the inelastic scattering reaction $H(^{19}Ne,p')^{19}Ne^*$ was used to populate states in $^{19}Ne^*$. The scattered protons were detected using the VAMOS spectrometer in coincidence with proton or alpha particles emitted from $^{19}Ne^*$ and detected with a DSSSD. Analysis of the particle-particle angular correlation can be used to determine spin and parity of the states [2]. Super-screening effect in superconductor was study in another experiment. Using beams of high intensity, good quality and purity obtained in the SPIRAL1 facility, a very accurate measurement of ^{19}O and ^{19}Ne lifetimes was obtained in different substratum [3]. A change of the lifetime was expected. This study is related to the electron screening effects, which is important at low energy in nuclear reactions during stellar hydrostatic combustion phases. The isotope ^{60}Fe is another cosmic γ-ray emitter, which radiation was observed by spacecrafts, and the reaction $^{60}Fe(n,\gamma)^{61}Fe$ was identified as an important reaction for the understanding of its abundance. This reaction was studied at GANIL via the measurement of the transfer reaction $^{60}Fe(d,p)$ [4]. The measurement of radiative alpha capture reactions is very important in the understanding of the origin of the p-nuclei, medium mass proton rich stable nuclei which origin is probably Supernovae SNII.

Besides this continuous activity performed in experimental nuclear astrophysics at GANIL, new ideas of experiments are proposed with the future beams that will be available with the new SPIRAL2 facility.

[1] D. J. Mountford et al Phys. Rev. C 85, 02280 (2012).
[2] New results. Experiment under analysis.
[3] P. Ujic et al., Phys. Rev. Lett. 110, 032501 (2013).
[4] S. Giron Thesis, University of Orsay, France.