Study of key resonances in the $^{30}\mathrm{P}(\mathrm{p},\gamma)^{31}\mathrm{S}$ reaction in classical novae

A. Meyer[a], N. de Séréville[a], F. Hammache[a], P. Adsley[a], M. Assié[a], D. Beaumel[a], C. Delafosse[a], F. Flavigny[a], A. Georgiadou[a], A. Gottardo[a], L. Grassi[a], J. Guillot[a], T. Id Barkach[a], M. MacCormick[a], I. Matea[a], L. Olivier[a], L. Perrot[a], C. Portail[a], I. Stefan[a], A. Parikh[b], A. Coc[c], J. Kiener[c], V. Tatischeff[c], A.M. Laird[d], S.P. Fox[d], N. Hubbard[d], J. Riley[d], F. De Oliveira[e], B. Bastin[e], K. Béroff[f], Á.M. Sánchez Benítez[e,g], A. Alellara[h], M. Assunão[h], V. Guimaraes[h], N. Oulebsir[i] and G. D'Agata[j,k]

[a]Institut de Physique Nucléaire, IN2P3/CNRS-Université de Paris XI, 91406 Orsay Cedex, France, [b]Departament de Física i Enginyeria Nuclear, Universitat Politècnica de Catalunya, E-08036 Barcelona, Spain, [c]Centre des Sciences Nucléaires et des Sciences de la Matière (CSNSM), IN2P3/CNRS-Université de Paris XI, 91405 Campus Orsay, France, [d]Department of Physics, The University of York, York YO10 5DD, United Kingdom, [e]Grand Accélérateur National d'Ions Lourds (GANIL), CEA/DRFCNRS/IN2P3, Bvd. Henri Becquerel, 14076 Caen, France, [f]Institut des Sciences Moléculaires d'Orsay (ISMO), UMR 8214, CNRS, Université Paris Sud, [g]Departamento de Ciencias Integradas, University of Huelva, 21071 Huelva, Spain, [h]Instituto de Física, Universidade de São Paulo, Rua do Matão 1371, 05508-090 São Paulo, Brazil, [i]Laboratoire de Physique Théorique, Université Abderahmane Mira, 06000 Béjaia, Algeria, [j]INFN-Laboratori Nazionali del Sud, Via S. Sofia, I-95125 Catania, Italy, [k]Dip. di Fisica e Astronomia, Università di Catania, Via S. Sofia, I-95125 Catania, Italy

Classical novae outbursts are the third most energetic explosions in the Universe after gamma-ray bursts and supernovae. During this explosive burning, nucleosynthesis takes place and the newly synthesized material is ejected into the interstellar medium. In order to understand these objects, the study of presolar grains and γ-ray emitters are of specific interest since they can give direct insights into the nucleosynthesis processes and isotopic abundances.
The ^{30}P$(p,\gamma)^{31}$S reaction is one of the few remaining reactions which rate uncertainty has a strong impact on classical novae model predictions [1] [2]. Sensitivity studies have shown that it has the largest impact on the predicted elemental abundance ratios of Si/H, O/S, S/Al, O/P and P/Al, which can be used to constrain physical properties of classical novae [3] [4]. The ^{30}Si$/^{28}$Si isotopic ratio, which is an important signature that helps to identify presolar meteoritic grains of a likely nova origin, depends also strongly on the ^{30}P$(p,\gamma)^{31}$S reaction rate [5].
To reduce the nuclear uncertainties associated to this reaction we performed an experiment at ALTO facility of Orsay using the ^{31}P$(^{3}$He$,t)^{31}$S reaction to populate ^{31}S excited states of astrophysical interest and detect in coincidence the protons coming from the decay of the populated states in order to extract the proton branching ratios.
After a presentation of the astrophysical context of this work, the current situation of the ^{30}P$(p,\gamma)^{31}$S reaction rate will be discussed. Then the experiment set up of this work and the analysis of the single and coincidence events will be presented.

References

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