

EM Capture as Fundamental Process in Nuclear Astrophysics

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Electromagnetic capture reactions play a fundamental role in several areas of astrophysics including the Big Bang, quiescent stellar hydrogen and helium burning, as well as explosive stellar nucleosynthesis. Turning to the nuclear physics, it is helpful to classify the mechanisms of these capture reactions: non-resonant (direct) capture, capture through isolated resonances, and capture through many resonances which may be treated statistically. Examples from the first two classes will be discussed in further detail.

The non-resonant reactions ${}^3\text{H}(\alpha, \gamma){}^7\text{Li}$ and ${}^3\text{He}(\alpha, \gamma){}^7\text{Be}$ are thought to be responsible for ${}^7\text{Li}$ production in the Big Bang (the latter reaction also plays an important role in solar neutrino generation). The present status of experiment and theory for both reactions will be presented. Of particular interest are the new seven-body calculations using realistic nucleon-nucleon interactions¹.

In explosive hydrogen burning scenarios an important reaction pathway beyond the CNO cycle is provided by the ${}^{17}\text{F}(p, \gamma){}^{18}\text{Ne}$ reaction. The reaction rate may be strongly affected by a low-energy 3^+ resonance which was observed for the first time in ${}^{17}\text{F}(p, p)$ elastic scattering at the Holifield Radioactive Ion Beam Facility (HRIBF)². These measurements constrain the excitation energy and proton width of the resonance, but the γ -ray width must be estimated from the mirror nucleus. Prospects for a direct measurement of the (p, γ) reaction will be discussed. With the presently available information, it now appears likely that the reaction rate at nova temperatures will be dominated by non-resonant capture. We will present measurements of the ${}^{14}\text{N}({}^{17}\text{F}, {}^{18}\text{Ne}){}^{13}\text{C}$ proton transfer reaction³ which can be used to determine the non-resonant capture cross section.

¹K. M. Nollett Phys. Rev. C **63**, 054002 (2001).

¹D. W. Bardayan *et al.*, Phys. Rev. Lett. **83**, 45 (1999).

²J. C. Blackmon *et al.*, Nucl. Phys. **A718**, 587c (2003).

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