Improving the $^{33}S(p,\gamma)^{34}Cl$ reaction-rate for classical nova explosions

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The analysis of microscopic grains within primitive meteorites has revealed isotopic ratios largely characteristic of the conditions thought to prevail in various astrophysical environments. A large ^{33}S abundance may suggest a grain of nova origin: nucleosynthesis calculations predict as much as 150x the solar abundance of ^{33}S in the ejecta of oxygen-neon novae. This overproduction factor may, however, vary by several orders of magnitude because of uncertainties in the $^{33}S(p,\gamma)^{34}Cl$ reaction-rate over nova temperatures. In addition, better knowledge of this rate would help with the interpretation of nova observations over the S-Ca mass region, and contribute towards the firm establishment of a nucleosynthetic endpoint in these phenomena. Finally, constraining this rate may help to confirm or rule out the decay of a metastable state of ^{34}Cl (E_x = 146 keV, $t_{1/2}$ =32 m) as a source for observable gamma-rays from novae.

Direct examinations of the $^{33}S(p,\gamma)^{34}Cl$ reaction in the past have only identified resonances down to E_R = 434 keV. At nova temperatures, lower-lying resonances could certainly play a dominant role. We discuss several recent, complementary studies dedicated to improving our knowledge of the $^{33}S(p,\gamma)^{34}Cl$ rate, using both indirect methods (measurement of the $^{34}S(^3He,t)^{34}Cl$ and $^{33}S(^3He,d)^{34}Cl$ reactions with the Munich Q3D spectrograph) and direct methods (in normal kinematics at CENPA, University of Washington, and in inverse kinematics with the DRAGON recoil mass separator at TRIUMF). Other indirect studies using the Munich Q3D spectrograph, relevant to improving the nuclear physics input to nova models, will also be discussed.