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# New calculated reaction rates for the astrophysical rp-process reactions $^{34}$S(p,$\gamma$)$^{35}$Cl and $^{34g,m}$Cl(p,$\gamma$)$^{35}$Ar

The two rp-reactions $^{34}$S(p,$\gamma$)$^{35}$Cl and $^{34g,m}$Cl(p,$\gamma$)$^{35}$Ar were studied via a shell-model approach. At energies in the resonance region near the proton-emission threshold many negative parity states appear. We present results of calculations in a full $(0+1)\hbar\omega$ model space which addresses this problem. Energies, spectroscopic factors and proton-decay widths are calculated for input into the reaction rates as well as to assess the impact on the predicted $^{32}$S/$^{34}$S isotopic ratio for pre-solar nova grains. Uncertainties were estimated using a Monte-Carlo method. The implications of these rates and their uncertainties on sulfur isotopic nova yields were investigated using a post-processing nucleosynthesis code. Comparisons are also made with a recent experimental determination of the reaction rate for the $^{34}$S($^{3}$He,d)$^{35}$Cl reaction. The thermonuclear $^{34g,m}$Cl(p,$\gamma$)$^{35}$Ar reaction rates are unknown because of a lack of experimental data. The rates for transitions from the ground state of $^{34}$Cl as well as from the isomeric first excited state of $^{34}$Cl are explicitly calculated taking into account the relative populations of the two states. The shell-model calculations alone are sufficient to constrain the variation of the $^{32}$S/$^{34}$S ratios to within about 30%.

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