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Shell-model calculations of the Cl-34(p,gamma)Ar-35 astrophysical rp reaction rates

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The thermonuclear Cl-34(p,gamma)Ar-35 reaction rates are unknown at nova temperatures due to a lack of experimental nuclear physics data for the resonances up to about 800 keV above the Ar-35 proton separation energy. We present results of calculations in a
full (0+1)(h/2π)ω model space using the interaction sdpfmu. The basis consists of a complete 1(h/2π)ω basis made from all possible excitations of one nucleon from 0p
to 1s-0d or the excitation of one nucleon from 1s-0d to 0p-1f. Such calculations were carried out recently for the first time for the P-30(p,gamma)S-31 reaction. We explicitly calculate the rates for transitions from the ground state of Cl-34 as well as from the isomeric first excited state of Cl-34. Spectroscopic factors and proton-decay widths are calculated for input into the reaction rate. Available experimental data are used in conjunction with the calculations to obtain an estimate for the reaction rate. The negative parity states contribute significantly to the total reaction rate, comparable to the positive parity states, both for transitions from the ground state of Cl-34 and the isomeric first excited state. The contributions to the positive parity states from the first excited state of Cl-34 are comparable to those from the ground state. The calculations also serve to identify the most prominent resonances in the reaction rates. The analysis should serve as a guide for experiments as the spin-parity assignments of the most prominent resonances and their relative strengths are given.

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