SHELL-MODEL STUDIES OF THE ASTROPHYSICAL RP-REACTION $^{30}P(P,GAMMA)^{31}S$

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In nova outbursts on oxygen-neon (ONe) white dwarfs, the $^{30}P(p,\gamma)^{31}S$ reaction plays a crucial role in the synthesis of heavier nuclear species, from Si to Ca. Models have shown that the $^{30}P(p,\gamma)^{31}S$ reaction is a potential bottleneck for nucleosynthesis towards heavier nuclei, partly because of the long beta decay halflife ($T_{1/2}$ = 2.5 min) of ^{30}P, which is comparable to the duration of nova nucleosynthesis. Its reaction rate is, however, not well determined due to uncertainties in the properties of key resonances in the burning region.This lack of knowledge of the thermonuclear reaction rate inhibits the interpretation of observables associated with the underlying astrophysics. The uncertainties in the reaction rate stem from unmeasured quantities, ambiguities in level properties measured in different experiments, and problems with theoretical estimates stemming mainly from the presence of several negative parity states near the threshold energy [1]. We present results for the first time of calculations in a full $(0+1)(h/2\pi)\omega$ model space which addresses the latter problem. For the negative parity states we use the interaction sdfpmw in the sdfp model space. For the positive parity states we use the we use the USDB Hamiltonian [2] for the charge-independent part and add the Coulomb, charge-dependent and charge-asymmetric nuclear Hamiltonian obtained by Ormand and Brown for the sd shell [3]. This composite interaction is called USDB-cdpn in NuShellX [4]. The cd refers to charge-dependent, and pn indicates that the calculations are done in the proton-neutron formalism. The gamma-decay lifetimes and ^{30}P to ^{31}S spectroscopic factors are calculated for input into the reaction rate equations. Available experimental data is used in conjunction with the calculations to obtain a best estimate for the reaction rate.

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