Nuclear Seminar

The Impact of Proton Resonances of $^{30,31}S$ on the $^{29,30}P(p, \gamma)^{30,31}S$ Thermonuclear Reaction Rates

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The dominant nova nucleosynthetic path followed by the thermonuclear runaway on the surface of the white dwarf is very sensitive to the chemical composition of the white dwarf, the extent to which the convective mixing occurs, and the thermal history of the envelope. Such details can be partially obtained via the laboratory analysis of the Si isotopic abundance ratios ($^{29}Si/^{28}Si$ and $^{30}Si/^{28}Si$) in presolar grains of nova origin. To estimate the Si isotopic abundances in presolar grains, it is critical to know the rates of the thermonuclear reactions which affect the Si production and destruction in novae. Two such reactions are $^{29}P(p,\gamma)^{30}S$ and $^{30}P(p, \gamma)^{31}S$. The $^{30}P(p, \gamma)^{31}S$ reaction rate also plays an important role in understanding how the nova nucleosynthetic path is shifted to the A > 30 mass region. At nova temperature range (0.1 – 0.4 GK), the $^{29}P(p, \gamma)^{30}S$ reaction rate is thought to be dominated by two low energy proton-unbound 3^+ and 2^+ resonances, whose properties were mostly unknown until the present work; while the $^{30}P(p, \gamma)^{31}S$ reaction rate is dominated by the resonances corresponding to the excitation energies in the range of 6 – 7 MeV in ^{31}S. Despite recent progress in determining the properties of the ^{31}S resonances, some of the known states lack firm spin-parity assignments, and the existence of unobserved resonances cannot yet be precluded. We investigated the level structure of ^{30}S via the $^{32}S(p,t)^{30}S$ and $^{28}Si(^3He,n\,\gamma)^{30}S$ reactions and that of ^{31}S via the $^{32}S(p,d)^{31}S$ reaction. In my talk, I will discuss these experiments and their results, and present astrophysical implications.

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