^{8}B Astrophysical Factor

A.M. Mukhamedzhanov and R.E. Tribble

The cross section for the ^{7}Be(p,γ) ^{8}B reaction at solar energies ($\sim$20 keV), or equivalently its S factor $S_{17}(0)$, plays a crucial role in the solar neutrino problem, for ^{8}B produced via this reaction is the source of most or, in some cases, all solar neutrinos observed in several existing and planned experiments (e.g., Homestake, Kamiokande, Super-Kamiokande, SNO). As it was underlined in the review of solar reaction rates [1], this cross section is "the most poorly known quantity in the entire nucleosynthetic chain that leads to ^{8}B". In this work we recap the contemporary results for $S_{17}(0)$ derived by different experimental methods. Both direct and indirect measurements have been used to determine $S_{17}(0)$ [1]. There have been 6 direct measurements of the ^{7}Be(p,γ)^{8}B reaction using radioactive ^{7}Be targets with uncertainties less than 20%. Most measurements of the ^{7}Be(p,γ)^{8}B S factor have been confined to the low-energy region, with the relative p -^{7}Be energy E<2, MeV. The measured S factors are extrapolated from the observed energy ranges down to E=0, each experiment gives a determination of $S_{17}(0)$ with uncertainty $\sim$10%. There are two types of indirect measurements, Coulomb dissociation and the asymptotic normalization coefficients (ANC) method. Coulomb dissociation of ^{8}B [2] gave $S_{17}(0)=16.7\pm3.2$, eVb while the most recent measurement using Coulomb dissociation [3] gave a slightly higher value of $S_{17}(0)$. The asymptotic normalization coefficients (ANC) method [4] yields $S_{17}(0)=17.2\pm1.8$, eVb. The result is derived using ANC's for ^{8}B $\rightarrow$ ^{7}Be + p determined from the (^{7}Be,^{8}B) transfer reaction on ^{10}B and ^{14}N. Note that among all these methods, direct and indirect, only the ANC method determines $S_{17}(0)$ without extrapolation down to zero energy from experimental data derived at higher energies. Hence, the uncertainty of $S_{17}(0)$ derived using the ANC comes from the uncertainty in the ANC. In all other experiments, in addition to the uncertainties in the absolute normalizations, the additional uncertainty is due to the extrapolation procedure. For example, a recently discovered the broad 2^- resonance in ^{8}B at 3 MeV [5] can affect the $S_{17}(0)$ factor determined by the extrapolation of the direct measurements down to E=0. In the case of Coulomb breakup, in addition to E2 contribution and the extrapolation procedure, the final state three-body Coulomb interaction (post-decay Coulomb acceleration) can taint the extracted $S_{17}(0)$ factor. It turns out that the direct measurements of the $S_{17}(E)$ should be carried out at energies above 1.5 MeV to compare with the Coulomb breakup results which seem to be to high at that region.

References

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