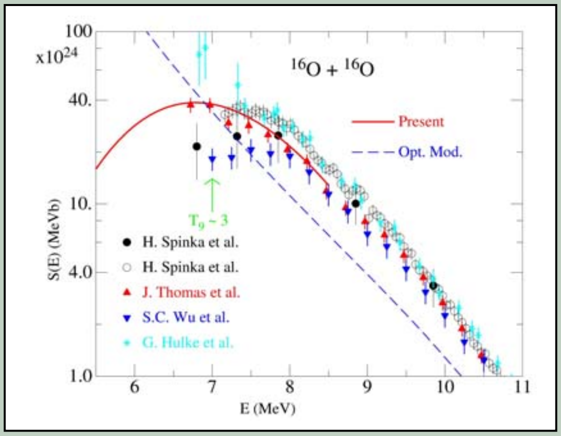
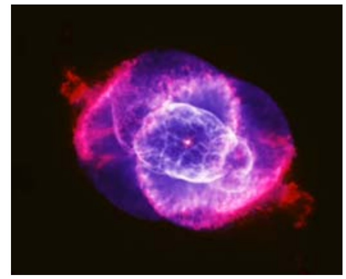
The Joint Institute for Nuclear Astrophysics

The ^{12}C and ^{16}O induced fusion cross sections at astrophysical energies



S-factor of the fusion reaction $^{16}O + ^{16}O$ taken from different experiments. The dashed line is the result of an optical model calculation while the solid line is obtained taking the fusion hindrance into account.



Fusion reactions between nuclei such as ^{12}C and ^{16}O play an important role in the history of stellar evolution, especially in the interior of highly developed stars, where these reactions are important pathways for the production of heavier elements. Although the reactions occur in explosive scenarios, the cross sections at the corresponding Gamow energies are extremely small and, therefore, require phenomenological extrapolation techniques. Most of the previous extrapolations were based on the optical model, which over-predicts the cross sections at the lowest energies.

In fusion reactions between medium-mass nuclei a fusion hindrance was recently observed at extreme sub-barrier energies. Because of energy conservation the fusion cross sections in these systems (which usually have negative Q-values) has to approach zero for $E \rightarrow -Q$. If one converts the cross section into a S-factor, a maximum in S(E) is observed. This onset of fusion hindrance occurs at energies, which correspond to relatively high excitation energies in the compound system of typically 20-40 MeV.

We have used the same recipe of extrapolating the S-factor for the astrophysically important reactions $^{12}C + ^{12}C$, $^{12}C + ^{16}O$ and $^{16}O + ^{16}O$. While these reactions have the additional complications of resonances in the compound system the new extrapolation technique is able to get a better description of the energy-averaged cross sections. The implication of these new extrapolations in various astrophysical scenarios is presently being investigated.

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