Nuclear Astrophysics with theTrojan Horse Method

Basic principle: astrophysically relevant two-body σ from quasi- free contribution of an appropriate three-body reaction

$$A + a \rightarrow c + C + s \quad \rightarrow\rightarrow\rightarrow \quad A + x \rightarrow c + C$$

A (TH nucleus): $x \oplus s$ clusters

Main Advantages: No Coulomb suppression, No electron screening, suitable for both direct and resonant two body reactions, n-induced reactions (using deuterons as virtual source of neutrons), reactions with RIB's.

For most of the reactions involving nuclei heavier than Li: S(E) factor dominated by narrow low-lying resonances →

→ Modified R-matrix Approach for resonant two-body reactions:

- no electron screening
- possibility to measure down to zero energy and subthreshold resonances
- no spectroscopic factors in the determination of the resonance strenght
- no need to know the absolute cross section

Astrophysical Scenarios and key nuclear reactions

Big Bang Nucleosynthesis and Light Element Depletion:
2H(d,p)3H, 2H(d,n)3He, 6,7Li(p,a), 10,11B(p,a), 9Be(p,a/d), 7Be(n,a)

Asymptotic Giant Branch Stars: 15N(p,a), 18O(p,a), 19F(p,a), 19F(a,p), 14N(n,p)
Novae: 17O(p,a), 18F(p,a)
Asymptotic Giant

Nucleosynthesis in heavier mass stars: 12C(12C,a), 12C(12C,p), 16O(16O,), 23Na(p,a)

TH nuclei: d,3He,6Li,14N,16O,20Ne

(red colour means still under analysis or to be performed soon)

Applications
Electron screening, energy production in fusion reactors

Recent publications:

R. Tribble, et al., Rep. Prog. Phys. 77 (2014), 106901 (Review Article)
C. Spitaleri et al., Phys. Rev. C 90 (2014) 035801
A. Tumino et al., ApJ 785 (2014) 96
R.G. Pizzone et al., ApJ 786 (2014) 112
M.L. Sergi et al., Phys. Rev. C 91 (2015) 065803
S. Cherubini et al., Phys. Rev. C 92 (2015) 015805
M. La Cognata et al. ApJ 805 (2015) 128
L. Lamia et al., ApJ 811 (2015) 99