UNIVERSITY OF NOTRE DAME
DEPARTMENT OF PHYSICS

# SPECIAL NUCLEAR SEMINAR

Tuesday, August 23

## *Light-ion Astrophysical S-factor Measurements in Stellar Core Conditions at the National Ignition Facility*

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Astrophysical models, like those used for stellar objects, require accurate thermonuclear reaction rates in order to predict the nuclear power production and dynamic evolution of these systems. Direct measurement of nuclear reaction rates in thermonuclear plasmas is challenging because these conditions are difficult to produce and diagnose. There are physics issues such as plasma electron-screening and other plasma-nuclear effects that are present in stellar cores but not in accelerator experiments, while accelerator experiments have physics not found in stars such as cold-matter target energy losses and bound electron screening.

Inertial confinement fusion (ICF) implosions produce extremely dense, hot plasmas that provide a path to study reactions in these thermonuclear conditions and to begin exploring some of these plasma-nuclear issues. However, ICF experiments have significant challenges not found in accelerator experiments that must be overcome first. For example, the complex temporal and spatial evolution of these systems can make absolute cross-section measurements difficult and quite challenging to model.

In this talk, we show that these issues can be overcome and ICF implosions can be used to make nuclear measurements in certain circumstances. In particular, the method of yield ratios is used to infer $^{2}H(d,n)^{3}He$ and $^{3}H(t,2n)^{4}He$ astrophysical S-factors by observing the $^{2}H(d,n)^{3}He$ and $^{3}H(t,2n)^{4}He$ yields relative to DT, in THD gas-filled implosions, using the DT reactivity as a reference. This platform is well suited for this purpose because it is produces the temperatures that enable reactions while being cool and dense enough to allow for the high collisionality necessary for thermonuclear conditions. Applying this technique to $^{2}H(d,n)^{3}He$ and $^{3}H(t,2n)^{4}He$ data shows excellent agreement with existing evaluations and accelerator data bolstering confidence in this method. We also provide several simple tests to evaluate whether other reactions or platforms are likely to benefit from this method.

*This work was performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344.

**4 pm – 5 pm**

**Nuclear Science Laboratory**

**124 Nieuwland Science Hall**

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All interested persons are cordially invited to attend
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