Contribution ID: **112** Type: **Poster Presentation**

Neutron Capture in a Plasma Environment

Wednesday 5 March 2025 13:16 (1 minute)

The National Ignition Facility (NIF) laser at Lawrence Livermore National Laboratory is capable of producing a plasma environment with temperatures ~10 keV, particle densities ~10^32 m^-3, and neutron fluxes of up to 10^34 m^-2 s^-1. These features, combined with the advanced x-ray, neutron and radiochemistry diagnostics that are available at the NIF, make it uniquely suitable for carrying out experiments to investigate interactions between Plasma Physics and Nuclear Physics. A NIF Discovery Science experiment has recently been commissioned to measure the neutron capture cross section of Thulium-171 (171Tm) at a neutron energy of 2.45 MeV. This presentation will outline the main features and challenges of this experiment, predicted results, and future complementary experiments that could be carried out on the NIF.

The plasmas at the NIF are produced by using the laser to compress capsules (diameter ~1 mm) containing deuterium or deuterium-tritium fuel on timescales of ~1 ns, resulting in a neutron source of ~100 μm in diameter and duration ~100 ps. The commissioned experiment will include trace amounts of 171Tm and other monitor isotopes in a deuterium capsule designed to minimize the neutron scattering background in the plasma. Therefore, the 171Tm isotopes undergoing neutron capture will have a temperature of ~10 keV, and so a significant population of nuclear excited states of 171Tm will be created (first excited state is at 5.036 keV). Initial capture cross section calculations indicate that the ground state and excited state cross sections are similar. Thus the experiment will yield a combined cross section that shows little dependence on the excited-state population and will provide a baseline for future excited-state measurements where significant differences are expected. 171Tm and other reaction products will be recovered and counted after the experiment using NIFs radiochemistry diagnostics.

The NIF facility also includes diagnostics for accurately measuring the plasma temperature, density, size and duration. This information can be used for calculating the populations of nuclear excited states and for modelling processes, such as nuclear excitation by electron transfer and capture (NEET and NEEC), which can affect population rates. Future experiments will be designed to investigate these processes. This will support the development of a reliable platform on the NIF for measuring capture cross sections of excited state nuclei.

Author: Dr APPELBE, Brian (Imperial College London)

Presenter: Dr APPELBE, Brian (Imperial College London)

Session Classification: Lunch and Posters