Notre Dame Science
Department of Physics

PLASMA NUCLEAR SCIENCE – A NEW FIELD OF RESEARCH

Dr. Johan Frenje, Massachusetts Institute of Technology
Monday, December 12, 2011
4:00 P.M. NSH 124

Nuclear physics experiments have traditionally been conducted with conventional accelerators. Gleaning good data from these experiments can however sometimes be problematic. For instance, characterization of thermonuclear reaction rates at solar energies requires cold-matter screening corrections and often extrapolation from high-energy measurements that are based on nuclear models that are not reliable. Those nuclear models are also not satisfactory, as they fail to describe the spectra of the reaction products in the final breakup state. Nuclear physics research will therefore benefit from an enlarged toolkit for studies of various fundamental nuclear reactions. In this presentation, we report on the first use of laser-driven Inertial Confinement Fusion (ICF) experiments for studies of basic nuclear physics. These experiments were carried out at the OMEGA laser facility at the University of Rochester, in which spherical capsules were spherically irradiated with powerful lasers to compress and heat the fuel to high enough temperatures and densities for significant nuclear reactions to occur. Three experiments using ICF plasmas will be discussed. In the first experiment, the differential cross sections for the elastic neutron-triton (n-3H) and neutron-deuteron (n-2H) scattering at 14.1 MeV were measured with significantly higher accuracy than achieved in previous accelerator experiments. In the second experiment, the 3H(3H,2n)4He reaction, which is an important mirror reaction to the 3He(3He,2p)4He reaction that plays an important role in the proton-proton chain that transforms hydrogen into ordinary 4He in stars like our Sun, was studied at center-mass energies in the range 15-40 keV, and in the third experiment, ICF plasmas were uniquely used to directly study the 3He+3He solar fusion reaction. As the conditions in these ICF implosions better mimic the burning core in stars than the conditions in accelerator experiments, these types of studies open up new areas of research fundamental to both stellar nucleosynthesis and basic nuclear physics. We call this field of research plasma nuclear science. The work described here was supported in part by NLUF (DOE award No. DE-NA0000877), FSC (Rochester Sub award PO No. 415023-G, UR Acct. No. 5-24431), US DOE (Grant No. DE FG03-03SF22691), LLE (No. 412160-001G), and LLNL (No. B504974), and GA under DOE (DE-AC52-06NA27279).

Nuclear Seminar

All interested persons are cordially invited to attend.