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Neutron-Induced Reactions in a High-Density Inertial Confinement Plasma and Their Nuclear Astrophysics Nexus

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The thermodynamic conditions of plasma density, temperature, pressure, and the neutron density during the implosion of a deuterium-tritium (DT)-filled capsule by laser-induced inertial confinement at the National Ignition Facility (NIF) constitute a unique stellar-like laboratory environment. In this study, we investigated neutron-induced reactions on Ar seeds added to the DT capsule, specifically the 40Ar(n,2n)39Ar (268 years) and 40Ar(n,γ)41Ar (110 min) reactions; we also searched for the signature of a rapid two neutron capture 40Ar(2n,γ)42Ar (32.9 years) reaction, similar to the r-process occurring in stellar explosive nucleosynthesis. We conducted in parallel direct experiments to measure for the first time the total cross-section of the 40Ar(n,2n)39Ar reaction using a 14-MeV neutron activation. The resulting long-lived argon 39,42Ar isotopic residues were analyzed by Noble Gas Accelerator Mass Spectrometry at the ATLAS accelerator (Argonne National Laboratory) while shorter-lived 41Ar was detected by ⊠-spectrometry shortly after implosion at NIF. Preliminary results of 39,41,42Ar yields and comparison with simulations will be presented.

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Authors: PAUL, Michael (Hebrew University of Jerusalem); BHATTACHARYA, S. (Hebrew University of Jerusalem); SAHOO, R. N. (Hebrew University of Jerusalem); CASEY, D. (Lawrence Livermore National Laboratory); CERJAN, C. (Lawrence Livermore National Laboratory); JEET, J. (Lawrence Livermore National Laboratory); VELSKO, C (Lawrence Livermore National Laboratory); ZYLSTRA, A. (Lawrence Livermore National Laboratory); AVILA, M. (Argonne National Laboratory); LOPEZ, E. (Argonne National Laboratory); DICKERSON, C. (Argonne National Laboratory); FOUGÈRES, C (Argonne National Laboratory); MCLAIN, J. (Argonne National Laboratory); PARDO, R. C. (Argonne National Laboratory); REHM, K. E. (Argonne National Laboratory); SCOTT, R. (Argonne National Laboratory); TOLSTUKHIN, I. (Argonne National Laboratory); VONDRASEK, R. (Argonne National Laboratory); TESSLER, M. (Soreq NRC); VAINTRAUB, S. (Soreq NRC); BAILEY, T. (U. of Notre Dame); CALLAHAN, L .K. (U. of Notre Dame); CLARK, A. M. (U. of Notre Dame); COLLON, P. (U. of Notre Dame); KASHIV, Y. (U. of Notre Dame); ROBERTSON, D. (U. of Notre Dame); KOESTER, U. (Institut Laue-Langevin); HOFFMANN, H. F. R. (Technical University Dresden); PICHOTTA, M. (Technical University Dresden); ZUBER, K. (Technical University Dresden); DOERING, T. (Helmholtz Zentrum Dresden Rossendorf); SCHWENGNER, R. (Helmholtz Zentrum Dresden Rossendorf); PURTSCHERT, R. (University of Bern)

Presenter: PAUL, Michael (Hebrew University of Jerusalem)

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