ZAPP: THE Z ASTROPHYSICAL PLASMA PROPERTIES COLLABORATION

J.E. Bailey[1], C. Ball[1], C. Blancard[2], A.L. Carlson[1], D. Cohen[3], Ph. Cosse[2], G. Dunham[1], T. Durmaz[4], J.L. Ellis[5], R.E. Falcon[5], G. Faussurier[2], F. Gilleron[2], I. Golovkin[6], M.R. Gomez[1], I. Hall[4], S.B. Hansen[1], C.A. Iglesias[7], M. Kernahan[1], P.W. Lake[1], D. Liedahl[7], T. Lockard[4], G. Loisel[1], J. MacArthur[1], J.J. MacFarlane[6], R.C. Mancini[4], D. Mayes[4], M.H. Montgomery[5], S.N. Nahar[8], T. Nagayama[1], T.J. Nash[1], D.S. Nielsen[1], J.C. Pain[2], M. Pinsonneault[8], A.K. Pradhan[8], G.A. Rochau[1], M. Sherrill[9], and D.E. Winget[5]

[1]Sandia National Laboratories, Albuquerque, New Mexico
[2]CEA, DAM, DIF, F-91297 Arpajon, France
[3]Swarthmore College, Swarthmore, Pennsylvania
[4]University of Nevada, Reno, Nevada
[5]University of Texas, Austin, Texas
[6]Prism Computational Sciences, Madison, Wisconsin
[7]Lawrence Livermore National Laboratory, Livermore, California
[8]Ohio State University, Columbus, Ohio
[9]Los Alamos National Laboratory, Los Alamos, New Mexico

March 22, 2012

Abstract

The new generation of z-pinch, laser, and XFEL facilities opens the possibility to produce astrophysically-relevant laboratory plasmas with energy densities beyond what was previously possible. Furthermore, macroscopic plasmas with uniform conditions can now be created, enabling more accurate determination of the material properties. This presentation will provide an overview of our research at the Z facility investigating stellar interior opacities, AGN warm-absorber photoionized plasmas, spectral line emission from photoionized plasmas near accretion powered objects, and white dwarf photospheres. The Z Astrophysical Plasma Properties collaboration is staging Z experiments that simultaneously investigate all four of these topics. Stellar opacities are an essential ingredient of stellar models and opacity models have become highly sophisticated, but laboratory tests have not been done at the conditions existing inside stars. Our research is presently focused on measuring Fe at conditions relevant to the base of the solar convection zone, where the electron temperature and density are believed to be 190 eV and 9x1022 e/cc, respectively. The second project is aimed at testing atomic kinetics models for photoionized plasmas. Photoionization is an important process in many astrophysical plasmas and the spectral signatures are routinely used to infer astrophysical objects characteristics. However, the spectral synthesis models at the heart of these interpretations have been the subject of very limited experimental tests. Our current research examines photoionization of neon plasma subjected to radiation flux similar to the warm absorber that surrounds active galactic nuclei. The third project is studying photoionized silicon plasmas, with the goal of determining the importance of Resonant Auger Destruction on spectra that emerge from photoionized plasmas near x-ray binaries. The fourth project is aimed at producing a white dwarf photosphere in the laboratory. Emergent spectra from the photosphere are used to infer the stars effective temperature and surface gravity. The results depend on knowledge of H, He, and C spectral line profiles under conditions where complex physics such as quasi-molecule formation may be important. These profiles have been studied in past experiments, but puzzles emerging from recent white dwarf analysis have raised questions about the accuracy of the line profile models. Proof-of-principle data has been acquired that indicates radiation-heated quiescent plasmas can be produced with 1 eV temperature and 1017 1019 e/cc densities, in a 20cm3 volume. Such plasmas would provide a valuable platform for investigating numerous line profile questions.

Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy under contract DE-AC04-94AL85000.