Available online at www.sciencedirect.com

ScienceDirect

Matter and Radiation at Extremes 2 (2017) 1−2

MATTER AND RADIATION AT EXTREMES

www.journals.elsevier.com/matter-and-radiation-at-extremes

Editorial for special issue on laser fusion

It is a dream of worldwide scientists to demonstrate fusion ignition and gain in the laboratory. The demonstration of laboratory fusion ignition via Inertial Confinement Fusion (ICF) will allow scientists to understand processes in the cores of stars, to point the way toward carbon-free energy with virtually unlimited fuel supply, and to contribute to maintaining a safe and reliable nuclear deterrent without testing. In addition, the facilities, diagnostics and modeling developed for fusion research have enabled the emerging field of high energy density physics (HEDP) that impacts a broad range of topics including condensed matter, planetary and stellar science.

To achieve ignition, the U.S. government had spent significant funds to build the world's biggest laser facility, the National Ignition Facility (NIF) at Lawrence Livermore National Laboratory in California, with the goal to ultimately demonstrate fusion ignition. Although the NIF was constructed and successfully transitioned to routine operations, the National Ignition Campaign, the first attempt to achieve fusion ignition with X-ray driven targets (indirect drive) was concluded with an unsuccessful result. Today NIF continues to pursue ignition and other HEDP topics but has not yet achieved ignition. However, NIF has made significant progress including the first demonstration of significant alpha self-heating of the imploded fuel. Despite these challenges and recognizing the progress that has been made, scientists are optimistic that fusion ignition will eventually be achieved. One of the attractive features of ICF is the variety of approaches that can potentially achieve fusion. In this special issue of **Matter and Radiation at Extremes** on Laser Fusion, we focus on the approaches of Indirect-Drive, Direct-Drive, and Fast-Ignition, and we collect 9 very interesting papers on the physical issues involved in these approaches.

For the Direct-Drive approach, we have 2 papers. *What are the motivation, challenges, and the future research program for Laser Direct Drive?* Mike Campbell and co-authors in the paper "Laser direct drive research program: Promise, challenge and path forward" will summarize the motivation and challenges for laser direct drive and will present the broad program underway that utilizes both the Omega facility at the University of Rochester and NIF. *What is the optimum laser configuration for Direct-Drive, and how can the laser configurations designed for the Indirect-Drive be used for Direct-Drive?* M. Murakami and D. Nishi will discuss in: "Optimization of laser illumination configuration for directly driven inertial confinement fusion".

For the Fast Ignition approach, we have one paper. *Most concepts utilize a hollow cone to facilitate the transport of the high energy electrons or protons into the compressed fuel. Then, how is the proton generated and transported in a hollow cone, and what materials should be used at the cone tip?* J.J. Honrubia et al. will discuss in: "On intense proton beam generation and transport in hollow cones".

For the In-direct Drive approach, we have 6 papers, with 4 on implosion physics and 2 on hohlraum physics. *In capsule design, we often use low Z materials such as plastic, high density carbon, or beryllium as the ablation material. Are higher Z ablators viable and what are advantages and challenges?* This topic will be presented by J.L. Kline and J.D. Hager in the paper "Aluminum X-ray mass-ablation rate measurements". *How do the modes couple during capsule implosion and what are the effects?* Jianfa Gu et al. will discuss in: "Effects of mode coupling between low-mode radiation flux asymmetry and intermediate-mode ablator roughness on ignition capsule implosions". *How do the high-Z ablator dopants smooth P2 asymmetry on capsule?* Yongsheng Li et al. will discuss in: "P2 asymmetry of Au's M-band flux and its smoothing effect due to high-Z ablator dopants". *A very fundamental question: We usually assume that ions and electrons are in equilibrium in hot spot physics research and analysis of experiments, but is that an accurate assumption?* Zhengfeng Fan et al. will discuss in: "Non-equilibrium between ions and electrons inside hot spots from National Ignition Facility experiments". *Concerning hohlraum energetics, we have a very important question*: *is NIF's present on-target energy large enough for ignition with Laser-Indirect targets?* Guoli Ren et al. will present an assessment in: "Analysis of hohlraum energetics of the SG series and the NIF experiments with energy balance model".

Finally, it is known that laser plasma instabilities (LPI) are obstacles to creating the necessary time-dependent drive symmetry inside the cylindrical hohlraums on NIF. Then, how about LPI in spherical hohlraums with cylindrical laser entrance holes? Can they offer potential advantage on LPI? Yaohua Chen et al. will present their experiments and simulations in: "First experimental comparisons of laser-plasma interactions between spherical and cylindrical hohlraums at SGIII laser facility".

We greatly appreciate the contributions of all authors to this special issue in which every paper presents important physics or perspectives. We wish that this special issue would contribute a valuable reference for ignition fusion community.

Peer review under responsibility of Science and Technology Information Center, China Academy of Engineering Physics.

http://dx.doi.org/10.1016/j.mre.2016.12.003

Finally, **Matter and Radiation at Extremes** aims to provide an open and important platform for the international physics community to motivate scholarly communication, to promote academic achievement, and to provide a forum for deepening physical understanding and extracting novel ideas. We are always here to welcome your important contributions to **Matter and Radiation at Extremes.**

Ke Lan, Editor of Special Issue on Laser Fusion,
Executive Editor-in-Chief, Matter and Radiation at Extremes*
Institute of Applied Physics and Computational Mathematics, Beijing 100088, China

Mike Campbell, Editor of Special Issue on Laser Fusion,
Editor on Board, Matter and Radiation at Extremes
Laboratory for Laser Energetics, University of Rochester, 250 East River Road, P.O. Box 278871, Rochester, NY 14623-1299, USA
E-mail address: mcamp@lle.rochester.edu.

*Corresponding author.
E-mail address: lan_ke@iapcm.ac.cn (K. Lan).

5 December 2016
Available online 27 December 2016