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Laser Fusion –Laser Plasma Interactions, Stopping Power and Magnetic Guide Fields

Wednesday, May 29, 2024 4:00 PM (30 minutes)

On December 5, 2022 a milestone was reached in fusion energy research with the achievement of scientific breakeven for the first time in a controlled laboratory environment [1]. This was done at the Lawrence Livermore National Laboratory (LLNL) using 2.05 MJ of laser drive energy and releasing 3.1 MJ of fusion energy in an indirect-drive scheme, coupling laser energy into x-rays before imploding the fuel capsule. This demonstration that fusion energy can now be used as a clean, carbon free, source of energy has spurred a significant jump in interest around the world in pursuing routes to fusion energy. We have been studying the physics of laser fusion at the University of Alberta for several decades and recently have been investigating issues related to direct -drive laser schemes using more advanced ignition techniques such as Shock ignition and Fast Ignition. Such schemes would have significantly higher gains than the indirect-drive scheme demonstrated at LLNL. Key issues for Shock ignition, using a high intensity laser spike to generate an intense compressional shock wave at the end of the normal fuel compression pulse, are the laser-plasma instabilities leading to backscatter and nonuniform illumination of the fuel capsule, degrading the fusion yield significantly. For the Fast Ignition technique, a separate intense 20-40 ps laser pulse is used to generate a beam of protons or electrons which is directed at a small spot on the side of the laser-compressed fuel core to ignite the fusion reactions. For Fast Ignition using protons, the stopping power of the protons in the dense compressed fuel core is an important parameter. For Fast Ignition using electrons, guiding of the electrons to the ignition point at the edge of the fuel core will require strong magnetic guide fields. We have been collaborating on a number of international experimental campaigns to investigate these issues. A brief overview of the issues and results from these campaigns will be presented.

1. H. Abu-Shawareb et al., Phys. Rev. Lett. 132, 065102 (2024)

Keyword-1

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Keyword-2

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Keyword-3

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