Seminar

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Institute for Plasma Research

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Title: Spectroscopic Study of Polarized Emission from Laser Produced Plasma and Its Manifestations.

Speaker: Ms. Geethika B R, Institute for Plasma Research, Gandhinagar

Date: 26th Feb, 2026 (Thursday)

Time: 10:30 AM

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Abstract

Laser produced plasma (LPP) is a unique system having significant fundamental interest and broad applications including inertial confinement fusion, particle acceleration, cancer therapy, pulsed laser deposition, and terahertz generation. Laser-Induced Breakdown Spectroscopy (LIBS), being an active area of LPP, has emerged as a powerful technique for elemental identification and concentration determination across diverse fields ranging from archaeology to space exploration. In fusion devices, LIBS has the potential to understand plasma wall interaction[1], quantify magnetic field[2], monitor deuterium production[3] etc. Given its widespread applications, significant efforts have been directed towards improving the signal-to- background/ noise ratio of the technique so as to improve the detection limit. One of the methods is Polarization-Resolved LIBS [4,5], in which specific polarization component is used to suppress the background emission. This technique has shown promising results, however, fundamental questions regarding its mechanistic aspect still remain not well addressed. In view of this, the present study is devoted to understand the fundamental aspects of polarized emission from LPP, so that the specific polarization can be effectively used to enhance the signal to background ratio in LIBS.

In the present study, plasma was generated using a pulsed Nd:YAG laser, and the optical emission spectra were recorded using a spectrograph coupled with an intensified charge-coupled device (ICCD) camera. Key spectral properties, such as line broadening, spectral shift, and line shape asymmetry, were investigated for laser-produced aluminium plasma. The plasma parameters were estimated using standard spectroscopic techniques and its spatio-temporal evolution were also investigated. Polarization-resolved measurements were recorded with a dedicated imaging system that can separate horizontal (H) and Vertical (V) polarizations in a single shot. To effectively explore the emission polarization for improving the signal-to-background ratio in PR-LIBS, a systematic study of the origin of polarization for both line and continuum emissions from LPP is conducted. Results shows that along the plume expansion direction, the degree of polarization (DOP) shows significant variation, including reversal from negative to positive, while its magnitude progressively decreases with time. In case of line emission, close to the sample the reason for the observed DOP appears to be due to the self-generated magnetic field. However, away from the sample the plasma- background interaction appears to play a role[6]. Consequently, the study was extended to understand effect of the observed DOP on estimation

of plasma parameters. The results shows that the estimated electron temperature varies based on the chosen polarization of emission at instances where the DOP is high. This indicates possible deviation from the expected Maxwell- Boltzmann distribution for energy states involved in the selected transitions. However, no such variations are observed for the electron density estimation [7]. Further, to explain the reason for the observed DOP in the continuum emission, a non-relativistic, partial wave approach was utilized to calculate the Bremsstrahlung emission cross section. This closely predicts the observed trend in DOP of continuum at different positions, times and emission wavelengths.

References:

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