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Suppression of Stimulated Brillouin Scattering in multiple-ion species inertial confinemen fusion Hohlraum Plasmas

P. Neumayer

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Suppression of Stimulated Brillouin Scattering in multiple-ion species inertial confinement fusion Hohlraum Plasmas*

P. Neumayer
Lawrence Livermore National Laboratory, USA

A long-standing problem in the field of laser-plasma interactions is to successfully employ multiple-ion species plasmas to reduce stimulated Brillouin scattering (SBS) in inertial confinement fusion (ICF) hohlraum conditions. Multiple-ion species increase significantly the linear Landau damping for acoustic waves. Consequently, recent hohlraum designs for indirect-drive ignition on the National Ignition Facility investigate wall liner material options so that the liner gain for parametric instabilities will be below threshold for the onset SBS. Although the effect of two-ion species plasmas on Landau damping has been directly observed with Thomson scattering, early experiments on SBS in these plasmas have suffered from competing non-linear effects or laser beam filamentation.

In this study, a reduction of SBS scattering to below the percent level has been observed in hohlraums at Omega that emulate the plasma conditions in an indirect drive ICF experiments. These experiments have measured the laser-plasma interaction processes in ignition-relevant high-electron temperature regime demonstrating Landau damping as a controlling process for SBS. The hohlraums have been filled with various fractions of CO_2 and C_3H_8 varying the ratio of the light (H) to heavy (C and O) ion density from 0 to 2.6. They have been heated by 14.5 kJ of 351-nm light, thus increasing progressively Landau damping by an order of magnitude at constant electron density and temperature. A delayed 351-nm interaction beam, spatially smoothed to produce a 200-μm laser spot at best focus, has propagated along the axis of the hohlraum. The backscattered light, both into the lens and outside, the transmitted light through the hohlraum plasma and the radiation temperature of the hohlraum has been measured. For ignition relevant laser intensities (3-9 10^{14} Wcm^{-2}), we find that the SBS reflectivity scales as predicted with Landau damping from >30% to <1%. Simultaneously, the hohlraum radiation temperature increased indicating improved coupling of the heater beams. These observations provide strong justification to pursue employing multiple-ion species plasmas in current target designs for the first attempt at ignition on the National Ignition Facility.

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Supporting remarks:

Dr. Neumayer is a as postdoctoral scientist within the NIF directorate who has made outstanding contributions to the experimental program and has assumed major responsibilities on backscatter calibrations at the Omega Laser Facility and recently also on the National Ignition Facility. Dr. Neumayer has first worked on Thomson scattering and laser propagation experiments before leading his own laser-plasma interaction experiments on Omega. He has successfully demonstrated reduction of stimulated Brillouin scattering and simultaneous increase in radiation temperature in inertial confinement fusion hohlraums by increasing Landau damping using multiple-ion species gas fills in inertial confinement fusion hohlraums. Following the successful experiments, this strategy for reducing scattering has now been adopted for hohlraum target designs for ignition experiments on the NIF.

Publications

Ideal Laser-Beam Propagation through High-Temperature Ignition Hohlraum Plasmas,
D. H. Froula, L. Divol, N. B. Meezan, S. Dixit, J. D. Moody, P. Neumayer, B. B. Pollock, J. S. Ross, and S. H. Glenzer,
Phys. Rev. Letters, **98**, 085001 (2007).

Observations of Plasmons in Warm Dense Matter
S. H. Glenzer, O. L. Landen, P. Neumayer et al.,
Phys. Rev. Letters, **98**, 065002 (2007).

Solid-density plasma characterization with x-ray scattering on the 200 J Janus laser ,
P. Neumayer et al., Rev. Sci. Instrum. **77**, 317 (2006).

Transient collisionally excited X-ray laser in nickel-like zirconium pumped with the PHELIX laser facility, P. Neumayer et al., Appl. Phys. B **74**, 957 (2004).

Informed individuals:

B. J. MacGowan, *Lawrence Livermore National Laboratory, L-399, University of California, P.O. Box 808, Livermore, CA 94551, USA*
Tel: (925) 422-2250. Brian MacGowan macgowan1@llnl.gov

J. D. Lindl, *Lawrence Livermore National Laboratory, L-399, University of California, P.O. Box 808, Livermore, CA 94551, USA*
Tel: (925) 422-5430. John Lindl lindl1@llnl.gov