Subsonic diffusive X-ray driven heat wave experiments on the Laser Mégajoule

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A campaign dedicated to the propagation of a radiation heat wave in a subsonic diffusive regime has been conducted in May 2016 on the Laser Mégajoule (LMJ) facility. In this regime, the matter is ablated by a Marshak wave overtaken by a shock wave as it has been experimentally studied in [1,2]. Here the experiments are designed in such a way the energy flux is dominated by the photon transport as it is the case in astrophysical plasmas when a compact object (young stellar object, white dwarf or neutron star) irradiates by intense radiation the surrounding clumpy and cloudy interstellar medium.

One LMJ quadruplet with pulse duration of 4 ns and total energy of 11 kJ irradiates a shield hohlraum to create, behind the shield, a Planckian X-ray radiation source of 110 eV without photons in the AU M-band energy range. An aluminium sample with annular slots covers the opposite side of the hohlraum. Two Broad-band X-ray Spectrometers, DMX and miniDMX, measure respectively the X-ray flux coming from the Laser Entrance Hole and the sample.

First the X-ray radiation escapes freely through the slot apertures and deposits energy on the sample walls. A multi-dimensional radiation hydrodynamic flow is produced. The sample matter is ablated and soon the slots are filled. The accumulated matter at the center stagnates in a densified region and a structure called “N-wave” is established. In the meantime, three shock waves propagate in the sample : two from the slot walls and on from the sample front side. The low energy miniDMX channels measure the X-ray flux emitted by the shocked, heated matter in the slots whereas the high energy channels measure the flux emitted by the hohlraum and attenuated though the matter in the slots. These measurements give rich information on the ablation dynamics behind the studied subsonic radiative Marshak wave.

The results are well predicted by simulation with the ALE radiation-hydrodynamic code FCI2 and the post-processing code DIANE. We present results analysis from samples with various thicknesses and slot widths.

References

[1] B. R. Cooper et al. , Phys. Plasma, 20, 033301 (2013)
[2] A.S. Moore et al., Phys. Plasma, 21, 063303 (2014)