Effects of an external magnetic field on Richtmyer-Meshkov instability in high energy density plasmas

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Interfacial instabilities, the Kelvin-Helmholtz, Rayleigh-Taylor, and Richtmyer-Meshkov (RM) instabilities, play a crucial role in various plasma phenomena such as astrophysical supernova explosions and inertial fusion implosions. Recently the experimental studies on these instabilities in "high energy density" setting have been performed intensely by using high power laser facilities. Compared with the classical instabilities in “low energy density”, various interactions should be considered in the laser plasma, which are for example the radiation, compression, kinetic effects, and magnetic fields.

One of the urgent and curious questions related to the RM instability is the interaction with a magnetic field. It is known that there are two important effects brought by the inclusion of an external field, which are the amplification of the ambient field and the suppression of the unstable growth.

We demonstrated by direct numerical simulations that the magnetic field could be amplified through the stretching motions driven by the RMI. The maximum field strength is more than two orders of magnitude higher than the initial size, and it appears associated with the interface as well as the bulk vorticity left by the rippled transmitted shock. The growth of RM instability can be reduced significantly by a strong field as a result of the extraction of vorticity from the interface. It is found that these magnetohydrodynamical evolutions of the RM instability is well characterized by the Alfven number, which is the ratio between the Alfven speed and the linear growth velocity of the instability.

We also introduce the recent progress in the laser experiments for the RM instability by the GEKKO laser in Osaka University.