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Two-dimensional (2D) hydrodynamics simulation of the lateral interaction of two laser-blow-off (LBO) plasma plumes

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In this work we present the numerical simulation of the interactions between two spatially separated LBO plasma plumes in the presence of various ambient gases at different pressures. In the LBO plasma plume, the neutral species are the major constituents. Thus, LBO has relevant importance in neutral beam generation and impurity injection in high temperature plasma, such as tokomak, where it is used as a diagnostic tool [1,2]. Previous numerical studies [3] indicate that the evolution of the plasma plume is clearly depicted based on the hydrodynamics description. As we see, the LBO is majorly formed by neutral constituent species. Therefore, in our simulation, the whole system is considered as a binary mixture of two species, one from the plasma plume and the other from the background gas. This binary system is modelled using the convective form of hydrodynamics equations; continuity, momentum, and energy equations; and solved numerically in two dimensions using the flux corrected scheme of Boris *et al* [4].

In simulation, we showed the characteristic dynamics of two plasma plumes in the ambient gas, shock wave formation, and their interactions [5,6]. The formation and geometrical aspects of the interaction zone and their pressure dependence observed in simulation agree well with the experimental results [7,8]. Our simulation suggests that colliding shock fronts play an important role in the formation of a structured interaction zone in the colliding plasma plume. The ambient gas pressure governs the shape and strength of the shock waves. The presence of regular and Mach reflections is captured in our simulation as observed in the recent experimental studies [5,6]. A couple of numerical results from the simulation are displayed in figures 1 and 2.

References

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Figures:

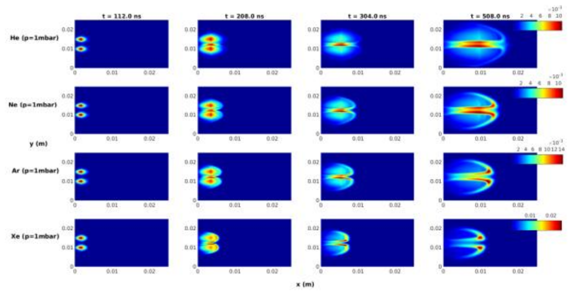

Fig. 1: (Left to right) Time evolution of the density variation of two plasma plumes in the presence of He, Ne, Ar, and Xe ambient gases at 1.0 mbar; the density shown here is normalised by the initial value of density in the respective simulation.

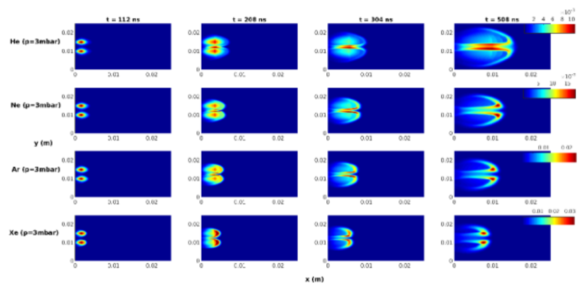

Fig. 2: (Left to right) Time evolution of the density variation of two plasma plumes in the presence of He, Ne, Ar, and Xe ambient gases at 3.0 mbar.