Modeling of shell-mixing into the central hotspot in inertial confinement fusion implosion

C. X. YU [1], Z. F. FAN [1], and J. LIU [1, 2, 3]

1) *Institute of Applied Physics and Computational Mathematics, Beijing 100088, China;*
2) *Center for Fusion Energy Science and Technology, Chinese Academy of Engineering Physics, Beijing 100088, China*
3) *Center for Applied Physics and Technology, Peking University, Beijing 100871, China*

In the implosion dynamics of inertial confinement fusion (ICF), the shell-mixing into the fusion fuel has been the focus of research interests. The experiments from the National Ignition Facility (NIF) also show that the shell-mixing is one of the key factors of hindering the fusion ignition [1, 2].

Starting from the mass conservation and energy conservation of hotspot, we construct the dynamics of hotspot combustion involving shell-mix by recalculating the special internal energy and heat capacity, in which the bremsstrahlung radiation loss and other energy transfer are considered. Using the power balance in the hotspot, the relations between the fractions of shell-mixing in the hotspot and the ignition threshold and self-sustainable combustion are investigated. The theoretical analysis and numerical simulation show that the enhancement of radiation loss induced by the shell-mixing plays the dominated role in the failure of ignition.

In Figure 1, we propose two methods for degrading the impact of shell-mixing based on the numerical results, where $x_j = n_{mix}/n_{DT}$ is the fraction of mix to the total number of DT in the hotspot, and $f = 2T_i/(T_i + T_e)$ is a non-equilibrium factor (NEF) of hotspot temperature [3]. In the left panel, favorable hotspot condition is at the high temperature region "B" which is less sensitive to the impact of mixing than high areal density region "A". In the right panel, higher NEF f has wider ignition region, which means electron temperature should be higher than the ion temperature in hotspot at stagnation stage.

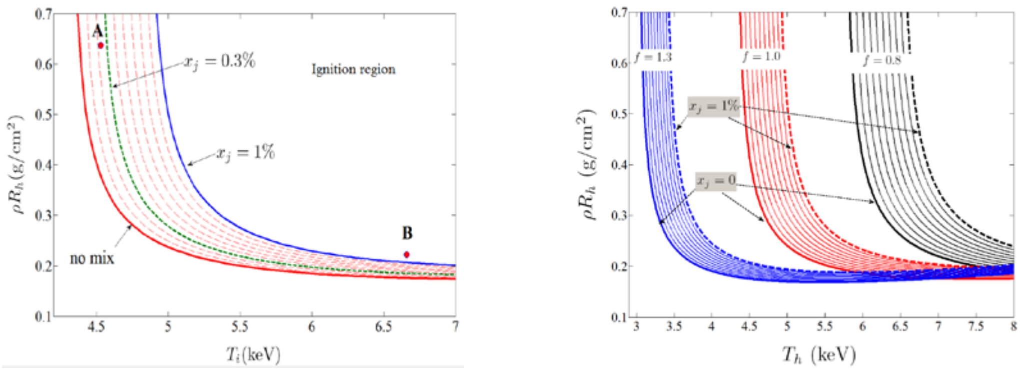

Figure 1: Two schemes for degrading the impact of shell-mixing.

References

[1] T. Ma, *et al*. Phys. Rev. Letts., **111**, 085004 (2013).

[2] H. S. Park, *et al*., Phys. Rev. Letts., **112**, 055001 (2014).

[3] Z. F. Fan, *et al*., Phys. Plasmas, **23**, 010703 (2016).