5th Asia-Pacific Conference on Plasma Physics, 26 Sept-1Oct, 2021, Remote e-conference

Nonlocal electron heat transport effects on ablative Rayleigh-Taylor instability

Rui Yan[1,2], Jun Li[1], Bin Zhao[3, 2],Jian Zheng[4, 2], Huasen Zhang[5] ,Hussein Aluie[6] ,Riccardo Betti[6, 7] and Xiyun Lu[1]

[1] Department of Modern Mechanics, University of Science and Technology of China,

[2]Collaborative Innovation Center of IFSA (CICIFSA), Shanghai Jiao Tong University,

[3]Department of Mathematics and Physics, NanJing Institute of Technology

[4]Department of Plasma Physics and Fusion Engineering, University of Science and Technology of China

[5]Institute of Applied Physics and Computational Mathematics, China Academy of Engineering Physics

[6]Department of Mechanical Engineering, University of Rochester

[7]Department of Physics and Astronomy, University of Rochester

e-mail (speaker): ruiyan@ustc.edu.cn

In ICF implosions, the ablative Rayleigh-Taylor instability (ARTI) seeded by short-wavelength target surface roughness and/or laser imprint can significantly degrade the implosion efficiency and obstacle thermonuclear ignition of the fusion fuel. The discrepancy between the experimental results and the numerical results [1,2,3,4] using the classical local heat transport model raises an important question on the impact of electron nonlocal heat transport (NLHT) on ARTI. NLHT modeling is a long-standing problem in inertial confinement fusion (ICF) research and it plays a crucial role in numerical investigation of key processes in ICF such as implosions and hydrodynamic instabilities. In this work we investigate the effects of NLHT on the evolution of the two-dimensional single-mode ARTI through numerical simulations with a multi-group diffusion model[5]. It is found that NLHT not only lowers the linear ARTI growth rates by altering the one-dimensional longitudinal equilibrium profiles but also reduces the ARTI bubble reacceleration in the highly nonlinear phase. The ablation near the spike tip is found larger than predicted by the local Spitzer-Harm model and larger ablation leads to weaker vortex generation as the pump of bubble reacceleration. It is also found that NLHT more effectively reduces the growth of shorter-wavelength ARTI modes seeded by laser imprinting phase in direct-drive laser fusion.

References

1. K. Shigemori, H. Azechi, M. Nakai, M. Honda, K. Meguro,N. Miyanaga, H. Takabe, and K. Mima, Phys. Rev. Lett. 78, 250 (1997).
2. H. Azechi, M. Nakai, K. Shigemori, N. Miyanaga, H. Shiraga, H. Nishimura, M. Honda, R. Ishizaki, J. Wouchuk, H. Takabe,et al., Physics of Plasmas 4, 4079 (1997).
3. S. G. Glendinning, S. N. Dixit, B. A. Hammel, D. H. Kalantar, M. H. Key, J. D. Kilkenny, J. P. Knauer, D. M. Pennington,B. A. Remington, R. J. Wallace, and S. V. Weber, Phys. Rev.Lett. 78, 3318 (1997).
4. T. Sakaiya, H. Azechi, M. Matsuoka, N. Izumi, M. Nakai,K. Shigemori, H. Shiraga, A. Sunahara, H. Takabe, and T. Yamanaka, Physical review letters 88, 145003 (2002).
5. G. P. Schurtz, P. D. Nicolaï, and M. Busquet, Physics of Plasmas7, 4238 (2000).