B-O6 AAPPS-DPP2019

3rd Asia-Pacific Conference on Plasma Physics, 4-8,11.2019, Hefei, China

Plasma instability of magnetically enhanced vacuum arc thruster

Lei Chang

School of Aeronautics and Astronautics, Sichuan University, Chengdu 610065, China

e-mail (speaker): leichang@scu.edu.cn

A two-fluid flowing plasma model is applied to describe the plasma rotation and resulted instability evolution in magnetically enhanced vacuum arc thruster (MEVAT). Typical experimental parameters are employed, including plasma density, equilibrium magnetic field, ion and electron temperatures, cathode materials, axial streaming velocity, and azimuthal rotation frequency. It is found that the growth rate of plasma instability increases with growing rotation frequency and field strength, and with descending electron temperature and atomic weight, for which the underlying physics are explained. The radial structure of density fluctuation is compared with that of equilibrium density gradient, and the radial locations of their peak magnitudes are very close, implying that the mode may be driven by density gradient. Temporal evolution of perturbed mass flow in the cross section of plasma column is also presented, which behaves in the form of clockwise rotation (direction of electron diamagnetic drift) at edge and anti-clockwise rotation (direction of ion diamagnetic drift) in the core, separated by a mode transition layer from n = 0 to n = 1. This work, to our best knowledge, is the first treatment of plasma instability caused by rotation and axial flow in MEVAT, and is also of great practical interest for other electric thrusters where rotating plasma is concerned for long-time stable operation and propulsion efficiency optimization.

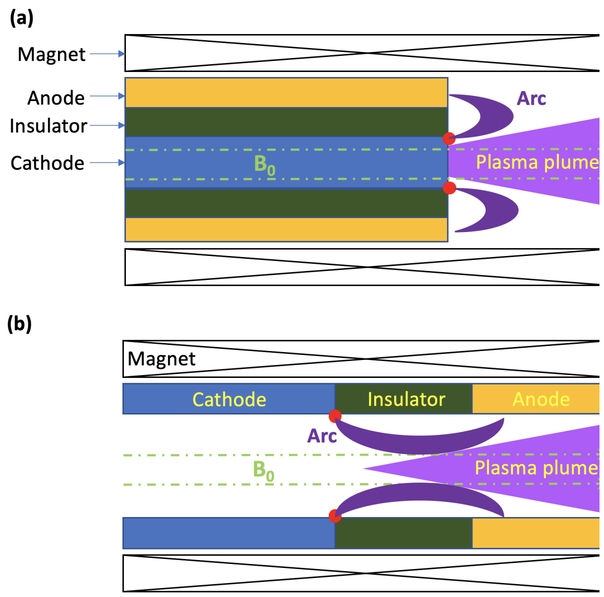

Fig 1. Schematics of typical magnetically enhanced vacuum arc thruster (MEVAT): (a) coaxial-type, (b) ring-type.

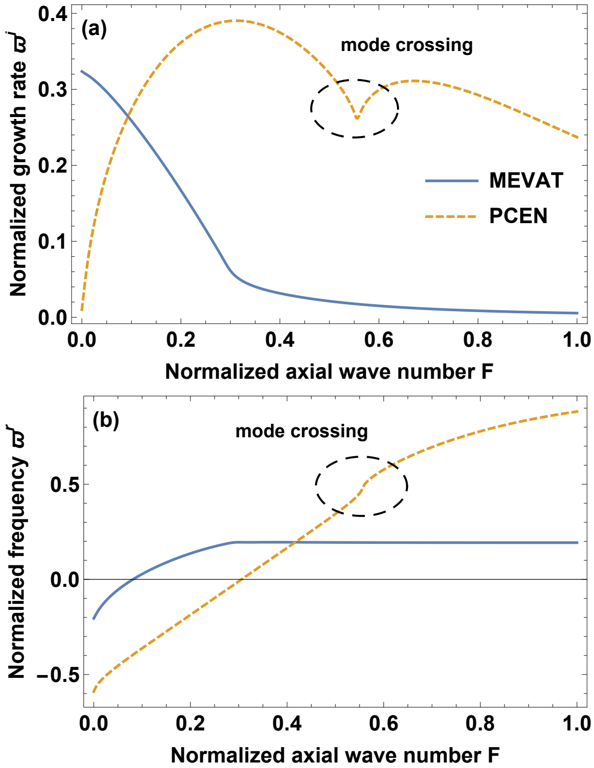

Fig. 2 Dispersion curves for MEVAT (solid line) and PCEN (dashed line), generated based on the conditions shown in Table I: (a) normalized growth rate ϖ^i ; (b) normalized frequency ϖ^r . (vs normalized axial wavenumber $F = k_\varsigma/\sqrt{\delta}$)

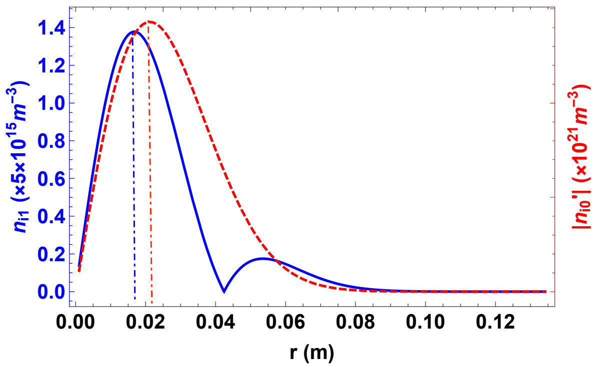

Fig. 3 Radial variations of perturbed density $n_{i1}(r)$ (solid) and equilibrium density gradient $|n_{i0}'(r)|$ (dashed line).

References

[1] L. Chang, T. P. Zhang, X. Y. Hu, X. M. Wu, and X. F. Sun, AIP Advances 9: 015328 (2019) (Editor's Pick)