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The role of collisionless trapped electron mode turbulence on removal of helium ash and transport of deuterium-tritium ions

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Removal of helium ash and the anomalous transport of deuterium (D) and tritium (T) ions driven by collisionless trapped electron mode (CTEM) turbulence in tokamak plasmas with weak magnetic shear are studied. We derive the eigenvalue of CTEM with helium ash, and calculate the quasi-linear turbulent fluxes of helium ash, D and T ions simutaneously. Based on the analytical results, the parametric dependence of CTEM instability as well as the anomalous transport of helium ash and D-T ions are investigated, in order to explore the parameter region that is favorable for expelling more helium ash than D and T ions. It is found that helium ash with higher temperature and steeper density profile plays a role of destabilizing CTEM instability, and has higher transport level than that of T ions. We also find that increasing electron temperature and flattening electron density profile are favorable for exhausting helium ash. Isotopic effects (i.e., increasing the fraction of T ions) enhance the transport of both helium ash and D-T ions. Moreover, the trend of stronger transport level of helium ash than that of D-T ions is enhanced by raising electron temperature and flattening electron density profile as well as isotopic effects. Besides, the diffusivity is much larger than the convection. This indicates that the CTEM turbulence driven helium ash transport is favorable for removing helium ash under the parameter region used in the present paper. The possible relevance of our theoretical results to experimental observations is also discussed.

References

Weixin Guo, Mingzhu Zhang, Lu Wang* and Ge Zhuang, *The role of collisionless trapped electron mode turbulence on removal of helium ash and transport of deuterium-tritium ions*, Nucl. Fusion 61 (2021) 016020