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Ion Inertial Effects on Three-dimensional Filament Dynamics

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The ion inertial effects on the sheath-limited filament dynamics have been investigated with the three-dimensional (3D) electrostatic Particle-in-Cell (PIC) simulations. We have shown that the radial propagation speed of a sheath-limited filament becomes slightly slower in deuterium-tritium (D-T) plasmas than in light hydrogen (H) plasmas because of the gyro motion effect. The filament (blob) radial propagation speed is the fundamental and important factor for the boundary layer transport. However, the isotope effects on filament dynamics including the radial propagation speed had not been focused on in previous studies. On the other hand, our previous work showed that the minor heavy ions decelerate the blob by the formation of the dipolar density distribution of minor heavy ions in a blob due to the polarization drift. Nevertheless, according to the traditional static estimation of the sheath-limited filament transport, it is expected that the sheath effect makes the radial propagation speed in D-T plasmas faster than that in H plasmas. Thus, in this study, the ion inertial effects on the sheath-limited filament dynamics have been investigated with the 3D-PIC simulations in order to evaluate the isotope influences in the polarization drift effect and the sheath effect. The simulations have revealed that the sheath effect is canceled out by the polarization drift effect. Therefore, the radial propagation speed in D-T plasmas ought to be roughly the same as that in H plasma. However, in the simulations, it has been observed that the radial propagation speed in D-T plasmas is slightly slower than that in H plasma. This fact is thought to arise from the gyro motion effect which induces the poloidal symmetry breaking, the poloidal movement of blob, and the deceleration of radial propagation.

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