Three-Dimensional Characteristics of the Quasi-Single Helical State in the KTX

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Abstract

The middle-sized Keda Torus eXperiment (KTX) with a major radius of R=1.4m and minor radius of a=0.4m, is located at the University of Science and Technology of China [1]. The characteristics of various quasi-single helicities (QSH) in the KTX are investigated using ideal MHD simulations with three-dimensional equilibria by the VMEC code to evaluate the possibilities and robustness of various QSH states achieved in the KTX [2]. For the first time, the VMEC simulations have demonstrated the potential formation of various QSH states in the RFP configuration in the KTX device.

It is found that in the core plasma region the negative magnetic shear imposes a substantial influence on the stabilization of interchange modes, which can enhance the magnetic fluctuations of the dominant single mode. The prominent reversal shear plays a critical role on the transition to the QSH phase. It is shown that the QSH state with a toroidal periodicity N_{fp}=6 is expected to be stably achieved by the negative magnetic shear in the future KTX experiments. In addition, the plasma confinement affected by subdominant modes is estimated using particle drift computations in the KTX. As the amplitude of residual subdominant modes increases the radial drift is significantly enhanced, which indicates that a drastic loss of ions arises from the subdominant modes with sufficient amplitudes. The result is in a good agreement with experimental observations in the Madison Symmetric Torus (MST) [3]. This work may shed a light on the transition mechanism between the multiple helicities (MH) phase and the QSH phase in revered-field pinch facilities. Moreover, for improving the confinement of RFP in the QSH scenario, the critical importance of subdominant mode amplitudes on the ion confinement should be prudently considered.

References

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