Role of rotation in the field penetration threshold in magnetized plasma

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In the magnetically confined plasma, the excitation of tearing modes by three-dimensional fields can greatly reduce the confinement performance of the plasma, and even cause major disruptions. The parameter dependence of the threshold for field penetration is a fundamental and important issue. J-TEXT research has discovered a non-monotonic dependence between density and the threshold for field penetration, where at high densities, the threshold becomes extremely low. This contradicts current empirical scaling, and analysis suggests that plasma rotation may be the dominant factor in this phenomenon. In further experiments, the edge safety factor of the plasma also exhibited a non-monotonic relationship with the threshold for field penetration at high densities.

Additionally, different relationship between the threshold and the toroidal field were obtained at different densities. A consistent result was obtained only when the influence of rotation was considered. Heating is believed to be able to change the electron temperature to affect the threshold for field penetration. In J-TEXT experimental research, it was found that the heating power of ECRH had different effects on the threshold for field penetration at different densities, and could even cause the threshold to decrease. Analysis showed that the dominant factor that affects the field penetration threshold was not the electron temperature, but the rotation of the plasma.

In summary, in the J-TEXT study of the parameter dependence of the threshold for field penetration, a series of anomalous phenomena have revealed the crucial role of plasma rotation, which has a far greater impact on the threshold than pa*rameters such as temperature and density. It is a factor that must be prioritized in the evolution of plasma parameters. These results have important implications for t*he design of the tolerance limits of future devices for error fields.

Reference：

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