Simulation Study on the Impact of Energy Particles on the Pedestal

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Using the hybrid simulation code MHD & Accurate Particles (MAP), the impact of energy particles on the pedestal was studied. In JET DT experiment #99896, it was observed that the plasma exhibited characteristics similar to the I-mode found in deuterium plasmas, featuring a temperature pedestal and L-mode-like density profile without the presence of ELMs. However, measurements from Mirnov coils did not show the weakly coherent mode (WCM) phenomenon, typically found in I-mode. Additionally, considering that the DT reactions in #99896 produced high-energy alpha particles and signals from high-energy particles were also detected, a plausible hypothesis is that high-energy particles affect the pedestal.
In this study, a hybrid simulation code MAP was used to directly calculate the time evolution of high-energy particles throughout the operation of the tokamak. In the EAST configuration, using the slowing-down beam ion distribution, it was found that some high-energy particles from the core region ($\rho<0.3$) moved to the edge region ($0.9<\rho<1$) and remained stable within the core-edge range. A simple magnitude estimation found that the parallel current generated by high-energy particles at the edge is about one-thousandth of the total plasma parallel current. Then the results were processed using BOUT++, and it was found that, after considering the distribution of high-energy particles, the parallel current of high-energy particles at the edge affects the peeling component of edge instabilities, thereby promoting the onset of edge instabilities. This work provides a new perspective for studying the relationship between core and pedestal instabilities.

Keywords: Energy particles, Pedestal, MAP, Simulation