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Nonlocal Plasma Response to Edge Perturbation in Tokamak

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The transient transport events are observed in toroidally magnetic confinement devices. For example, the cold pulse experiment shows a rapid transient increase of electron temperature in the plasma core in response to an abrupt cooling at the edge. Understanding the nonlocal transport is important to control plasma core and/or fuel supply in ITER and DEMO. The nonlocal particle transport has been investigated based on 4-field reduced MHD model applying edge density source. It is shown that 0/0 and 1/0 modes play an important role for nonlocal transport. The edge cooling is also investigated based on 3-field gyro-fluid model, however, the nonlocal transport is found to be limited in the peripheral region [1]. To identify the effects of density source and temperature sink in the edge region, we have extended 4-field model[2] to 5-field model which consists of the vorticity equation, Ohm's law, parallel ion momentum equation, electron density equation and electron temperature equation. Simulation study on nonlocal plasma response in tokamak is performed using global fluid code based on the 5-field model. A nonlocal plasma response to edge perturbation is found. The simulation result shows that (i) the mean central electron temperature increases according to the edge cooling (it is shown for the first time), (ii) the magnetic island located at q=2 rational surface plays an important role (acting as internal transport barrier) as well as non-resonant modes such as 0/0 and 1/0 (here m/n implies Fourier mode with poloidal mode number m and toroidal mode number n), (iii) re-distribution of electron temperature occurs after switching off source and sink where meso-scale mode plays a major role.

Reference

[1] N. Miyato, et al., IAEA FEC2014, TH/P2-12 (2014).

[2] M. Yagi, et al., Nucl. Fusion 45 900 (2005).

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