Influence of energetic ions on magnetic island

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Influence of energetic ions on the evolution of magnetic island has been studied systematically for the island width is much smaller than the orbit width of energetic ions, where energetic ions affect magnetic island mainly through the interaction with the outer region of tearing modes. First, the effects of circulating energetic ions (CEI) on the stability criterion have been studied[1-2]. The stability criterion[1] including the effects of CEI has been derived analytically. These effects depend on the toroidal circulating direction, and are closely related to the momentum of energetic ions. CEI provide an additional source or sink of momentum to affect tearing modes. For co-CEI, tearing modes can be stabilized if the momentum of energetic ions is large enough. On the other hand, the growth of tearing modes can be enhanced by counter-CEI. Based on the above model, the effects of energetic ions on tearing modes are studied by global kinetic/MHD hybrid simulations. The dependence of kinetic effects on energetic ion beta, gyroradius and speed is studied systematically and the results agree in large part with the previous analytic results for the kinetic effects of CEI. For trapped energetic ions, their effects on tearing mode stability are dominated by the adiabatic response due to large banana orbit width and strong poloidal variation of particle pressure.

In addition to the above effects, we study the effect of an uncompensated cross field current resulting from energetic ions on the island, which is yielded based on quasi-neutrality. It produces a return parallel current, and may compensate the loss bootstrap current in the island, and depends on the island propagation frequency, the density gradient of energetic ions and magnetic shear. For the weak magnetic shear, this effect becomes significant, and cancels partially or overcomes the destabilizing effect of the bootstrap current.

Based on the analysis, a possibility to suppress neoclassical tearing modes by co-CEI for the operation scenario with weak magnetic shear for ITER is provided.

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