Unresolved Issues in the Simulation of H-mode Pedestal and ELMs in Tokamaks*

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Abstract

There are a number of unresolved issues related to the integrated modeling of the H-mode pedestal and Edge Localized Modes (ELMs) in tokamaks. The objective of the integrated modeling simulations is to predict the height, width, and shape of the pedestal as well as the frequency and consequences of the periodic ELMs that occur in most H-mode discharges.[1,2,3,4] The following are among the unresolved issues: (1) If all of the anomalous transport were completely suppressed in the pedestal, the effect of the remaining neoclassical transport would be to produce an electron temperature that is significantly higher than the ion temperature at the top of the pedestal, which is not consistent with experimental observations. Hence, models are being developed in which the anomalous ion thermal transport is reduced more than the anomalous electron thermal transport. (2) During an ELM crash, the diffusion of the current density caused by neoclassical resistivity by itself does not remove the pedestal current density fast enough to stabilize the current-driven peeling mode in simulations. There must be fine-scaled magnetic reconnection to remove the pedestal current density on the time scale of an ELM crash, which is less than a millisecond. (3) A model is needed for integrated simulations in which a significant part of the pedestal current is transferred to the wall during an ELM crash, rather than having the pedestal current driven into the plasma during each ELM crash. (4) The models currently used in the integrated simulations do not include the vertical asymmetry effect that is observed in experiments — that it takes less power to make the L to H-mode transition if the X-point of the divertor is in the direction of the ion grad B drift. (5) Plasma blobs, which carry plasma particles and energy to the outboard wall, are not yet included in integrated modeling simulations. These unresolved issues will be discussed together with examples of recent integrated modeling simulations of tokamak H-mode plasmas.

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