Physics Requirements for Understanding the H–Mode Pedestal*

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An important priority for the fusion program is to develop a sufficient physics understanding of the H-mode pedestal structure that reliable predictions and control schemes for the height of the pedestal can be obtained. This is a challenging proposition due to the complexity and richness of the physics of the pedestal. Present understanding shows that the pedestal structure is determined by a combination of transport, MHD and atomic physics processes. The pedestal is a self-consistent solution of these processes as they vary from the closed field lines at the top of the pedestal to the open field lines of the scrape-off layer and ultimately to the limiting material surfaces of the plasma. Thus, the pedestal cannot be understood purely in terms of physics occurring inside the separatrix. Moreover, the problem is inherently 2D due to the characteristics of transport on the open field lines and possibly 3D due to non-uniformities of the fuelling sources. Obtaining a predictive capability for the pedestal requires advances in several areas. Existing boundary fluid transport codes need to be validated with experimental measurements, particularly turbulence measurements, over a large range of experimental conditions. Transport simulation codes must be developed which include kinetic effects to treat the ion orbits, which are large compared to scale lengths of density and temperature profiles, and to incorporate non-adiabatic electron physics. High resolution measurements of edge pressure profiles and of edge current density profiles are needed for validating existing models of edge MHD stability, such as those based on peeling/ballooning modes. Spatially resolved measurements of the fuelling source are needed from a variety of experimental conditions and they must be compared to predictions from appropriate neutrals codes. Ultimately, these physics ingredients must be incorporated into integrated modeling codes that can be used to determine how the relevant physics processes interact. This task must be performed carefully and must use modules for the various physics mechanisms that have been independently validated in order that the output of such codes can be accepted with confidence.

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