ABSTRACT

We have made two significant discoveries in our recent studies of quiescent H-mode (QH-mode) plasmas in DIII-D. First, we have found that we can control the edge pedestal density and pressure by altering the edge particle transport through changes in the edge toroidal rotation. This allows us to adjust the edge operating point to be close to, but below the ELM stability boundary, maintaining the ELM-free state while allowing up to a factor of two increase in edge pressure. The ELM boundary is significantly higher in more strongly shaped plasmas, which broadens the operating space available for QH-mode and leads to improved core performance. Second, for the first time on any tokamak, we have created QH-mode plasmas with strong edge co-rotation; previous QH-modes in all tokamaks had edge counter rotation. This result demonstrates that counter NBI and edge counter rotation are not essential conditions for QH-mode. Both these investigations benefited from the edge stability predictions based on peeling-ballooning mode theory. The broadening of the ELM-stable region with plasma shaping is predicted by that theory. The theory has also been extended to provide a model for the edge harmonic oscillation (EHO) that enhances edge transport in the QH-mode. Many of the features of that theory agree with the experimental results reported either previously or in the present paper. One notable example is the prediction that co-rotating QH-mode is possible provided sufficient shear in the edge rotation can be created.