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Core Barrier Formation Near Integer q Surfaces in DIII-D[1]

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Recent DIII-D experiments have significantly improved our understanding of internal transport barriers (ITBs) that are triggered close to the time when an integer value of the minimum in q is crossed. While this phenomenon has been observed on many tokamaks, the extensive transport and fluctuation diagnostic set on DIII-D has allowed us to study in detail the generation mechanisms of q-triggered ITBs as pertaining to turbulence suppression dynamics, shear flows, and energetic particle modes. In these discharges, the evolution of the q profile is determined by MSE polarimetry and the integer q_{min} crossings are further pinpointed in time by the observation of Alfven cascades. High time resolution measurements of the ion and electron temperatures and the toroidal rotation show that the start of improved confinement is simultaneous in all 3 channels, and that this event precedes the traversal of integer q_{min} by 5-20 ms. There is no significant low-frequency MHD activity prior to or just after the crossing of integer q_{min}. A drop in core ion temperature and rotation that often occurs just before the ITB onset is coincident with a high frequency core-localized TAE mode that begins at the crest of the preceding Alfven chirping modes and is a possible cause of the core ion loss via expulsion of fast ions. A reduction in local turbulent fluctuations is observed at the start of the temperature rise, and concurrently, an increase in turbulence poloidal flow velocity and flow shear is measured with the beam emission spectroscopy diagnostic. For the case of a transition to a steady internal barrier the fluctuation level remains at a reduced amplitude. The timing and nature of the temperature and rotation changes leading to internal barriers suggests transport improvement due to increased shear flow arising from fast ion loss.

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