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EX/P7-06: Turbulence and Transport Response to Resonant Magnetic Perturbations in ELM-Suppressed Plasmas

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Long wavelength turbulence increases dramatically in the outer regions of DIII-D plasmas with the application of radial resonant magnetic field perturbations (RMP) to suppress edge-localized modes (ELMs). Correspondingly, transport increases and global energy confinement decreases in these low collisionality RMP-ELM suppressed discharges. This process is evident through a sharp reduction in core and pedestal density, while ion and electron temperatures may change only slightly. Low wavenumber density turbulence (k_perp rho_i<1) in the range of 60-300 kHz, measured with beam emission spectroscopy (BES), is modified and generally increases throughout the outer region (0.6< rho<1.0) of the plasma in response to RMPs over a range of q_95 values; ELM suppression, in contrast, occurs for a narrower range in q_95. This turbulence has radial and poloidal correlation lengths on the scale of a few cm. Radial magnetic field modulation experiments indicate that these turbulence modifications occur on a time scale of a few milliseconds or less near rho=0.85-0.95, significantly faster than transport time-scales and faster than the local pressure gradients and shearing rates evolve at these locations. As the internal coil current is varied from 3.2 to 4.2 kA, the turbulence magnitude varies in phase by 30% or more, while local density changes by only a few percent. This dynamical behavior suggests that the turbulence is directly affected by the RMP, which may partially or largely explain the resulting increased transport and stabilization of the pedestal against peeling-ballooning instabilities that are thought to drive ELMs. Zonal flow damping by the RMP is a mechanism being investigated as a potential causal agent. Understanding this transport process will be crucial to extrapolating and optimizing the RMP ELM-suppression technique in ITER.

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