Scaling of Turbulence and Transport with Toroidal Mach Number

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Turbulence characteristics have been measured as a function of the toroidal Mach number ($M=v_{tor}/c_s$) in L-mode and H-mode discharges on DIII-D using the recently upgraded, wider-field, high-sensitivity Beam Emission Spectroscopy system. These characteristics include turbulence amplitude, spectral distribution, radial and poloidal correlation lengths, and poloidal velocity. Fluctuation measurements were obtained along the outboard midplane from $0.4 < r/a < 1.0$ during a series of repeated discharges. The toroidal Mach number is varied utilizing the recently implemented counter neutral beam injection capability on DIII-D. Other relevant dimensionless parameters (ρ^*, q, T_e/T_i, β, ν^*, κ) are maintained nearly constant during this rotation scan. Plasmas with rotation in the co-current direction are obtained with 5 MW of co-injection neutral beams, resulting in a core Mach number of M=0.5 in L-mode. These plasmas are compared to balanced-injection discharges with otherwise similar parameters. In L-mode plasmas, the turbulence characteristics are similar in the two Mach number conditions investigated, except for a clear and expected variation in Doppler-shifted frequency spectrum. The poloidal advection velocity of the turbulence is measured and shown to compare well with the independently measured ExB velocity. Energy confinement in the L-mode discharges varies little with the change in Mach number, while the energy confinement in H-mode increases approximately 30% with the increasing Mach number, consistent with increasing ExB shearing. Details of the turbulence characteristics and transport parameter dependence on Mach number in L and H-modes will be presented.

*Supported by U.S. DOE under DE-FG02-89ER53296 and DE-FC02-04ER54698.