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Assessing low wavenumber pedestal turbulence in NSTX with measurements and simulations[1]

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Global confinement predictions depend upon the validation of pedestal turbulence models. Spherical torus (ST) edge turbulence simulations are among the most challenging turbulence simulations, so here we present an assessment of low-k pedestal turbulence ($k_\theta \rho_i < 1.5$, $0.8 < r/a < 0.95$) with multi-point beam emission spectroscopy (BES) measurements during ELM-free, MHD quiescent H-mode phases in NSTX. BES measurements show broadband turbulence up to 100 kHz with poloidal wavenumber $k_\theta \rho_i \sim 0.2$, poloidal correlation length $L_p/\rho_i \sim 10$, and decorrelation time $\tau_d/(a/c_s) \sim 5$. The dimensionless turbulence parameters are largely consistent with drift-wave turbulence models and previous measurements of tokamak L-mode core turbulence. Parametric dependencies among turbulence quantities and transport-relevant plasma parameters (density and temperature gradients, collisionality, etc) are most consistent with transport driven by trapped-electron mode, kinetic ballooning mode, and microtearing mode turbulence, and least consistent with ion temperature gradient turbulence. Also, the parametric dependencies are consistent with turbulence regulation by equilibrium flow shear and collisional damping of zonal flows. Finally, the dependencies indicate a connection between taller, wider pedestals and larger turbulent structures. The measurements and parametric dependencies broadly characterize low-k pedestal turbulence in high-performance spherical torus plasmas and establish validation benchmarks for pedestal and edge simulations. Additional results cover edge turbulence measurements and parametric dependencies before and after the LH transition, and initial gyrokinetic and fluid simulations of NSTX pedestal turbulence.

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