# Control of Fluctuations in the GAMMA-10 by Sheared Flow

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## Abstract

Using two-dimensional nonlinear numerical simulations and theoretical models, we investigate transport properties of the GAMMA-10 experiment at Tsukuba University, Japan. The GAMMA-10 team has shown experimentally that a sheared radial electric field $E_r$ reduces low frequency drift wave fluctuations, thereby qualitatively changing the fluctuation spectrum (T. Cho, *et al.Phys. Rev. Lett.* **97**, 055001 (2006)). Microchannel plate tomography (MCP) produces microsecond time-resolved images of the soft X-ray emission proportional to the square of the electron pressure. This diagnostic agrees with the theoretical expectations (J-H Kim, *et al., Phys. Plasmas* **13**, 062304 (2006)) for the growth and decay of vortices in the rapidly rotating, sheared $E \times B$ flow of the plasma in the GAMMA-10's 6 meter central cell. Nonlinear simulations demonstrate that an unstable trapped electron mode with maximum growth rate in the range of the azimuthal mode number $m = 6$ (corresponding to $k_y \rho_s = 0.6$) produces a fast inverse cascade of fluctuation energy; this results in a nonlinear state dominated by vortices with $m = 1$ and 2 energy components. Vortices in the strongly sheared flow are intermittent, as discussed by Kim *et al.* Simulation visualizations differ qualitatively from the MCP snapshots of the vortex structures. GAMMA-10 experiments are performed using a steady state hydrogen plasma with $n = 3 \cdot 10^{18}/\text{m}^3$, on-axis electron temperature $T_e = 750$ eV, and a uniform axial magnetic field $B_z = 0.41$ T. The ion temperature is anisotropic: $T_{i,\perp} = 6.5$ keV and $T_{i,||} = 2.5$ keV; therefore the ITG mode in the slab limit is weak compared with the case of isotropic ion temperatures. The effects of the quadrupole anchor cells, which are rotating in the frame of reference of the plasma, are discussed.

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