Measurements of bicoherence and long-range correlations during biasing in the HSX stellarator

R. S. Wilcox[1], B.Ph. van Milligen[2], C. Hidalgo[2], D.T. Anderson[1], J.N. Talmadge[1], F.S.B. Anderson[1], M. Ramisch[3]

1 HSX Plasma Laboratory, University of Wisconsin–Madison, Madison, Wisconsin 53706, USA

2 Asociación EURATOM-CIEMAT, Avda. Complutense 22, 28040 Madrid, Spain

3 Institut für Plasmaforschung, Universität Stuttgart, D-70569 Stuttgart, Germany

Fluctuation measurements have been made using Langmuir probes in the edge of plasmas in the HSX stellarator during biasing experiments to investigate the role of quasi-symmetry in zonal flow formation. The residual zonal flow response is predicted to be larger in magnetic configurations that minimize neoclassical ripple transport, such as quasi-symmetric stellarators. When a bias probe is inserted into the plasma and energized, long-range correlations of floating potential signals are measured between two toroidally separated Langmuir probe tips. The phase of low frequency potential fluctuations between the two probes goes to zero, and the coherence of these fluctuations rises significantly over a large radial region during biasing. This behavior would be expected in the presence of zonal flows, and is consistent with similar measurements in other devices. Simultaneously, the bicoherence of E_θ fluctuations is measured using two pins on a single probe. Bicoherence indicative of broadband 3-wave coupling is measured during biasing, which is consistent with similar measurements from biased discharges in TJ-II. This is distinct from the bicoherence measured during spontaneous L-H transitions at TJ-II, where the levels of significant bicoherence are confined to frequencies that sum nearly to zero, suggesting a direct drive to the zero-frequency zonal flow. Comparative measurements have been made in HSX between experiments in both an optimized quasi-symmetric magnetic configuration (QHS) and in a configuration with the symmetry intentionally degraded (Mirror). No significant differences are observed in the bicoherence or long-range correlation measurements when the magnetic configuration is changed.