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Transport and fluctuations in high temperature spheromak plasmas

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A systematic analysis is presented of thermal transport in a driven spheromak that extends well into the collisionless regime and spans a wide range of magnetic fluctuation levels. The relationship between internal fluctuations and energy/helicity transport is of fundamental interest to many self-organized configurations in laboratory and space plasmas and the subject of ongoing multi-institutional collaborations. With the recent achievement on the SSPX spheromak[1] of electron temperature $T_e \sim 350eV$ in the core, and good confinement (core electron thermal diffusivity $\chi_e < 10m^2/\,\mathrm{sec}$ for $T_e > 200eV$), we are now comparing heat transport in the experiment with a variety of models including classical, Bohm, and stochastic[2]/diffusive[3]/open[4] field lines. Using Thomson scattering to measure T_e, n_e profiles and the CORSICA equilibrium code to calculate internal current profiles from magnetic probe fits, we find that χ_e decreases as T_e increases, a scaling behavior more classical-like than Bohm or open field line models would indicate. Lower T_e and higher χ_e is observed in the transition region between the core and the separatrix where NIMROD 3d resistive MHD calculations[5] show the possible existence of chaotic field lines. We will also discuss plans including multi-pulse Thomson scattering and neutral beam heating. [1] E.B. Hooper, et al., Nucl. Fusion 39, 863 (1999). [2] A.B. Rechester and M.N. Rosenbluth, Phys. Rev. Lett. 40, 38 (1978). [3] J.D. Callen, Phys. Rev. Lett. 94, 055002 (2005). [4] R.W. Moses, et al., Phys. Plasmas 8, 4839 (2001). [5] B.I. Cohen, et al., Phys. Plasmas 12, 056106 (2005). This work was performed under the auspices of the U.S. Department of Energy by the University of California Lawrence Livermore National Laboratory under Contract No. W-7405-Eng-48.