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Fluctuation driven EMFs in the Madison Dynamo Experiment

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The Madison Dynamo Experiment is a 1 m diameter sphere filled with liquid Sodium designed to study MHD in a simply connected geometry. Two impellers drive a two-vortex flow, based on the calculations of Dudley and James, intended to excite system-scale dynamo instability. We present a collection of results from experiments measuring hydrodynamic fluctuations and their MHD effects. An equatorial baffle was added to the experiment in order to diminish the large-eddy hydrodynamic fluctuations by stabilizing the shear layer between the two counter-rotating flow cells. The change in the fluctuation levels was inferred from the change in the spatial spectrum of the induced magnetic field. This reduction correlated with a 2.4 times increase in the induced toroidal magnetic field (a proxy measure of the effective resistivity). Furthermore, the local velocity fluctuations were directly measured by the addition of a 3-d emf probe (a strong permanent magnet inserted into the flow with electrical leads to measure the induced voltage, and magnetic probes to determine the magnetic fluctuations). The measured emfs are consistent with the enhanced magnetic diffusivity interpretation of mean-field MHD.