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Initial results from the Madison Dynamo Experiment[1]

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The Madison dynamo experiment is designed to self-generate magnetic fields from flows of conducting metal in a simply connected spherical geometry. This talk will present initial results from the experiment since commencement of operations in August of 2004. Thus far, the experiment has been operated at 60% of its design specifications achieving magnetic Reynolds numbers of 130, based on propellor tip speed. The technical operation of the experiment has been demonstrated (i.e., transfers of liquid sodium, rotating seals, etc). The experimental approach to understanding the electromagnetic properties of the sodium involves comparisons between experimental measurements of the magnetic field in the sodium experiment, measurements of the velocity field in a dimensionally identical water experiment, and predictive MHD codes that model the currents induced in the turbulent flows by externally applied fields. Initial results include: direct observation of an ω effect, the production of a toroidal magnetic field from a poloidal magnetic field; the expulsion of poloidal flux by vortical fluid motion; measurement of gain for the expected dynamo eignenmode; and measurement of the turbulent shredding of a large scale magnetic field by small scale turbulence, as determined from a spatial array of magnetic probes generating mode number spectra. As background, the theoretical basis for the experiment and hydromagnetic modeling results will be reviewed, including results from recent 3D MHD computation of the backreaction and the role of turbulence on self-excitation. An interesting implication of the simulations is that one role of the turbulence is to increase the critical magnetic Reynolds number for self-excitation, a result consistent with an increased resistivity due to the turbulence, as in the beta effect. Future plans will be discussed, including the strategy observing self-excitation.

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