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A spherical Couette experiment to observe inductionless MHD instabilities at medium Reynolds numbers

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A long, albeit contentiously, discussed result of magnetized spherical Couette flow was the observation of an angular momentum transporting, magnetically induced instability in a turbulent (Re $\approx 10^7$) liquid metal flow, which was described in [1] as the long sought-after Magnetorotational Instability (MRI). In contrast to the MRI as usually described, this instability was non-axisymmetric and demonstrated an equatorial symmetry whose parity depended on the strength of the applied magnetic field. Subsequent numerical investigations [2,3] turned up a collection of induction-free instabilities—related to the hydrodynamic jet instability, the Kelvin-Helmholtz-like Shercliff instability, and a return flow instability—that replicated the parity properties, as well as the torque on the outer sphere (the proxy measurement of angular momentum transport). A more modestly scaled (Re $< 10^5$), but more comprehensively diagnosed (Ultrasonic Doppler Velocimetry (UDV), electric potential measurements), spherical Couette experiment is being carried out at the Helmholtz-Zentrum Dresden-Rossendorf in order to better characterize these instabilities, their criteria, and their saturation. Presented are initial data from the experiment, as well as some phenomenology of the saturation and bifurcation of the instabilities via nonlinear transfer of energy between azimuthal modes as revealed by the numerical simulations.

[1] Sisan, D., et al. , Phys. Rev. Lett., 93, 114502 (2004)
[2] Hollerbach, R., Proc. Roy. Soc. A 465, 2003-2013 (2009)
[3] Gissinger. C., et al, Phys. Rev. E, 84, 026308 (2011)