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A coherent liquid-sodium dynamo to understand the magneto-hydrodynamic amplification of magnetic fields RICHARD SONNENFELD, JIAHE SI, New Mexico Tech Physics Dept., STIRLING COLGATE, Retired, ARTHUR COLGATE, JOE MARTINIC, New Mexico Tech Physics Dept., MARK NORNBERG, University of Wisconsin – Madison — Accretion disks of plasma create currents responsible for the huge magnetic fields of active galactic nuclei. Circulating iron creates Earth's magnetic field. The question of how small "seed" magnetic fields in conducting fluids/plasmas are amplified by factors of tens to millions is called the "dynamo problem." We have simulated the differential rotation of accretion disks with a "plasma" consisting of 125 liters of liquid sodium metal constrained between co-rotating cylinders which produce Taylor-Couette flow at Reynolds numbers up to 10^7. Given a radial seed field of 10 G, our apparatus converted mechanical to magnetic energy to produce an 80-G toroidal field. This effect (called the ω-effect) is predicted in dynamo theory, but our experiment showed, in 2011, the largest gain obtained by any experiment in the world. We attribute this success to the largely coherent flow field in the instrument. We are now studying the β-effect, in which fluid turbulence dissipates magnetic energy by increasing the effective resistivity of the fluid. The β-effect is studied by applying an external B-field pulse and observing its penetration into the liquid sodium flows vs time for varying rates of rotation and levels of turbulence.

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