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Dynamos in the Lab and Implications for Planetary Magnetism

C.B. Forest
United States (cbforest@wisc.edu)

Observation and simulation are the main tools by which planetary dynamos are now studied. Both have serious limitations, for example observations often can't measure key parameters, and simulations are unable to resolve all relevant scales required to match astrophysical dynamos. Dynamo experiments, on the other hand, can be complementary to observation and simulation. Liquid metal experiments can operate with Reynolds numbers (both magnetic and fluid) comparable to liquid metals cores in regimes inaccessible by simulation, but can allow measurements of flows and magnetic fields in their cores. I will highlight recent measurements of $\tilde{v}$ and $\tilde{b}$ in the core of the Madison liquid sodium experiment. This has allowed the turbulent EMF $\left\langle \tilde{v} \times \tilde{b} \right\rangle$ to be directly measured and identified as a turbulent resistivity. Its implications for simulations of planetary dynamos may be significant. Recent experiments on a new approach using plasmas (rather than liquid metals) have now shown that unmagnetized plasma can be stirred, which shows a path towards plasma dynamo experiments which can operate at much higher magnetic Reynolds numbers (well above critical, and therefore closer to natural dynamos) but also much larger magnetic Prandtl numbers (Rm/Re). Interestingly, the plasma dynamos can be fully resolved by simulations offering a new complementarity. A large new plasma dynamo experiment has been constructed and is nearly operational; prospects for new lessons from plasmas will be presented.