Magnetic fields in the Cosmos: how laser-driven experiments can shed light on turbulent dynamo

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The ubiquitous nature of cosmical magnetic fields is revealed by diffuse radio-synchrotron emission and Faraday rotation observations. The energy density of these fields is typically comparable to the energy density of the fluid motions of the plasma in which they are embedded, making magnetic fields essential players in the dynamics of observable matter in the Universe. The standard model for the origin of intergalactic magnetic fields is through the amplification of seed fields via turbulent dynamo to the level consistent with current observations. We have conceived and conducted a series of high-power laser experiments at Omega and NIF to study the dynamo amplification of magnetic fields. The properties of the fluid and the magnetic field turbulence are characterized using a comprehensive suite of plasma and magnetic field diagnostics. In this talk, we describe the large-scale 3D simulations we performed with the radiation-MHD code FLASH on ANL's Mira to help design and interpret the experiments. We then discuss the results of the experiments we carried out at the Nation's largest laser facilities, which indicate that magnetic Reynolds numbers above the expected dynamo threshold are achieved and seed magnetic fields, produced by the Biermann battery mechanism, are amplified by turbulent dynamo.