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3D MHD simulation of Caltech plasma jet experiment: First results[1]

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We present a 3D ideal MHD simulation of the Caltech plasma jet experiment. The simulation uses the 3D adaptive mesh refinement code AMR3d previously developed by H. Li and S. Li (LANL) for simulating magnetically driven astrophysical jets. The simulation involves injection of toroidal magnetic flux continuously into the plasma thereby increasing the magnetic energy and helicity. This flux injection is equivalent to the anode-cathode voltage drop in the experiment. In both the simulation and the experiment, the Lorentz force is observed to squeeze the plasma radially and lengthen it axially to form a jet. With suitably chosen parameters, the jet in the simulation agrees quantitatively with the experimental jet in magnetic/kinetic/inertial energy, total poloidal current, voltage, jet radius, and jet propagation velocity. Specifically, the jet velocity in the simulation is proportional to the poloidal current divided by the square root of the jet density, in agreement with both the experiment and analytical theory. This confirms that the jet gains its kinetic energy via the Lorentz force. Imposition of a small non-axisymmetric perturbation causes the jet in the simulation to a kink, but so far this kinking is only qualitatively similar to the experimentally observed kink.

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