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Theoretical foundation of Madison Plasma Dynamo Experiment[1]

IVAN KHALZOV, CARY FOREST, University of Wisconsin-Madison, MPDX TEAM — The Madison Plasma Dynamo Experiment (MPDX) has successfully started its operational phase. The primary goal of the MPDX is to investigate the dynamo – magnetic field self-generation and sustainment in hot, unmagnetized, fast flowing plasmas. This is achieved by combining a multicusp confinement technique with a novel method of driving plasma flows at the vessel boundary. We present a detailed numerical study of plasma confinement by the multicusp field and dynamo generation by boundary driven spherical plasma flows in a model of MPDX. In the dynamo study, we first consider the class of steady, axisymmetric, counter-rotating flows inside an insulating sphere and optimize them to obtain the lowest critical magnetic Reynolds number Rm_{cr} required for dynamo excitation. Second, we investigate the influence of magnetic boundary conditions (resistive and ferritic walls) on the dynamo action for this class of flows. Third, we consider the dynamos generated by three-dimensional steady flows enclosed in a perfectly conducting sphere. Finally, we present results for the so-called "fast" dynamos, which are obtained with time-periodic axisymmetric boundary-driven flows. Based on these results we describe possible scenarios for experimental demonstration of dynamo action in MPDX.

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