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Fast Ion Confinement in the MST Reversed Field Pinch[1]

GENNADY FIKSEL[2], Department of Physics, University of Wisconsin-Madison and Center for Self-Organisation in Laboratory and Astrophysical Plasmas, USA

The influence of magnetic fluctuations and consequent magnetic stochasticity on transport and confinement of fast ions is important for fusion plasmas as well as for astrophysical situations. In fusion plasmas it affects the feasibility of neutral atom injection as a means to heat the plasma and will determine the confinement of fusion produced alpha-particles during magnetic reconnection. For astrophysical plasmas, energetic particle transport in stochastic fields can be important in thermal conduction in galaxy-cluster plasmas and cosmic ray propagation. We use the reversed field pinch laboratory plasma to measure transport of fast particles in a stochastic magnetic field. The standard RFP plasma contains a stochastic magnetic field which becomes particularly ergodic during reconnection events. We measure the confinement of fast ions generated by injection of energetic neutral atoms. The confinement is determined through detection of neutrons from the fusion reaction between the beam-produced deuterium ions and the background deuterium plasma. The results indicate that even for a level of magnetic fluctuations at which the magnetic field is stochastic the fast ions energy loss is consistent with the classical slowing down rate and their confinement time is at least 20 ms. This is much longer than expected (1 ms) from the simple picture of the ions streaming along the stochastic magnetic field. However, a several-fold increase in the magnetic stochasticity, as observed during reconnection events in MST, can significantly deteriorate the ion confinement These observation are in agreement with numerical simulation of ion trajectories as well as with analysis of the overlapping of islands in the ion guiding center trajectories.

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