DPP09-2009-000044

Abstract for an Invited Paper
for the DPP09 Meeting of
the American Physical Society

Investigation of ion heating due to reconnection in the MST reversed-field pinch[1]

GENNADY FIKSEL, University of Wisconsin-Madison and Center for Magnetic Self-Organization in Laboratory and Astrophysical Plasmas

Anomalous ion heating in laboratory and astrophysical plasmas is not well understood. In the Madison Symmetric Torus (MST) reversed-field pinch experiment, ions are heated rapidly during impulsive reconnection, attaining temperatures exceeding hundreds of eV, often well in excess of the electron temperature. The energy source for this heating is the equilibrium magnetic field energy released during reconnection, but the means by which magnetic energy is converted to ion thermal energy has not yet been established. The results and diagnostic techniques reported here aim to test several distinct theoretical models that could describe the energy conversion is both laboratory and space plasmas: viscous damping of tearing flows, ion cyclotron heating, and stochastic heating. Neutral-beam-based diagnostics are used for ion temperature measurements. Rutherford scattering monitors the majority ions, while charge-exchange- recombination spectroscopy monitors the minority ions. The high spatial (several centimeters) and temporal (tens of microseconds) resolution of these diagnostics allows for detailed comparison of the dynamics of the ion heating with theoretical predictions. The energy budget of the ion heating and its mass scaling in hydrogen, deuterium, and helium plasmas was determined by measuring the fraction of the released magnetic energy converted to ion thermal energy. The fraction ranges from about 10-30% and increases approximately as the square root of the ion mass. Ion heating increasing with ion mass agrees with observations in other laboratory experiments as well as in the solar corona. In addition, a recent upgrade of the charge-exchange diagnostic now allows simultaneous measurement of the perpendicular and parallel ion temperature, facilitating still further discrimination among the proposed heating mechanisms.

[1]Work supported by the USDOE and NSF.