Laboratory Study of Physics of Magnetic Reconnection

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Many important elementary processes in space and astrophysical plasmas can be studies in laboratory. Critical ideas and theories can be tested in the dedicated and controlled experiments. One such example will be described in this presentation on the topic of magnetic reconnection.

Magnetic reconnection is believed to play essential roles in coronal activities of stars and accretion disks, magnetospheric disturbances, and relaxation phenomena in laboratory plasmas. The concept of magnetic reconnection was introduced more than 50 years ago in order to explain solar flares. Sweet and Parker developed a theoretical model in two-dimensional magnetohydrodynamics (MHD), but its predicted reconnection rates are too slow to explain solar observations. Later, Petschek proposed an alternative model with slow shocks and a much smaller reconnection layer. Petschek's theory predicts faster reconnection rates, but it has been challenged by recent simulations. These important physics issues are also being addressed by dedicated laboratory experiments, such as MRX (Magnetic Reconnection Experiment) in Princeton. It has been found that the measured reconnection rates agree excellently with a generalized Sweet-Parker theory in which, at low collisionality, the resistivity is much larger than the classical Spitzer value. Other important findings include strong non-classical ion heating and observations of lower-hybrid fluctuations. We will discuss how these experimental results may shed light on reconnection in astrophysical plasmas.

References:

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