Plasma Emission Spectroscopy When There Is Magnetic Reconnection Associated with Rayleigh-Taylor Instability in the Caltech Spheromak Jet Experiment

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The Caltech spheromak jet experiment produces plasma-filled, twisted open magnetic flux tubes relevant to solar coronal loops, astrophysical jets, spheromaks, and open field lines in tokamaks. Since the experiment started, several interesting phenomena have been observed and identified: i) flow-driven collimation of the jet [1], ii) ideal MHD kink instability [2], and iii) kink-induced, magnetic Rayleigh-Taylor instability [3]. Recently, fast magnetic reconnection associated with Rayleigh-Taylor instability has been speculated to occur in the experiment [3] and since then, we have intensively studied magnetic reconnection using comprehensive diagnostics such as a high resolution spectroscopic system, a high speed extreme ultra-violet (EUV) movie camera, and a high frequency B-dot probe [4].

In this presentation, we will show spectroscopic data and their analysis including spectral line intensity ratios and Doppler and Stark broadenings that are used to determine the electron and ion temperatures of a plasma jet; analysis reveals that both the electron and ion temperatures increase as magnetic reconnection occurs. In addition, a spatially localized energetic EUV burst is imaged at the presumed position of fast magnetic reconnection in a plasma jet; this EUV burst also indicates strong localized electron heating. We will discuss that the electron heating is consistent with Ohmic dissipation while the ion heating is consistent with ion trajectories becoming stochastic.

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