Japan Geoscience Union Meeting 2010
(May 23-28 2010 at Makuhari, Chiba, Japan)

PEM029-07 Room: 303 Time: May 25 10:45-10:58

Hinode observations of magnetic reconnection events accompanied by plasma ejections in the solar chromosphere

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Hinode's solar optical telescope (SOT) observations have revealed for the first time that the chromosphere is full of explosive phenomena with large variety of magnitude and morphology, which view is beyond our previous knowledge. Microflares accompanied by plasma ejections, such as X-ray jets and chromospheric surges, were well studied with previous observations including Yohkoh soft X-ray observations and ground-based observations, strongly suggesting that a new magnetic flux emerging from below the solar surface forms an anti-parallel field configuration with pre-existing field, resulting in magnetic reconnection between them. Hinode's high spatial resolution observations show that a completely anti-pallarelled field configuration is not necessary for magnetic reconnection; magnetic reconnection can be triggered if there are some tens of degree separation in angle between the magnetic fields, which may be referred as component reconnection. One of such examples is penumbral micro-jets (Katsukawa et al. 2007) discovered as intermittent occurrences of tiny chromospheric jets from horizontally oriented flute field structures in the sunspot penumbrae. Moreover, Hinode captured a sunspot light bridge which produced chromospheric plasma ejections intermittently and recurrently for almost two days (Shimizu et al. 2009). Sunspot light bridges are one of fundamental structures in sunspots and may be responsible for disintegration of sunspot magnetic flux in decaying phase. The observations suggest that current-carrying highly-twisted magnetic flux tubes are trapped below a cusp-shaped magnetic structure of the umbra along the light bridge. The field of the trapped twisted flux tubes has a 90 degree separation from the almost vertically oriented umbral fields. The poloidal component of the twisted tube is anti-parallel to the umbral field at one side, which is preferable for magnetic reconnection. This light bridge was observed for almost 4 days and we investigated temporal evolution of magnetic field parameters with changing behavior of chromospheric ejections and footpoint brightenings (heating). Frequent ejections were observed for the first two days and less number of ejections was observed in the latter period. The observed properties suggested that the amount of twist may easily change the observed hehavior of plasma ejections. We should note that the magnetic field configuration estimated at the light bridge is quite similar to the magnetic field configuration proposed for explaining flux transfer events (FTEs), which are magnetic reconnection events at the day side of the earth's magnetoshere. Their similarity will be briefly discussed for establishing further studies on comparison between light bridge events and FTEs.

Keywords: The Sun, magnetic reconnection, magnetic field, plasma ejection