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High Spatio-temporal Resolution Observations of Flux Emergence and its associated Eruptions

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Magnetic flux emergence is one of important drivers of vigorous solar eruptions in various scales from small scale Hα surges to large scale Coronal mass ejections. Using the Goode Solar Telescope (GST), we studied flux emergence of sub-granular scale in solar active regions and its influences to upper atmospheric change.

The GST in the Big Bear Solar Observatory made it possible to clearly observe the photospheric signatures of flux emergence with very high spatial (0".11 at 7057 Å) and temporal (15 s) resolution. TiO observations with the pixel scale of 0".0375 showed several elongated granule-like features (GLFs) that consist of fine threads and show diverging flow along their longer axis with the speed of 4 kms^{-1}. Figure 1 shows the GST/TiO photospheric intensity maps and SDO/HMI line-of-sight magnetograms. HMI magnetogram revealed that this GLF is a photospheric indicator of emerging flux, specifically emerging horizontal field[1]. Figure 2 shows another observation of TiO GLFs formed at the vicinity of an active region (left) and SDO/HMI inclination map (right). Inclination angle near 90° indicates that emerging magnetic field in GLFs region is highly horizontal[2].

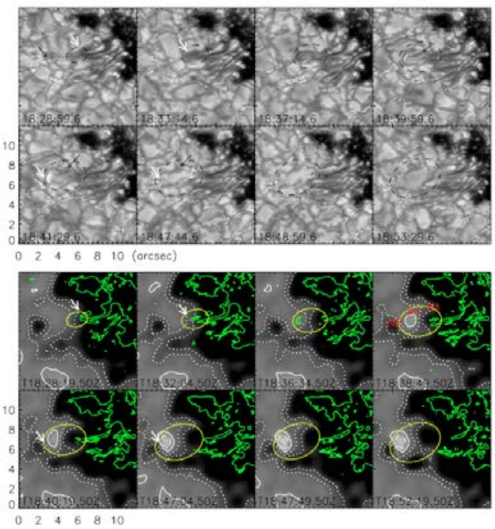

Figure 1. Top: time series of TiO observations taken on 2010 Sep. 27. Black dashed ovals indicate the GLF of interest. Bottom: line-of-sight SDO/HMI

As shown in Figure 3, the formation of GLFs as a proxy of flux emergence are often related to ejections of Hα jets with brightenings, and eruptions of successive flares in active regions. Figure 3 shows the Hα jet ejecting from the region of Figure 2. We found that the negative magnetic flux have been gradually increased in the positive magnetic polarity region, thus resulting in a series of jet ejections with C-class flares as shown in Figure 3. Finally, M3.8 flare occurred in the region with a CME eruption.

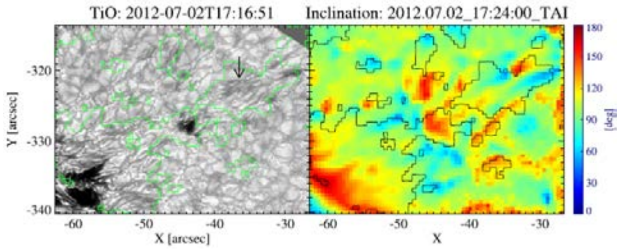

Figure 2. TiO image showing GLFs (left) and the distribution of the inclination angle obtained from the SDO/HMI vector magnetogram (right).

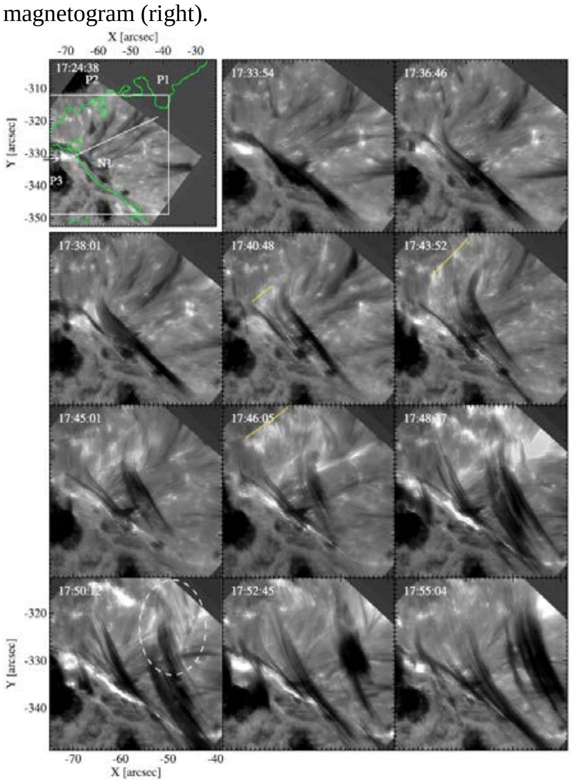

Figure 3. GST/Hα -0.7Å images for the C3.7 flare. A green curve represents the PIL.

These observations indicate that the continuous emergence of magnetic field plays an important role in formation of active region sub structures and driving eruptions of successive jets and flares.

References

[1] E.-K. Lim et al., ApJ, 740, 82 (2011)
[2] E.-K. Lim et al., ApJ, 817, 39 (2016)