Unresolved Mixed Polarity Magnetic Fields at Flux Cancellation Site in Solar Photosphere at 0″.3 Spatial Resolution

KUBO, Masahito (NAOJ)
LOW, Boon Chye, LITES, Bruce W. (High Altitude Observatory)

Mutual disappearance of opposite-polarity magnetic elements from the solar surface following their apparent "collisions" are often observed in line-of-sight magnetograms. This phenomenon is called "magnetic flux cancellation". The study of magnetic flux cancellation is important for understanding the nature of the flux removal process from the solar surface layers. Five flux cancellation events at granular scales were investigated with the vector magnetic field measurements at high spatial resoluiton by *Hinode* spectropolarimeter, and the horizontal magnetic fields between the canceling opposite-polarity magnetic elements were detected in only one event that takes place in a small emerging flux region [1]. This finding is interesting since almost all theoretical scenarios proposed to explain photospheric flux cancellation expect an increase in the horizontal magnetic field between the canceling opposite-polarity magnetic elements.

We investigate circular polarization (Stokes V) profiles at the polarity inversion line (PIL) formed by canceling opposite-polarity magnetic elements (Figure 1) [2]. This cancellation event was located just outside an active region NOAA 10944 on 2007 March 2 and its temporal evolution was investigated in Ref [1]. The *Hinode* spectropolarimeter provides the Stokes profiles with a 0″.15 slit width and a 0″.16 pixel sampling along the slit. A highly asymmetric, strongly redshifted Stokes V profile in the Fe I 630.25 nm line is observed at the PIL (Figure 2*b*). The observed anomalous Stokes V profile is reproduced successfully by a simple summation of the nearly symmetric Stokes V profiles observed at pixels immediately adjacent to the PIL, as shown by the diamond symbols in Figure 2*b*. Similar results are obtained at the neighboring pixel along the PIL (Figure 2*d*) or obtained for Fe I 630.15 nm line. This result suggests that the anomalous Stokes V profiles observed at the PIL are not indications of a flux removal process, but are the result of a mixture of unresolved, opposite-polarity magnetic fields at an estimated resolution element of about 0″.3. The hitherto undetected flux removal process accounting for the larger-scale disappearance of magnetic elements during the observing period is likely to also fall below resolution.

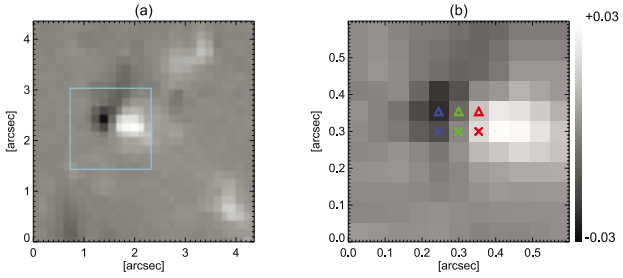

Figure 1: Total circular polarization map for the whole flux cancellation region (panel *a*), and for the canceling magnetic bipole (panel *b*). The solid box of panel *a* is identical to the field of view of panel *b*. The green symbols in panel *b* represent pixels at the polarity inversion line. The blue and red symbols represent pixels next to the polarity inversion line, and they have negative and positive magnetic polarity, respectively.

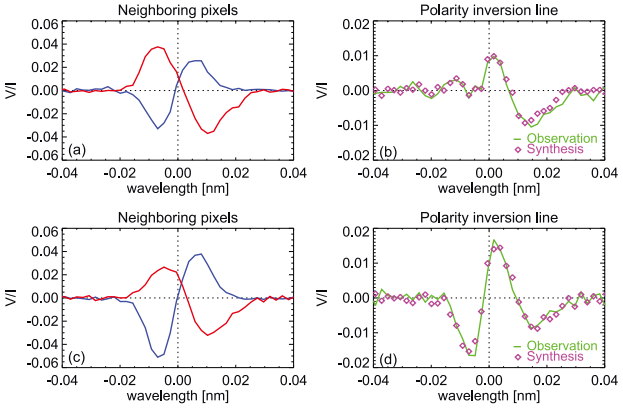

Figure 2: The red and blue solid lines in panel *a* and the green line in panel *b* represent the observed Stokes V profiles of the Fe I 630.25 nm line at pixels represented by red, blue, green cross symbols in panel *b* of Figure 1, respectively. The diamond symbols in panel *b* show the profile synthesized from the observed red and blue profiles in panel *a*. Panels *c* and *d* are same as their upper panels, but for the pixels represented by the triangle symbols in panel *b* of Figure 1. The vertical dotted line represents the averaged position of the line centers over the map.

References

[1] Kubo, M., et al.: 2010, *ApJ*, **712**, 1321.
[2] Kubo, M., et al.: 2014, *ApJ*, **793**, L9.