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Granular scale magnetic flux cancellations

M. Kubo, B. C. Low, and B. W. Lites

High Altitude Observatory, National Center for Atmospheric Research, P.O. Box 3000, Boulder, CO 80307, USA, e-mail: kubo@ucar.edu

Abstract. We summarize the evolution of granular-scale "magnetic-flux cancellation" as observed with Hinode/SOT. Further details and results of this work are given in Kubo et al. (2009).

Key words. Sun: granulation – Sun: magnetic fields – Sun: photosphere

1. Magnetic Flux Loss on the Sun

Opposite-polarity magnetic elements have been observed to disappear together from the photosphere after their collision. Such mutual flux loss is called "magnetic flux cancellation" as a descriptive term (Martin et al. 1985). The studies on the magnetic flux budget suggest that the flux cancellation is essential to the dissipation of photospheric magnetic flux in a quiet region (Schrijver et al. 1997) and in an active region (Kubo et al. 2008). Two different physical processes are usually proposed to explain the flux cancellation (Zwaan 1987). One is a submerging Ω-loop across the photosphere, and another is a emerging U-loop. In both cases, the cancelling opposite-polarity magnetic elements disappear when the cusps of such loops pass through the photospheric layer. An important observable signature for understanding flux cancellation is the motion of a horizontal magnetic field connecting the cancelling magnetic elements. Spectropolarimetric measurements at high spatial resolution are necessary to catch the horizontal magnetic fields actually produced by the flux cancellation process. We have investigated the evolution of five cancellation events just outside the moat region of a sunspot as observed with the Solar Optical Telescope (SOT, Tsuneta et al. 2008) aboard Hinode (Kosugi et al. 2007). Hinode/SOT obtained a time series of G-band images and spectropolarimetric maps in full resolution mode. We examine photospheric vector magnetic fields, Doppler velocities, and surface flows at the cancellation sites from this data set. For the understanding the elementary process of the magnetic flux cancellation, we have selected granular-scale cancellation events, and avoided the complicated magnetic field configurations as observed in active regions.

Our observed opposite-polarity magnetic elements approach an intergranular junction which has strong red shifts and surface converging flows. These approaching magnetic elements then collide with each other . We find that a horizontal magnetic field is not observed between the opposite-polarity magnetic elements in four of the five events at any time as they approach and cancel each other. These events are interesting because in the usual idea of the submergence of an Ω-loop

Send offprint requests to: M. Kubo

or the buoyant rise of a U-loop, the appearance of a horizontal field is the observational signature of the loop top (or bottom) passing through the photosphere. This means that we still observe only the approaching process of the opposite-polarity magnetic elements in the case of the flux cancellations without the horizontal field.The basic process of flux cancellation is not yet resolved even with the ~ 200 km spatial resolution of the SOT. Our observational results suggest that the unresolved flux cancellation takes place at the polarity inversion line within the area resolved by a single pixel of the SOT/SP.

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