Magnetic Field Properties of Flux Cancellation Sites

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Magnetic fields of the Sun successively emerge from below the photosphere. Previous authors compare a rate of magnetic flux emergence in a form of ephemeral regions with total magnetic flux on the entire solar surface, and they indicate that magnetic fields in the quiet region are replaced with emerging magnetic flux in the short period from several hours to several days. In addition to their emergence, removal of magnetic fields from the solar surface is an important issue. Possible mechanism related to the field removal is magnetic flux cancellation, in which one magnetic polarity element collides with another polarity element, followed by disappearance of the magnetic elements in the longitudinal magnetograms. Coronal activities are observed for the flux cancellation sites. Most of X-ray bright points, which are numerous compact X-ray emitting features located all over the latitude almost uniformly, are observed in the cancellation sites. Large flares and coronal mass ejections are associated with collisions of the large opposite polarity elements such as sunspots or plages.

We examine temporal change in magnetic fields and velocity fields for 12 collision events observed with the Advanced Stokes Polarimeter (ASP) to understand the physical process of the magnetic flux cancellation. The ASP measures the full Stokes spectral profiles with high accuracy in order to obtain three components of photospheric magnetic fields. We also study associated response in the corona with the Yohkoh/SXT and the TRACE. Dark filaments are observed in H-alpha line for the five collision events above the polarity inversion line in between the colliding opposite polarity elements.

We find formation of new magnetic connection between the colliding opposite polarity elements both in the photosphere and in the corona. In some cases, the opposite polarity elements to be collided appear at different time and widely separated positions. Magnetic fields horizontal to the solar surface are formed on the polarity inversion line in between such colliding elements, and transient bright X-ray loops connecting the opposite polarity elements appear. We suggest that formation of coronal loops and photospheric horizontal fields are due to magnetic reconnection between colliding field lines. We also find that the change of about 90 degrees in the direction of photospheric horizontal fields in between the colliding elements occurs in association with formation and disappearance of the dark filaments. Such relationship between magnetic fields in the photosphere and dark filaments in the low corona is important for understanding physical process of magnetic flux cancellation and formation process of dark filaments.