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Coronal condensations caused by magnetic reconnection between solar coronal loops

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Employing SDO/AIA multi-wavelength images, we report the coronal condensations during the magnetic reconnection (MR) between a system of open and closed coronal loops on 2012 January 19. Higher-lying open loops, observed in AIA 171 Å images, move downward and interact with the lower-lying closed loops, resulting in the formation of dips in the former. An X-type structure forms at the interface. The interacting loops reconnect and disappear. Two sets of newly reconnected loops then form. During the MR process, bright emission appears sequentially in the AIA 131 Å and 304 Å channels repeatedly in the dips of higher-lying open loops. This indicates the cooling and condensation process of hotter plasma from ~0.9 MK down to ~0.6 MK, and then to ~0.05 MK, also supported by the light curves of the AIA 171, 131, and 304 Å channels. Without support from underlying loops, the condensation then rains back to the surface along both legs of newly reconnected loops, and the leg of higher-lying open loops. Our results suggest that the MR between loops leads to the condensation of hotter coronal plasma and its downflows. MR thus plays an active role in the mass cycle of coronal plasma because it can initiate the catastrophic cooling and condensation. This underlies that the magnetic and thermal evolution has to be treated together and cannot be separated, even in the case of catastrophic cooling.

During the MR process, disturbances originating from the MR region propagate upward across the dip of higher-lying loops with the mean speed and mean speed amplitude of 200 km/s and 30 km/s, respectively. The mean speed of the propagating disturbances decreases from ~230 km/s to ~150 km/s during the condensation process, and then increases to ~220 km/s. This temporal evolution of the mean speed anti-correlates with the light curves of the AIA 131 and 304 Å channels that show the cooling and condensation process of coronal plasma. Furthermore, the propagating disturbances appear quasi-periodically with a peak period of 4 minutes. Our results suggest that the disturbances represent the quasi-periodic fast propagating magnetoacoustic waves originating from the MR between loops.

By investigating the loops over an extended period of time from January 16 to 20, we present a case of repeated condensations caused by repeated MR. In these five days, MR between higher-lying and lower-lying loops occurs repeatedly, forming dips in higher-lying loops. During the MR process, cooling and condensation of coronal plasma occur repeatedly. 15 condensation events occur in five days. 79 other similar events are identified in 2012 January at different times and different positions above the limb. We suggest that the formation of condensations by MR is common in the solar corona.

References

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