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Formation of solar quiescent coronal loops through magnetic reconnection in an emerging active region

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Coronal loops are building blocks of solar active regions. However, their formation mechanism is still not well understood. Here we present direct observational evidence for the formation of coronal loops through magnetic reconnection as new magnetic fluxes emerge into the solar atmosphere. Extreme-ultraviolet observations of the Atmospheric Imaging Assembly (AIA) onboard the Solar Dynamics Observatory (SDO) clearly show the newly formed loops following magnetic reconnection within a plasma sheet. Formation of the loops is also seen in the Hα line-core images taken by the New Vacuum Solar Telescope. Observations from the Helioseismic and Magnetic Imager onboard SDO show that a positive-polarity flux concentration moves towards a negative-polarity one with a speed of ~0.4 km/s before the formation of coronal loops. During the loop formation process, we found signatures of flux cancellation and subsequent enhancement of the transverse field between the two polarities. The three-dimensional magnetic field structure reconstructed through a magnetohydrostatic model shows field lines consistent with the loops in AIA images. Numerous bright blobs with an average width of 1.37 Mm appear intermittently in the plasma sheet and move upward with a projected velocity of ~114 km/s. The temperature, emission measure and density of these blobs are about 3 MK, 2.0×10^28 cm^−5 and 1.2×10^10 cm^−3, respectively. A power spectral analysis of these blobs indicates that the observed reconnection is likely not dominated by a turbulent process. We have also identified flows with a velocity of 20 to 50 km/s towards the footpoints of the newly formed coronal loops.

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