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Twist and Writhe of the Magnetic Flux in the Super Active Region NOAA 11429

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Abstract We used full-disk line-of-sight magnetograms taken by the *Helioseismic and Magnetic Imager* (HMI) onboard the *Solar Dynamics Observatory* (SDO) to study the variation of coronal magnetic helicity in the Active Region (AR) NOAA 11429, where several GOES M- and X-class flares and coronal mass ejections (CMEs) occurred. The magnetic flux, total magnetic-helicity flux, and helicity accumulation over the period of interest, *i.e.* 6 to 11 March 2012, were measured and are discussed. We also evaluated the tilt-angle evolution within the standard polarity flux-weighted centroids approach. The AR displays a shearing motion of the magnetic structures along the polarity inversion line, reaching values of about 1.0 km s^{-1}. The variations of magnetic helicity flux and the tilt-angle seem to be time-correlated, and both display three-phase evolutionary patterns. We also found that the flare/CME activity is higher during the first observation phase when the tilt-angle decreases and the negative magnetic helicity is accumulated. The main changes in the accumulated helicity curve are observed only after the onset of the two strongest flare/CME events. After the major event (GOES X5.4 class/CME of 7 March) there was a decrease in the occurrence of flares and CMEs. This phase is marked by a decrease of the flux of magnetic helicity from the convection zone to the corona and a change in the orientation of the tilt of the AR. This behavior suggests that the combination of these two quantities might be important in the description of the magnetic complexity accumulated by an AR during its lifetime.

Keywords Active regions · Magnetic fields, photosphere · Velocity fields, photosphere

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