through the process of structuring a coronal electric current in a twisted flux tube emerging to form a coronal magnetic structure. Interestingly, when a strongly twisted flux tube emerges, there spontaneously forms a structure inside the flux tube, where a coronal electric current changes flow pattern from field-aligned dominant to cross-field dominant. We demonstrate that this structure plays a key role in releasing free magnetic energy via rapid dissipation of a coronal electric current, thereby producing a flare.

[구 SS-03] Formation of a large-scale quasi-circular flare ribbon enclosing three-ribbon through two-step eruptive flares

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The formation process and the dynamical properties of a large-scale quasi-circular flare ribbon were investigated using the SDO AIA and HMI data along with data from RHESSI and SOT. Within one hour time interval, two subsequent M-class flares were detected from the NOAA 12371 that had a βγδ configuration with one bipolar sunspot group in the east and one unipolar spot in the west embedded in a decayed magnetic field. Earlier M2.0 flare was associated with a coronal loop eruption, and a two-ribbon structure formed within the bipolar sunspot group. On the other hand, the later M2.6 flare was associated with a halo CME, and a quasi-circular ribbon developed encircling the full active region. The observed quasi-circular ribbon was strikingly large in size spanning 650” in north-south and 500” in east-west direction. It showed the well-known sequential brightening in the clockwise direction during the decay phase of the M2.6 flare at the estimated speed of 160.7 km s-1. The quasi-circular ribbon also showed the radial expansion, especially in the southern part. Interestingly, at the time of the later M2.6 flare, the third flare ribbon parallel to the early two-ribbon structure also developed near the unipolar sunspot, then showed a typical separation in pair with the eastern most ribbon of the early two ribbons. The potential field reconstruction based on the PFSS model showed a fan shaped magnetic configuration including fan-like field lines stemming from the unipolar spot and fanning out toward the background decayed field. This large-scale fan-like field overarched full active region, and the footpoints of fan-like field lines were co-spatial with the observed quasi-circular ribbon. From the NLFF magnetic field reconstruction, we confirmed the existence of a twisted flux rope structure in the bipolar spot group before the first M2.0 flare. Hard X-ray emission signatures were detected at the site of twisted flux rope during the pre-flare phase of the M2.0 flare. Based on the analysis of both two-ribbon structure and quasi-circular ribbon, we suggest that a tether-cutting reconnection between sheared arcade overarching the twisted flux rope embedded in a fan-like magnetic field may have triggered the first M2.0 flare, then secondary M2.6 flare was introduced by the fan-spine reconnection because of the interaction between the expanding field and the nearby quasi-null and formed the observed large-scale quasi-circular flare ribbon.

[구 SS-04] Electrostatic upper-hybrid waves and energetic electrons in the Earth's radiation belt

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Electrostatic fluctuations near upper-hybrid frequency, which are sometimes accompanied by multiple-harmonic electron cyclotron frequency bands above and below the upper-hybrid frequency, are common occurrences in the Earth's radiation belt, as revealed through the twin Van Allen Probe spacecraft. In the literature upper-hybrid emissions are used for estimating the background electron density, which in turn can be used to determine the plasmapause locations, but the role of energetic electrons in generating such fluctuations has not been discussed. The present paper carries out detailed analyses of data from the Waves instrument, which is part of the Electric and Magnetic Field Instrument Suite and Integrated Science (EMFISIS) suite onboard the Van Allen Probes. Combined with theoretical calculation, it is demonstrated that the peak intensity associated with the upper-hybrid fluctuations is