Observation and Modeling of Flare-productive Active Regions

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Towards a better understanding of the origin of space-disturbing activity phenomena, it is crucially important to reveal the nature of flare-productive active regions (ARs). In this study, we first conduct a statistical investigation of all flare events (>M5.0 GOES class) for the whole six years from May 2010. The 51 flares under study are found to emanate from 29 ARs, which can be classified into four categories based on their formation processes, namely, (1) Spot-Spot, a complex AR with AR-sized magnetic neutral lines, (2) Spot-Satellite, in which a newly-emerging field appears next to the pre-existing sunspot, (3) Quadrupole, where two emerging fields collide against each other, and (4) Inter-AR, the flares occurring between two separated ARs. Then, we reproduce these four cases by conducting a series of 3D MHD simulations and find, for example, that the sheared magnetic neutral lines in these ARs are created through the stretching and advection of horizontal magnetic fields due to relative spot motions. As ARs develop, free magnetic energy becomes stored in the AR corona, which could be eventually released through flare eruptions. In the presentation, we also mention the relationship between the free energy stored in the corona and the magnetic parameters that are widely used for flare predictions, and discuss why these parameters successfully predict the flare events. [references: Toriumi et al. 2017, ApJ, 834, 56; Toriumi & Takasao 2017, ApJ, 850, 39]

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