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太陽活動領域：誕生から噴出まで
Solar Active Regions: From Birth to Eruption

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Solar-terrestrial environment is largely influenced by flares and CMEs sourced from the Sun. In particular, stronger events are known to be produced from solar active regions (ARs) including sunspots. Therefore, it is of great importance to understand the creation mechanism of ARs and their relationship with solar eruptions. Now it is widely accepted that ARs are caused by emerging magnetic flux, which is created by the dynamo effect in the convection zone. As a result of this flux emergence, several magnetic elements of the same polarity merge together at the solar surface and eventually form a single sunspot. Observations have revealed that large and complex ARs, the so-called delta sunspots, produce stronger flares. This may be because the free magnetic energy (or non-potentiality) is stored in such complex, sheared ARs with larger magnetic flux. Recent developments in the numerical modeling of flux emergence and flare eruptions open the door to further understanding of physical mechanisms behind such events. For example, our numerical simulations suggest that the flare-productive quadrupolar AR NOAA 11158, which is responsible for many X- and M-class flares, is produced from a single flux tube that is greatly disturbed in the convection zone during its emergence process. In this presentation, motivated by the above scientific curiosity, we review the observational and theoretical progress in the field of flux emergence, AR formation including delta-sunspots, and the resultant triggering of flare eruptions. After that, we discuss the future prospects.
Keywords: the Sun, active region, flux emergence, flare, MHD