

## Solar Sigmoidal Active Regions: From Formation to Eruption

The formation, evolution and eruption of solar active regions is a main theme in solar physics. Ultimately the goal is predicting when, where and how an eruption will occur, which will greatly aid space weather forecasting. S-shaped active regions (sigmoids) facilitate this line of research, since they provide conditions that are easier to disentangle and have a high probability for erupting as flares and/or coronal mass ejections. This talk explores the behaviour of solar sigmoids via both observational and magnetic modelling studies. Data from the most modern space-based solar observatories are utilized in addition to data-constrained magnetic field modelling to gain insight into the physical processes controlling the evolution and eruption of solar sigmoids. We use X-ray and spectroscopic observations and magnetic field models to introduce the underlying magnetic and plasma structure defining these regions. By means of a large comprehensive observational study we investigate the formation and evolution mechanism. Specifically, we show that flux cancellation is a major mechanism for flux rope formation and evolution. We make use of topological analysis to describe the magnetic field structure of the sigmoids. We show that when data-constrained models are used in sync with MHD simulations and observations we can arrive at a consistent picture of the scenario for CME onset, namely the positive feedback between reconnection at a generalized X-line and the torus instability. In addition we show that topological analysis is of great use in analysing the post-eruption flare- and CME-associated observational features. Such analysis is used to extend the standard 2D flare/CME models to 3D and to find potentially large implications of topology to understanding 3D reconnection and energetic particles production in flares.