Contributed Talk

Splinter HiRes

The new understanding of penumbral formation

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Fully-fledged penumbrae are a well characterised phenomenon from an observational point of view. Also, MHD simulations reproduce the observed characteristics and provide us with insights on the physical mechanisms possibly running behind the observed processes. Yet, how this penumbral magneto-convection sets in is still an open question. Due to the fact that penumbra formation is a relatively fast process (of the order of hours), it has eluded its observation with sufficient spatial resolution by both, space- and ground-based solar observatories. Only recently, some authors have witnessed the onset of both orphan and sunspot penumbrae in detail. We are one of those. In July 2009, we observed the early stages of the NOAA 11024 leading sunspot while developing its penumbra. The spectro-polarimetric dataset lead us to new observational findings. In this contribution, we put into context our and other authors? results to draw the overall picture of sunspot formation. Most important, the comparison on the properties of different types of penumbrae lead us to the conclusion that the formation of penumbrae is not just one mechanism. The sole cause necessary for penumbral magneto-convection is a stably inclined magnetic field. Observations show that inclined fields can be caused by flux emergence, to form orphan penumbrae, or by field lines dragged down from upper photospheric layers, to form sunspot penumbra. This conclusion, together with the recent finding by Jurcak et al. on a canonical value of the vertical component of the magnetic field blocking the action of penumbral magneto-convection in umbral areas, is a crucial step forward to our understanding on the coupling of solar plasmas and magnetic fields in penumbral atmospheres. We shall present all these new insights on penumbra magneto-convection.