Title: The Factors Determining the Eruptive Character of Large Solar Flares

Abstract:

Solar flares and coronal mass ejections (CMEs) are the most energetic phenomena in our solar system and are the dominant contributors to adverse space weather at Earth. Flares associated with a CME are usually referred to as eruptive events, while flares that are not accompanied by a CME are called confined or "CME-less" events. Based on the statistical results, we find that the total unsigned magnetic flux (Φ_{AR}) of active regions (ARs) is a key parameter governing the eruptive character of large flares, with the proportion of eruptive flares exhibiting a strong anti-correlation with Φ_{AR}. This means that an AR containing a large magnetic flux has a lower probability that the large flares it produces will be associated with a CME. We carry out the first statistical study that investigates the flare-CME association rate as function of the flare intensity and the AR characteristics that produces the flare, in terms of its total unsigned Φ_{AR}. We find that the slope of the flare-CME association rate with flare intensity reveals a steep monotonic decrease with Φ_{AR}. This means that flares of the same GOES class but originating from an AR of larger Φ_{AR}, are much more likely confined. Based on an AR flux as high as 1.0×10^{24} Mx for solar-type stars, we estimate that the CME association rate in X100-class "superflares" is no more than 50%. Our results imply that Φ_{AR} is a decisive quantity describing the eruptive character of a flare, as it provides a global parameter relating to the strength of the background field confinement.