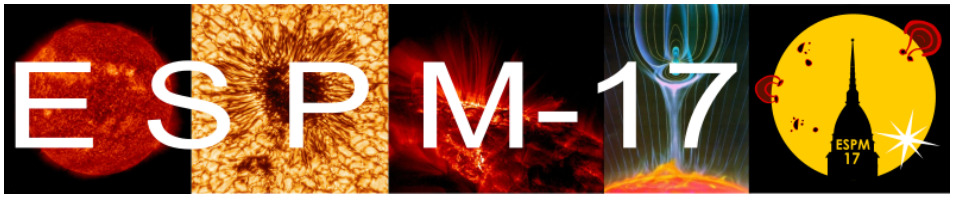

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Determine the magnetic flux of active regions from their enclosed sunspots area

The relationship between the total magnetic flux of active regions (ARs) and the area of their enclosed sunspots serves as a fundamental property of ARs. Notably, deducing the historical magnetic flux of the brightening magnetic features on the Sun, i.e., faculae and networks, is compelling for understanding the long-term variations of the solar surface magnetic flux. It is also significant for attaining a dependable long-term reconstruction of solar irradiance which has essential implications for climate modeling. Our objective is to derive a reliable relationship between the total unsigned magnetic flux of ARs and the area of their encompassed sunspots using a large sample of ARs. We utilized the Space-weather HMI Active Region Patches (SHARPs) data series from HMI/SDO, which offers cutout maps and key informations of thousands of automatically identified and tracked ARs, with each monitored from before the time it showed up until after it disappeared. With such data, we discerned sunspots and determined both the area and flux of the sunspots and the ARs they reside in. We took the evolution and position into consideration. From our analysis, 460 ARs meet the study's criteria. We observed that the relationship between an AR's total flux ($\Phi_{\rm AR}$, in Mx) and the area of its associated sunspots (S, in mH) follows a power-law: $\log \Phi_{\rm AR} = (0.760 \pm 0.009) \log S + (20.292 \pm 0.018)$. Additionally, the relationship between a sunspot's flux ($\Phi_{\rm spot}$) and its area (S) is well expressed by another power-law function: $\log \Phi_{\rm spot} = (0.919 \pm 0.003) \log S + (19.520 \pm 0.006)$.

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