Statistical properties of the emergence of magnetic flux sheets in the quiet Sun

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The emergence of small-scale magnetic flux in the quiet Sun plays a vital role in maintaining solar magnetic activity. Two emergence mechanisms have been observed within individual granules: compact magnetic loops and granule-covering magnetic flux sheets. While loops are frequently observed, evidence for flux sheet emergence is less abundant. This study statistically analyses these flux sheets, quantifying their frequency and potential contribution to the photospheric magnetic budget, and examining the associated plasma dynamics and granular phenomena. Using spectro-polarimetric data from the Hinode satellite's Solar Optical Telescope (Fe I 630.15 and 630.25 nm) and the Swedish Solar Telescope (Fe I 630.15, 630.25, and 617.3 nm), we developed a two-step method to identify flux sheet emergence. This involved detecting magnetic flux patches based on transverse and longitudinal magnetic flux density calculations and linking them to host granules via velocity field analysis. We identified 42 flux sheet emergence events, characterising their magnetic properties and the host granules' plasma dynamics. Our findings align with numerical simulations, showing a similar occurrence rate of approximately 0.3 events per day per Mm^2. Investigating the relationship between flux emergence and granular phenomena, we found that flux sheets often emerge in association with nascent granules, exploding granules, or granules with granular lanes. We highlight the potential role of recycled magnetic flux from downflow regions in facilitating flux sheet emergence. Our analysis suggests that these flux sheet events contribute to the overall distribution of small-scale magnetic flux that feeds the quiet Sun atmosphere.