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Asymmetry of weak photospheric fields in solar cycles 21-24: Implications to magnetic field structure and diffusion

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Weak magnetic field elements make a dominant contribution to the total magnetic field on the solar surface. Still, quite little is known of their properties and long-term occurrence.
We study the spatial-temporal evolution of the weak-field shift and skewness of the distribution of photospheric magnetic field values during solar cycles 21-24. We use WSO and SOLIS/VSM synoptic maps to construct butterfly diagrams for weak-field shifts and skewness.
Weak-field shift and full-field skewness depict a spatial-temporal solar cycle evolution, which is closely similar to that of the large-scale surface magnetic field. Magnetic field distribution has a systematic non-zero weak-field shift and a large skewness already at the emergence of active regions. We find evidence for coalescence of opposite-polarity fields during the surge evolution. This is clearly most effective at the supergranulation scale. However, a similar dependence of magnetic field coalescence on spatial resolution was not found in polar coronal holes.
Our results give evidence for the preference of even the weakest field elements toward prevailing magnetic polarity since the emergence of active regions, and for a systematic coalescence of stronger magnetic fields of opposite polarities to produce weak fields during surge evolution and at the poles. Our results suggest that supergranulation process is reduced or inhibited in polar coronal holes. This result is further supported, e.g., by the fact that the spectral index of diffusion of coronal bright points is larger in the polar coronal hole than at other latitudes, indicating that diffusion is less limited in the polar coronal hole.

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