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Vortex tubes of turbulent solar convection

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Abstract

The investigation of the turbulent properties of solar convection is important for understanding the multi-scale dynamics observed on the solar surface. In particular, recent high-resolution observations have revealed ubiquitous vortical structures, and numerical simulations have demonstrated links between vortex tube dynamics and the magnetic field organization. Simulations have shown the importance of vortex tube interactions in mechanisms of acoustic wave excitation on the Sun. In this paper, we investigate the mechanisms of formation of vortex tubes in highly turbulent convective flows near the solar surface by using realistic radiative hydrodynamic large-eddy simulations. Analysis of data from the simulations indicates two basic processes of vortex tube formation: (i) the development of small-scale convective instability inside convective granules and (ii) a Kelvin-Helmholtz-type instability of shearing flows in intergranular lanes. Our analysis shows that vortex stretching during these processes is a primary source of the generation of small-scale vorticity on the Sun. © 2012 The Royal Swedish Academy of Sciences.

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