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Some surprising results on convective transport in the Sun

KATEPALLI SREENIVASAN, New York University, SHRAVAN HANASOGE, Princeton University, THOMAS DUVALL, JR., NASA — Convection in the interior of our Sun comprises structures on a wide spectrum of scales. The dynamical parameters relevant to the problem cannot be replicated in laboratory experiments or numerical simulations, so our understanding of these observed features is quite incomplete even at the phenomenological level. We analyze observations of the wavefield in solar photosphere using techniques of time-distance helioseismology to deduce flows in the solar interior. We downsample and synthesize 900 billion wavefield observations to produce 3 billion cross-correlations, which we average and fit, measuring 5 million wave travel times. Using these travel times, we deduce the underlying flow systems and study their statistics to bound convective velocity magnitudes in the solar interior, as a function of depth and spherical-harmonic degree. We find the convection velocities so deduced to be 20-100 times weaker than suggested by current theoretical estimates. This result indicates the prevalence of a different paradigm of turbulence from that predicted by existing models, prompting the question: what mechanism transports the heat flux of a solar luminosity outwards? We cast our results in terms that should be particularly relevant to turbulent transport in convective systems with rotation.

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