Universal Scaling of Stellar Convective Fluctuations: Evidence for the Ultimate Regime of Convection

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Abstract

In the early 1960s, both Spiegel and Kraichnan predicted an asymptotic regime of convection in which the thermal boundary layer becomes fully turbulent for very large Rayleigh numbers.This regime was later termed "ultimate," in the sense that it is the most efficient regime to transport heat through convection. Since this prediction, tremendous efforts have been made to discover this regime either in laboratory experiments or in numerical simulations. However the question still remains open, the main obstacle being the limited range of values for the Rayleigh and Prandtl numbers. Returning to the original context of Spiegel's work, stars appear to be very good candidates for finding this regime because of the extreme values of their characteristic fluid numbers. Leveraging photometric data from space- and ground-based observations, and 3D radiative hydrodynamical simulations of stellar surfaces, I aim to demonstrate that this regime is inherent to all stars.

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