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Heat Transport Processes in Turbulent Rayleigh-Bénard Convection described with PDF equations: Numerics and Models JOHANNES LUELFF, MICHAEL WILCZEK, Institute for Theoretical Physics, University of Muenster, RICHARD STEVENS, University of Twente, RUDOLF FRIEDRICH, Institute for Theoretical Physics, University of Muenster, DETLEF LOHSE, University of Twente — Rayleigh-Bénard convection, i.e. the convection of a fluid enclosed between two plates that is driven by a temperature gradient, is the idealized setup of a phenomenon ubiquitous in nature and technical applications. Of special interest for this system are the statistics of turbulent temperature fluctuations, which we are investigating for a fluid enclosed in a cylindrical vessel. To this end, we derive an exact evolution equation for the probability density function (PDF) of temperature from first principles. Appearing unclosed terms are expressed as conditional averages of velocities and heat diffusion, which are estimated from direct numerical simulations. Our theoretical framework allows to connect the statistical quantities to the dynamics of Rayleigh-Bénard convection, giving deeper insights into the temperature statistics and transport mechanisms in different regions of the fluid volume, i.e. in the boundary layers, the bulk and the sidewall regions. Furthermore, a minimalistic model of the conditional averages that still incorporates the core features is developed by physical reasoning to highlight the overall character of the heat transport processes.

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