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Statistical description of Rayleigh-Bénard convection yields limit cycle behavior JOHANNES LUELFF, Institute for Theoretical Physics, WWU Muenster, MICHAEL WILCZEK, Johns Hopkins University Baltimore, RUDOLF FRIEDRICH, Institute for Theoretical Physics, WWU Muenster, RICHARD STEVENS, Johns Hopkins University Baltimore, DETLEF LOHSE, University of Twente — Rayleigh-Bénard convection describes the buoyancy-induced movement of a fluid enclosed between two horizontal plates, and serves as an idealized setup of phenomena occuring in nature and technical applications. The temperature fluctuations that occur in the fully turbulent case are of special interest, yet they can't be directly described from first principles due to the chaoticity of the system. Therefore we describe the statistics of temperature fluctuations by investigating the probability density function (PDF) of temperature, for the case of a cylindrical vessel and for periodic horizontal boundary conditions. Our ansatz is to derive exact evolution equations that describe the shape and deformation of the PDF; unclosed terms appearing in the form of conditional averages are estimated from direct numerical simulations of the two turbulent Rayleigh-Bénard systems. Following these steps, for both cases a limit cycle behavior appears in the phase space of the temperature PDF, highlighting the connection between the statistics and the dynamics of the system that our ansatz permits. The properties, interpretations and implications of this limit cycle are discussed; also, it is shown that the limit cycle can be connected to coherent structures formed by the convecting fluid.

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