Abstract Submitted
for the DFD19 Meeting of
The American Physical Society

Temperature fluctuations in turbulent Rayleigh-Bénard convection[1] PENGER TONG, Department of Physics, Hong Kong University of Science and Technology, Hong Kong, XIAOZHOU HE, School of Mechanical Engineering and Automation, Harbin Institute of Technology (Shenzhen), China, YIN WANG, Department of Physics, Hong Kong University of Science and Technology, Hong Kong — Non-Gaussian fluctuations with an exponential tail in their probability density function (PDF) are often observed in nonequilibrium steady states (NESSs) and one does not understand why they appear so often. Turbulent Rayleigh-Bénard convection (RBC) is an example of such a NESS, in which the measured PDF $P(\delta T)$ of temperature fluctuations δT in the central region of the flow has a long exponential tail. Here we show that because of the dynamic heterogeneity in RBC, the exponential PDF is generated by a convolution of a set of dynamics modes conditioned on a constant local thermal dissipation rate ϵ. The conditional PDF $G(\delta T|\epsilon)$ of δT under a constant ϵ is found to be of Gaussian form and its variance σ_T^2 for different values of ϵ follows an exponential distribution. The convolution of the two distribution functions gives rise to the exponential PDF $P(\delta T)$. This work thus provides a physical mechanism of the observed exponential distribution of δT in RBC and also sheds new light on the origin of non-Gaussian fluctuations in other NESSs.

[1]This work was supported in part by the Research Grants Council of Hong Kong SAR and the National Natural Science Foundation of China.

Penger Tong
Department of Physics, Hong Kong University of Science and Technology

Date submitted: 22 Jul 2019 Electronic form version 1.4