

ICTS MONTHLY COLLOQUIUM

Macroscopic arrow of time from multiscale perspectives

Fundamental laws of physics are symmetric under time reversal (T) symmetry, hence we are tempted to deduce that the evolution of the world may be T-symmetric. On the other end, there is an important conjecture that a conservative system with many particles becomes randomized. The latter process, called thermalization, is related to the second law of thermodynamics that makes the macroscopic world asymmetric. In addition to these two divergent topics, I will cover additional T-breaking frameworks: multiscale energy transfer, open systems, and asymmetric objects. In driven dissipative nonequilibrium systems, including turbulence, the multiscale energy flux from large scales to small scales helps determine the arrow of time. In addition, open systems are often irreversible due to particle and energy exchanges between the system and the environment. Causality and asymmetric objects are other important factors that break the T symmetry. I emphasize that deductions based on idealizations—point particles, spherical balls, isolated systems—may lead to erroneous conclusions on the evolution of macroscopic world.



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Mahendra Kumar Verma is a professor at the Indian Institute of Technology Kanpur. His research interests lie in turbulence, nonequilibrium statistical physics, climate science, and nonlinear dynamics. Prof. Verma earned his bachelor's degree in computer science from the Indian Institute of Technology Madras in 1988, and a Ph.D. in physics from the University of Maryland, College Park in 1994. He is a recipient of the Swarnajayanti Fellowship (2006), INSA Teacher's Award (2016), the Dr. A. P. J. Abdul Kalam Cray HPC award (2018), Sanjay Mittal Chair at IIT Kanpur (2019-2022), and J. C. Bose Fellowship (2023). He is also an elected fellow of the Indian National Science Academy, the Indian Academy of Sciences, National Academy of Science India.

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