

The 230th HENPIC seminar by Haitao Quan (PKU), July 03-2025, Thursday, 3:00pm (Beijing time)

Title: Mesoscopic statistical thermodynamics: from classical to quantum and relativistic

Abstract:

Over past three decades, a lot of efforts have been put on the extension of fundamental thermodynamic concepts (such as what constitutes a quantum isothermal process) and the applicability of the basic laws of thermodynamics in mesoscopic and quantum systems. It's revealed that, on the level of ensemble averages, the laws of thermodynamics still apply to small systems. E.g., the efficiency of a quantum heat engine does not surpass that of a classical one. However, the statistical thermodynamics of small systems exhibits new features: under arbitrarily far-from-equilibrium conditions, fluctuations in thermodynamic quantities become significant, and the distribution functions of these quantities satisfy a set of rigorously valid identities. These identities define what are known as fluctuation theorems. Fluctuation theorems recast the familiar second law of thermodynamics from an inequality into an equality, with the second law emerging as a corollary. This talk will briefly introduce some developments in mesoscopic statistical thermodynamics, including mesoscopic heat engines fluctuation theorems, and extensions to quantum or special relativistic regimes. We will also discuss experimental verifications of these theorems in both classical and quantum systems.

About the speaker:

全海涛，北京大学博雅特聘教授。2002 年和 2007 年分别在中南大学和中国科学院理论物理研究所获得学士和博士学位。2007 年至 2012 年分别在美国能源部洛斯阿拉莫斯国家实验室和马里兰大学从事博士后研究。2012 年入职北京大学物理学院，2019 年起任博雅特聘教授。全海涛的主要研究领域是统计物理和量子物理的基本问题。他先后获得过的奖励和荣誉包括：国家自然科学奖二等奖（第二完成人）（2008 年），全国百篇优秀博士学位论文奖（2009 年），国家杰出青年科学基金（2018 年）。他指导的多名博士生获得北京大学优秀博士论文奖和北京大学优秀毕业生荣誉称号。他还担任学术期刊 *Thermo-X* 和 *Communications in Theoretical Physics* 编委和全国统计物理与复杂系统学术委员会委员。

Summary