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Some Implications of Scale-Invariant Model of Boltzmann Statistical Mechanics from Cosmic to Photonic Scales

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Boltzmann statistical mechanics governs dynamics of all systems composed of large numbers of weakly interacting particles. Stochastic quantum fields and classical hydrodynamic fields share a common foundation based on universal view of statistical mechanics that is valid across diverse scales of space and time from cosmic to photonic schematically shown in Fig. 1. Because classical thermodynamics is also founded on statistical mechanics, the same degree of universality could therefore be attributed to the science of thermodynamics. Recently, a quantum mechanical foundation of turbulence was suggested based on the fact that energy spectrum of stationary isotropic turbulence is governed by Planck distribution function. Therefore, the gap between problems of quantum mechanics and turbulence was closed through connections between Cauchy, Euler, Bernoulli equations of hydrodynamics, Hamilton-Jacobi equation of classical mechanics, and finally Schrödinger equation of quantum mechanics. Also, derivation of invariant Schrödinger equation from invariant Bernoulli equation for incompressible potential flow revealed the universal role of quantum mechanics across the entire spectrum of scales of space and time shown in Fig. 1. The present talk will focus on some of the implications of a scale-invariant model of statistical mechanics to generalized thermodynamics. In particular, examples of the application of the model to the exceedingly large scale of cosmology, large scale of astrophysics, and much smaller scales of hydrodynamics, molecular-dynamics, electro-dynamics, and photonics will be presented. Attention will be particularly focused on small electrodynamic, photonic, and sub photonic scales. The scale-invariant feature of the model helps in extrapolation of the laws of nature to the very large (cosmological) and very small (sub photonic) scales thus facilitating the understanding of those domains of physical science that are less accessible to ordinary human intuition.

Fig.1 Scale-invariant model of statistical mechanics from cosmic to photonic scales

Biography

Siavash H. Sohrab received his PhD in Engineering Physics in 1981 from University of California, San Diego, his MS degree in Mechanical Engineering from San Jose State University in 1975, and his BS degree in Mechanical Engineering from the University of California, Davis in 1973. He joined Northwestern University as Postdoctoral Fellow (1982-1984), Assistant Professor (1984-1990), Associate Professor (1990-2015), and Research Professor (2016-) of Mechanical Engineering.

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