Special Random Interaction Seminar

SYK models of extremal black holes and strange metals

Speaker: Subir Sachdev

Harvard University

Homi Bhabha Chair Professor, TIFR

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The Sachdev-Ye-Kitaev (SYK) model describes fermions on a `quantum dot' with all-to-all interactions. It realizes a many-body quantum state without quasiparticle excitations, and is nevertheless exactly solvable in the low temperature limit. The absence of quasiparticles leads to fastest possible thermalization in the `Planckian time' of order $\hbar/T$. Black holes also share the property of thermalization in such a Planckian time, with T the Hawking temperature. Moreover, it turns out that the theory of low energy quantum fluctuations of near-extremal black holes is identical to a Schwarzian theory of low energy fluctuations of the SYK model.

On the condensed matter side, the SYK model has been used to build finite-dimensional strange metal states by assembling a lattice of SYK quantum islands. Such metals exhibit a linear-in-temperature resistivity, and the linearity is linked to quantum-critical exponents of the SYK model. Inhomogeneity can also lead to linear-in-field magnetoresistance, as observed recently in the pnictide superconductors.