Conformally invariant charge fluctuations in a strange metal

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In this talk I will give a common-sense introduction to the topic of strange metals. First observed in copper oxide high-temperature superconductors, the strange metal state is now found in a wide variety of materials, ranging from organic molecular crystals to cold atom simulators to twisted bilayer graphene. The key feature is Planckian dissipation, where the scattering rate $\tau^{-1} = k_B T / \hbar$ is determined only by fundamental constants, representing a conjectured universal limit on the degree of quantum entanglement possible in a many-body system. I will trace the history of this field, from the marginal Fermi liquid theory of the late 1980's to the development of the SYK model by Sachdev and Ye in 1993, which Kitaev showed in 2014 could be "derived" using holographic duality, drawing intriguing parallels to black holes.

Additionally, I will present new momentum-resolved inelastic electron scattering experiments on density fluctuations in the strange metal $Bi_2Sr_2CaCu_2O_{8+x}$, revealing that the density fluctuations are quantum critical and exhibit conformal invariance—a property that featured prominently in Kitaev's derivation. Finally, I will discuss evidence for a newly identified excitation, the "scramblon," which is a characteristic of the extreme dissipative nature of these weird materials.

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