

## **Quantum entanglement, strange metals and black holes**

Prof. Subir Sachdev

*Department of Physics, Harvard University*

Entanglement is a counterintuitive feature of quantum mechanics, which implies that a measurement of one particle can instantaneously determine the state of another well-separated particle. Remarkably, quantum entanglement can also happen en masse, and determines observable properties of macroscopic objects.

I will present a simple model of many-particle entanglement, which has led to new insights into two very different classes of systems. First, we have crystals of materials containing layered arrangements of copper and oxygen atoms. At low temperatures, these materials exhibit superconductivity, the ability to conduct electricity without resistance. But at higher temperatures they exhibit a “strange metal,” which conducts electricity and heat in a novel manner linked to the collective quantum entanglement of the electrons. Second, we have black holes, astrophysical objects so dense that even light cannot escape past a horizon. Hawking argued that quantum entanglement can be present across the horizon, and this leads to radiation from the black hole. Remarkably, the simple model of entanglement leads to a common description of the physical properties of both classes of systems.