“String theory and the mysterious quantum matter of condensed matter physics”

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Abstract

The general nature of matter formed from fermions is mysterious. The established methods of many body quantum physics fail and empirically one finds that the phenomenological Fermi-liquid and BCS theories fail: non Fermi-liquid quantum critical metals are observed in heavy fermion systems and cuprate high Tc superconductors. Remarkably, it appears that the mathematics of string theory is capable of describing such states of fermion matter. The AdS/CFT correspondence translates this problem into an equivalent general-relativity problem involving the propagation of classical fields in an Anti-de-Sitter space-time with a black hole in its center. Triggered by the success of AdS/CFT predicting the low viscosity of the quark-gluon plasma, the focus shifted very recently to the fermions, creating much excitement. It appears that both emergent Fermi-liquids and non Fermi-liquids can be gravitationally encoded, as well as ‘holographic’ superconductors having suggestive traits in common with the real life high Tc variety.