Quantum Criticality, Superconductivity and the AdS/CFT Correspondence

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Abstract

The understanding of non-Fermi liquids and their habit to turn into superconductors is severely hampered by the inability to describe systems of strongly interacting fermions with the methods of quantum field theory. Remarkably, the AdS/CFT duality of string theory might be the magic bullit. This dualizes the physics of strongly interacting quantum matter into (semi) classical gravitational physics where typically the phenomenological, highly emergent properties of the former are in correspondence with generic properties of special black holes. The highlight is the "AdS2 metal", a non-Fermi-liquid state characterized by local quantum criticality and algebraic pseudogap behavior, dual to a charged black hole [1]. Fermi-liquids are found as instabilities of such metals [2], but also "holographic superconductors" via a mechanism which is a generalization of BCS. This can be tested in the laboratory through a measurement of the pair susceptibility exploiting the second order Jospehson effect [3]. Very recently we discovered that the AdS2 metal reacts in a peculiar way to static periodic potentials [4]: this has a fascinating resemblance to the "nodal-antinodal dichotomy" puzzle in underdoped cuprates.

References:

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[3] J.H. She et al., Phys. Rev. B 84, 144527 (2011).

[4] Y.Liu, K. Schalm, Y.W. Sun and J. Zaanen, arXiv:1205.5227 (2012) .

About the speaker

Zaanen got his PhD in 1986, and after appointments at the Max-Planck-Institut Stuttgart and Bell Laboratories, he got a faculty appointment at Leiden University, being promoted to full professor in 2000. His research focus has been on strongly correlated electrons in general (e.g. Zaanen-Sawatzky-Allen, inventor of LDA+U), and high Tc superconductivity specifically (e.g. prediction of cuprate stripes). His present research revolves around quantum liquid crystals, topological insulators and especially applications of string theory to condensed matter (the "Leiden-MIT" AdS/CFT fermions).