

Quantum spin liquids and the phases of the cuprates

Subir Sachdev 

Department of Physics, Harvard University

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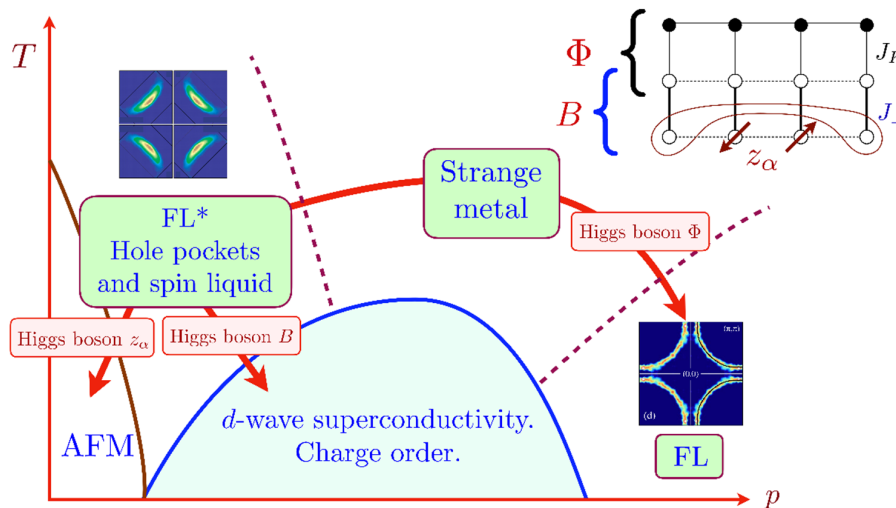
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Author introduction

Subir Sachdev is the Herchel Smith Professor of Physics at Harvard University. He has been elected to national academies of science in India, United States, and England. He is a recipient of several awards, including the Dirac Medal from the International Centre for Theoretical Physics, and the Lars Onsager Prize from the American Physical Society. Sachdev's research describes the connection between the observable properties of matter and many-particle quantum entanglement. Some of this work is described in the books *Quantum Phase Transitions* and *Quantum Phases of Matter*. The Sachdev-Ye-Kitaev model of many-particle entanglement has led to new insights on high temperature superconductivity in the copper-oxide compounds. The SYK model has also led to an understanding of how black holes with a net electrical charge realize Hawking's black hole entropy in a manner consistent with the principles of quantum mechanics.



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Abstract Soon after the discovery of high temperature superconductivity in the cuprates, Anderson proposed a connection to quantum spin liquids. But observations since then have shown that the low temperature phase diagram is dominated by conventional states, with a competition between superconductivity and charge-ordered states which break translational symmetry. We employ the "pseudogap metal" phase, found at intermediate temperatures and low hole doping, as the parent to the phases found at lower temperatures. We argue that the pseudogap is associated with a spin liquid, and that a particular spin liquid has the needed confining instabilities to resolve a number of open puzzles on the cuprate phase diagram.

Keywords spin liquids, superconductors, fractionalization, emergent gauge fields

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