Quantum Critical Behavior in a Resonant Level Coupled to a Dissipative Environment

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Abstract

A key property of quantum phase transitions (QPTs) is the possibility to create exotic quantum states at the quantum critical point; these exotic zero temperature states then cause anomalous physical properties at finite temperature. Despite the ubiquity of QPTs in contemporary theoretical physics, obtaining clear experimental signatures has been challenging. I start by presenting a recent experiment in which it was possible to thoroughly characterize a QPT: the system is a fully-tunable single-molecule transistor built from a spin-polarized carbon nanotube quantum dot connected to strongly dissipative contacts [1]. In this system, nonequilibrium properties of the QPT are also probed by applying a large bias. I then turn to the theoretical understanding of this QPT obtained by mapping the problem onto that of a resonant Majorana fermion level in a Luttinger liquid. The unitary conductance obtained in the experiment is seen as a competition between the two leads, much as in the two-channel Kondo problem. The deviations from unitarity at nonzero temperature are connected to residual interactions among the Majoranas; in this way, the experiment observes a signature of Majorana critical behavior.

Reference:

[1] H. T. Mebrahtu, I. V. Borzenets, D. E. Liu, H. Zheng, Y. V. Bomze, A. I. Smirnov, H.U. Baranger, G. Finkelstein, Nature 488, 61 (2012).

About the speaker

Prof Harold Baranger got his PhD from Cornell University in 1986, and then did a post-doc at the Universite Paris Sud in Orsay, France, before joining the staff at Bell Laboratories. He moved to Duke University, his present address, in 1999. Prof Baranger's primary long-term interest is in quantum transport and nanoscale physics, and in particular in the interference and correlation effects that they reveal. Recent topics include (i) quantum phase transitions in quantum dots and wires, (ii) waveguide QED, (iii) transport through single molecules, and (iv) quantum error correction in correlated environments.