Non-trivial Entropy of a Correlated Kondo Impurity

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Measuring entropy in a highly correlated system cannot be simply interpreted as counting its ground state accessible microstates, offering crucial insights into the system's nature when conventional methods like conductance fall short. This is especially true when the system hosts anyonic particles whose entropy is fractional and whose conductance derivation is highly non trivial. However, entropy measurements typically rely on bulk properties, which lack sensitivity for systems comprising only a few particles.

In this talk, I will present the entropy evolution of a single Kondo impurity while progressively screened by an electron bath. This process results in a highly correlated system where the local impurity mediates electron-electron interactions and constitutes a flourishing basis for understanding a large variety of intricate many-body problems.

Our charge Kondo circuit employs a metallic island with two degenerate charge states to emulate a Kondo pseudospin [1], measured non-invasively via a capacitively coupled charge sensor [2]. Connecting charge and entropy through a Maxwell relation, we establish the reduction of the impurity's residual entropy due to its screening by the electron bath up to a factor of 2. This reduction follows the universal renormalization flow from a single free spin with $k_B \log(2)$ entropy (2 equivalent microstates) to a screened singlet with 0 entropy (1 single microstate). Additionally, the incorporation of a second electronic channel should provide access to the fractional entropy $S_K = k_B \log(\sqrt{2})$ [3] attributed to the presence of a free Majorana state at the impurity site.

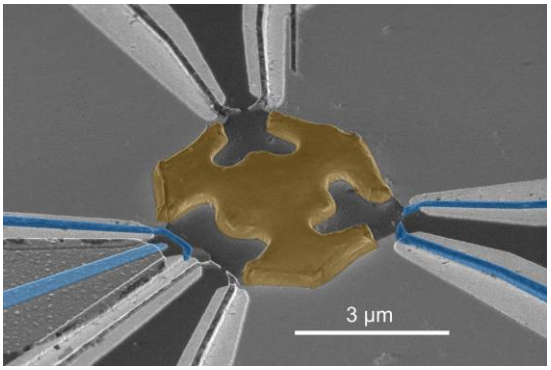

Fig.1. colored e-beam micrograph of a metal-semiconductor charge Kondo device with a charge sensor. A micron-scale metallic island (orange) is connected to a 2d-electron gas (darker areas) through a quantum point contact formed by field effect using split gates (dark blue, right). A capacitively coupled sensor defined by a "barring" gate (dark blue, left) and a lateral gate (light blue, left) probes the island charge.

References:

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[2] C. Piquard *et al,* Nat Commun 14, 7263 (2023)

[3] V. J. Emery and S. Kivelson, Phys. Rev. B 46, 10812–10817 (1992)