Fluctuations along symmetry crossover in a Kondo-correlated quantum dot

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Understanding the emergence of universal properties in entangled many-body states is a major task in various branches of physics. The key challenge is to unveil how they are governed by quantum fluctuations. The Kondo effect is one of the paradigms for such many-body states, arising from entanglement of a localized electron with conduction electrons that screen its magnetic moment. It plays an important role in transport through quantum dots, where the dot and conducting electrons are entangled in a singlet ground state with SU(2) symmetry to screen the localized spin S=1/2. Interestingly, when several degrees of freedom including orbital magnetic moment as well as spins are combined in a highly degenerate internal moment, more peculiar Kondo many-body states are formed with different symmetries because of the resulting rich spin-orbital configurations. At the heart of these phenomena are the quantum fluctuations between different configurations reflecting quantum uncertainty. However, the evolution of fluctuations between different symmetries of the Kondo states remains unexplored.

Here, by tuning the Kondo state in a carbon nanotube (CNT) with a magnetic field, we change the quantum fluctuations to directly measure their influence on the many-body properties. Non-equilibrium current noise measurements along the crossover between SU(4) and SU(2) symmetry of the ground state quantitatively demonstrate how fluctuations affect the residual interaction between quasiparticles to enhance the Kondo resonance. This work provides a new way to measure quantum fluctuations via the effective charge e* in the non-linear noise, which can be used to unveil their critical role in quantum phase transitions [1].

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[1] M. Ferrier, T. Arakawa, T. Hata, R. Fujiwara, R. Delagrange, R. Deblock, Y. Teratani, R. Sakano, A. Oguri and K. Kobayashi, Phys. Rev. Lett. 118, 196803 (2017).