

# Dynamical quantum phase transitions in hybrid quantum dot systems

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We investigate the nonequilibrium transport and dynamical properties of hybrid quantum-dot structures coupled to superconducting and normal leads, considering both single- and double-dot configurations. The time evolution following sudden changes of system parameters is studied using the time-dependent numerical renormalization group (td-NRG), which provides a nonperturbative description of strong electronic correlations and accurately captures the transient response.

We first consider a correlated quantum dot connected to a superconducting and a normal reservoir and analyze its response to quantum quenches across the boundary separating its competing ground states. In equilibrium, the interplay between proximity-induced superconducting correlations and Coulomb repulsion favors either a singly occupied doublet state or a BCS-like singlet state, depending on the system parameters. Following a quench across this quantum phase boundary, we analyze the Loschmidt echo and the associated return rate, finding characteristic nonanalytic structures at low energies that provide signatures of dynamical quantum phase transitions [1]. We further investigate nonequilibrium dynamics in systems combining ferromagnetic and superconducting contacts [2], as well as Zeeman-field-induced dynamical transitions in Yu-Shiba-Rusinov configurations [3].

We then turn to hybrid double quantum dots forming an Andreev molecule. The resulting phase diagram contains singlet and doublet phases, together with a less common triplet ground state arising from strong effective interactions mediated by the superconducting lead [4]. Finally, we investigate the transient dynamics associated with triplet blockade in an Andreev junction comprising two quantum dots coupled in series between superconducting and normal reservoirs. When the dots are singly occupied with parallel spins, local Cooper pairing is strongly inhibited, leading to a pronounced suppression of subgap charge transport and the emergence of a dynamical triplet blockade [5].

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## References

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