Dynamic Cooper pair splitter

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Cooper pair splitters are promising candidates for generating spin-entangled electrons. However, the splitting of Cooper pairs is a random and noisy process, which hinders further synchronized operations on the entangled electrons. To circumvent this problem, we propose and analyze a dynamic Cooper pair splitter that produces a noiseless and regular flow of spin entangled electrons [1]. The Cooper pair splitter is based on a superconductor coupled to two quantum dots, whose energy levels are tuned in and out of resonance to control the splitting of Cooper pairs. We identify the optimal operating conditions, for which exactly one Cooper pair is split per period of the external drive and the flow of entangled electrons becomes noiseless. To characterize the regularity of the Cooper pair splitter in the time domain, we analyze the $g^{(2)}$-function of the output currents and the distribution of waiting times between split Cooper pairs. Based on recent experiments demonstrating real-time detection of Cooper pairs in static systems [2] as well as dynamic control over the emission time statistics of a single-electron transistor [3], our proposal seems feasible using current technology, and it paves the way for dynamic quantum information processing with spin-entangled electrons.

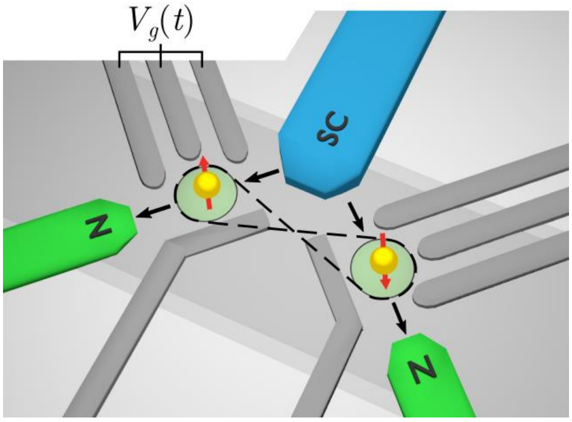

Figure 1: Schematic of the dynamic Cooper pair splitter, consisting of a superconductor (blue) coupled to two quantum dots (light green), themselves coupled to separate normal-metal leads (green). The splitting of Cooper pairs is dynamically controlled via a time-dependent gate voltage $V_g(t)$.

[1] *F. Brange, K. Prech, and C. Flindt, arXiv:2102.01406 (2021).*
[2] *A. Ranni, F. Brange, E. T. Mannila, C. Flindt, and V. F. Maisi, arXiv:2012.10373 (2020).*
[3] *F. Brange, A. Schmidt, J. C. Bayer, T. Wagner, C. Flindt, and R. J. Haug, Sci. Adv. 7, eabe0793 (2021).*