Quantum synchronization

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Synchronization of self-oscillators is a universal phenomenon that is important both in fundamental studies and in technical applications. Recent experimental progress in optomechanical systems has motivated the study of synchronization in quantum systems. We have studied the synchronization of a van der Pol self-oscillator with Kerr anharmonicity to an external drive [1]. We have shown that this system exhibits genuine quantum signatures like multiple resonances in both phase locking and frequency entrainment not present in the corresponding classical system. Very recently, we have predicted a novel quantum phenomenon in synchronization which we called *quantum synchronization blockade* [2]. Classically, the tendency towards spontaneous synchronization is strongest if the natural frequencies of the self-oscillators are as close as possible. We have shown that this wisdom fails in the deep quantum regime, where the uncertainty of amplitude narrows down to the level of single quanta for a proposal of how to stabilize Fock states in superconducting circuits). Under these circumstances identical self-oscillators cannot synchronize and detuning their frequencies can actually *help* synchronization.

[1] N. Lörch, E. Amitai, A. Nunnenkamp, and C. Bruder, Phys. Rev. Lett. **117**, 073601 (2016).

[2] N. Lörch, S.E. Nigg, A. Nunnenkamp, R.P. Tiwari, and C. Bruder, arXiv:1703.04595; accepted for publication in Phys. Rev. Lett.