Quantum dynamics of Dissipative Kerr solitons

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Dissipative Kerr solitons arising from parametric gain in ring microresonators are usually described and understood within a classical mean-field framework. In this work, I develop a quantum-mechanical model of dissipative Kerr solitons in terms of the Lindblad master equation formalism and study the model via the truncated Wigner method. In my talk, using the theory of open quantum systems, I will show that the solitons experience a finite coherence time due to quantum fluctuations originating from losses. The Liouvillian spectrum of the system is characterized by a set of eigenvalues with finite imaginary part and vanishing real part in the limit of vanishing quantum fluctuations. This arrangement emerges asymptotically in the limit of large input power, and the Liouvillian gap vanishes as a power law of the total photon occupation in the microring modes. This shows that DKSs are a specific manifestation of a dissipative time crystal. Establishing the link between DKSs and dissipative time crystals is an important step in the study and characterization of spontaneous time-translational symmetry breaking in quantum systems out of equilibrium. While being a theoretical work per se, special consideration will be given to the experimental implementations of the system under investigation.

References

[1] K. Seibold et al, Phys. Rev. A 105.053530 (2022).
[2] K. Seibold et al, Phys. Rev. A 101.033839 (2020)

Figures

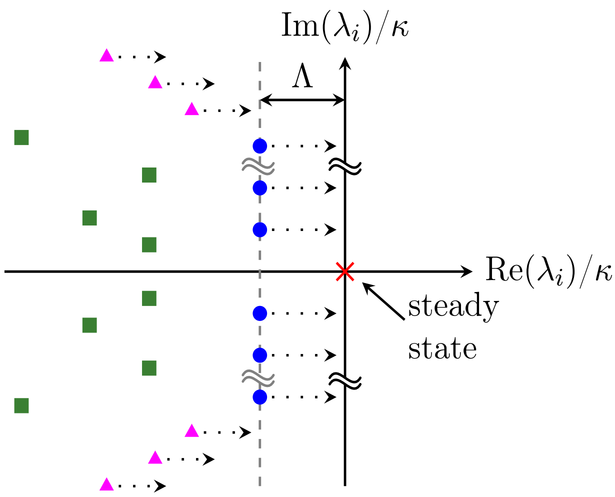

Figure 1: Schematic representation of the spectrum of the Liouvillian.