Optimized steering: Quantum state engineering and exceptional points

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The state of a quantum system may be steered towards a predesignated target state, employing a sequence of weak blind measurements (where the detector's readouts are traced out). I will present the steering of a two-level system using the interplay of a system Hamiltonian and weak measurements and show that any pure or mixed state can be targeted. Furthermore, I will discuss that the optimization of such a steering protocol is underlain by the presence of Liouvillian exceptional points. More specifically, for high-purity target states, optimal steering implies purely relaxational dynamics marked by a second-order exceptional point, whereas for low-purity target states, it implies an oscillatory approach to the target state. The dynamical phase transition between these two regimes is characterized by a third-order exceptional point. I will also present preliminary experimental data from our collaborator's lab that matches our theoretical predictions.

[1] Parveen Kumar, Kyrylo Snizhko, Yuval Gefen, and Bernd Rosenow, Optimized steering: Quantum state engineering and exceptional points, Phys. Rev. A 105, L010203 (2022)

[2] Yotam Shapira, Parveen Kumar, Kyrylo Snizhko, Tom Manovitz, Nitzan Akerman, Yuval Gefen, and Roee Ozeri, Steady state geometry of a steered trapped ion qubit, to be published.