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Quantum Zeno and anti-Zeno effect in non-Markovian decay process of single-photon polarization states

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The quantum Zeno effect is a feature of quantum-mechanical systems allowing a system's time evolution to be freezed, or at least slowed down, by measuring the system frequently enough [1-5]. On the contrary, it is also possible to exploit frequent measurements to accelerate the system's evolution, obtaining the quantum anti-Zeno effect. In my presentation, I will describe an experiment investigating quantum Zeno and anti-Zeno effects in the non-Markovian decay process of single-photon polarization states. In our implementation, we simulate a noisy quantum channel exploiting a set of half wave-plates introducing correlated random phase shifts between the vertical and horizontal polarization components. Each phase shift represents a stochastic process defined by a random variable, sampled each time by a specific probability distribution depending on the previous phase shifts (non-Markovian behavior). This stochastic polarization dephasing leads to a decay of the probability to find the system in its initial state. To induce the Zeno effect, we perform repeated measurements by inserting a polarizer between subsequent wave-plates. By controlling the interplay between the application of a sequence of repeated measurements and the probability distribution characterizing the noise of the channel, it is possible to induce on the quantum state both Zeno or anti-Zeno effect. This experiment represents a proof of principle of a technique allowing to control the dynamics of a quantum system in any realistic physical scenario affected by time-correlated noise. In real scenarios, the randomness on the phase can be due to imperfections of the measurement apparatus or to the interaction with an external reservoir, usually entailing non-Markovianity [7] in the observed quantum system.

[1] B. Misra and E.C.G. Sudarshan. The Zeno's paradox in quantum theory, J. Math. Phys. 18, 756 (1977).
[2] W.M. Itano, D.J. Heinzen, J.J. Bollinger, and D.J. Wineland. Quantum Zeno effect, Phys. Rev. A 41, 2295 (1990).
[3] P. Kwiat, H. Weinfurter, T. Herzog, A. Zeilinger, and M.A. Kasevich. Interaction-Free Measurement, Phys. Rev. Lett. 74, 4763 (1995).
[4] A.G. Kofman and G. Kurizki. Quantum Zeno effect on atomic excitation decay in resonators, Phys. Rev. A 54, R3750(R) (1996).
[5] A.G. Kofman and G. Kurizki. Acceleration of quantum decay processes by frequent observations, Nature 405, 546-550 (2000).
[6] F. Piacentini, A. Avella, E. Rebufello, R. Lussana, F. Villa, A. Tosi, M. Gramegna, G. Brida, E. Cohen, L. Vaidman, I.P. Degiovanni, and M. Genovese. Determining the quantum expectation value by measuring a single photon, Nat. Phys. 13, 1191 (2017).
[7] A. Rivas, S.F. Huelga, and M.B. Plenio. Quantum non-Markovianity: characterization, quantification and detection, Rep. Prog. Phys. 77, 094001 (2014).

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