Quantum Nonlinear Spectroscopy *Via* a Spin Sensor

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In classical nonlinear spectroscopy, a weak, classical force is applied to perturb the evolution of a quantum system and the response in a certain order of the force is related to the corresponding order of correlation functions of the system. Such spectroscopy can only access one type of correlations in the quantum system, namely, those involving only time-ordered commutators between displacement operators, as a result of the quantum evolution of the system under the perturbation. Using a quantum sensor coupled to a target quantum system, the perturbation amounts to a "quantum force". By preparing the initial state of the sensor and choosing a certain measurement basis of the sensor, we can pre- and post-select the coupling between the sensor and the target system. This way, from the correlations of the sequential weak measurement of the target system *via* a qubit sensor, we can access arbitrary types and orders of correlations of the target system. Such quantum spectroscopy provides a new approach to quantum many-body physics and a method for classical-noise-free detection of a quantum object. In this talk, I will introduce the theory of quantum spectroscopy *via* a qubit sensor and recent experimental progresses.

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