What happens when you look at a spin?

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Quantum superpositions were first observed in the celebrated Stern-Gerlach experiment in 1922 using atomic spins. Coherent quantum dynamics of superpositions was since shown to dominate the evolution of all isolated microscopic systems. However, the coupling of a non-isolated quantum system to its environment leads to superposition decoherence and collapse. Such open quantum system dynamics is believed to be at the heart of the quantum to classical transition and the process of quantum measurement. In this talk I'll describe some of our recent work studying open quantum dynamics using a highly controllable quantum system; spins of ultracold trapped ions; that are coupled to the electromagnetic vacuum via spontaneous photon scattering. I'll show that decohernce, entanglement, and quantum measurement are intertwined in this process and that by using spin-photon entanglement decoherence can be reversed. The implications on dissipated multi-spin systems and quantum error-correction of spontaneous scattering errors will be discussed.