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Quantum Control in Atom Optics

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With recent advances in the field of atom optics, the study of quantum mechanics is entering a truly exciting era. Laser light can now be used to manipulate atoms with an unprecedented degree of control. The present state of the art in quantum control is passive, or “open-loop,” quantum control, where light forces atoms into a desired quantum state using a preset sequence of actions. This type of quantum control, while bringing us closer to the realization of quantum technologies such as the quantum information processor, has also opened up many possibilities from fundamental studies in quantum mechanics. Yet, in spite of the impressive successes so far, the area of quantum control still has enormous untapped potential. The next step beyond the current paradigm of quantum control lies in active, or “closed-loop,” quantum control, where the system is perturbed in response to a continuous measurement process. Specifically, I will discuss cavity quantum electrodynamics, where light provides a real-time measurement of an atom, as an interesting testing ground for quantum feedback control.