Controllability and coherent control in atomic systems

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Theories of quantum control have, until recently, made the assumption that the Hilbert space of a quantum system can be truncated to finite-dimensions. All the beautiful results of optimal control of chemical reactions, and control in quantum computing are based upon this premise. Controllability in an infinite-dimensional quantum system is hard to prove with conventional methods, and infinite-dimensional systems provide unique challenges in designing control fields. In this talk, I will present recent finite controllability results for an infinite-dimensional quantum system. These results are important from the viewpoint of developing more efficient quantum computing protocols, particularly in quantum computing systems. I will illustrate these ideas with examples from the control of infinite-dimensional quantum systems such as Rydberg atoms and trapped ions.