On the Stochastic Control of Quantum Ensembles

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Over the last 50 years quantum mechanics has come to be applied in very sophisticated ways. Some of these applications involve the control and observation of quantum systems using subtle noncommutative effects. However only recently has there been any attempt to look at these from a control theory perspective. In this talk we cast some of the main ideas from Nuclear Magnetic Resonance (NMR) as applied to imaging and spectroscopy in a system theoretic framework. For example, NMR spectroscopy is taken to be a system identification problem. Many key aspects of high resolution NMR spectroscopy involve manipulating and controlling nuclear spins in such a way as to generate a suitable signal for the identification problem. This active control of nuclear spin is presented as a problem in the control of nonlinear systems. We will show how the framework of control on Lie groups fits this problem in a natural way and illustrate how its use leads to improvements over standard techniques. This is based on Joint work with Navin Khaneja and Steffen Glaser.