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Coherent observers for linear quantum systems

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In classical control theory, an (state) observer is a dynamical system capable of con-verging asymptotically to a fixed system: specifically, if the fixed system, termed the plant, has variables x(t) (the dynamical state) then there are analogue dynamical variables, x~(t), of the observer such that the error e(t) = x(t) x~(t) tends to zero (at least on average) for large times. An observer is therefore a physical system that obtains information from a given plant system, and which simulates an internal replica dynamics converging asymptotically to the plant's through coupling/measurement. The concept was introduced by Luenberger and plays an important role in controller design. In the quantum setting, the observer may make continuous measurements on a quantum system, or instead interact coherently with the system. In the former case, the observer may also compute the conditioned state of system using a quantum filter (quantum trajectories), and control problems may be split into a separate observation and actuation stage. Of course, no such distinction arises in the classical case, however the goal there is to have an autonomous system and accordingly we restrict our interest will be in quantum coherent observers where the coupling between the plant and the observer is designed so as to achieve the desired convergence of real and simulated evolutions. In this talk, firstly we review different algorithms to design coherent quantum observers for linear quantum systems. Then, we give an explicit construction for a quantum observer coherently replicating the dynamics of a cavity mode system, without any disturbance of the system's dynamics. This gives the exact analogue of the Luenberger observer used in controller design in engineering.

Biography

Nina H Amini is a CNRS researcher at Laboratory L2S at CentraleSupelec since October 2014. She did her first postdoc from June 2012 for six months at ANU, College of Engineering and Computer Science and her second postdoc at Edward L. Ginzton Laboratory, Stanford University since December 2012. She received her Ph.D. in Mathematics and Control Engineering from Mines-ParisTech (Ecole des Mines de Paris), in September 2012. Prior to her Ph.D., she earned a Master in Financial Mathematics and Statistics at ENSAE and the Engineering Diploma of l'Ecole Polytechnique, in 2009. Her research interests include stochastic control, quantum control, (quantum) filtering theory, (quantum) probability, and (quantum) information theory.

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