Special issue on quantum control and information processing

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The integration of quantum physics and engineering methodologies has become one of the most interesting and potentially transformative programs relating to emergent technologies. The concept is not especially new, with many of the main theoretical themes established long before the recent experimental advances that have since taken place, however the focus of quantum technologies and the advance in experimental techniques have opened up this subject to specialists outside of mathematical and theoretical physics, and there is currently intense interest in the general physics and engineering communities in problem of controlling quantum systems. The subject of quantum control is of importance to quantum information processing on two fronts: it is an enabler of quantum information technologies and will be a necessary step in quantum engineering; it also contributes to the foundational issues through its broader operational approach to modelling and interacting with quantum systems.

Control necessarily involves the interaction of the system required to be controlled (the plant) with an external agency (the controller, or governor). One distinguishes the cases where the controller acts in a way that utilizes feedback from the plant (closed loop control), or behaves in a way independent of the plant (open loop control). When extending this to quantum control systems we have the additional modelling issue of where to place the “Heisenberg cut” between the observed and observer components of the control system. The essential complication is as to how we choose to model the controller: at one extreme the controller is completely classical and nothing more than a set of classical functions determining a time-dependent Hamiltonian

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interaction (open-loop); at the other extreme the controller is a fully quantum system (coherent control). Somewhere in between, we may view the controller as an actuator whose actions are determined by measurement of the plant system. Ultimately, control is about setting a control objective and designing an optimal controller subject to the particular modelling approach adopted. The set of articles in this volume treat different approaches but involve the use of feedback to control quantum systems.

We are grateful to Dr. Brandt for kindly inviting us to put together this special issue. We hope that this special issue will be of interest to scientists in quantum information and that they will enjoy reading these papers, and learn about this rapidly developing field. We express our thanks to Sithara Shenoy, and the editorial staff of QINP for their help and support in bringing out this special issue.