Guest Editorial: Special Issue on Control of Quantum Mechanical Systems

IT is perhaps not too surprising (at least for a control audience) that "manipulating and controlling things at a small scale" was already a key part of the program that Richard P. Feynman formulated in his 1959 visionary lecture [1] which is commonly recognized as the birth place of Quantum Information. Quoting from [1]: "The principles of Physics as far as I can see do not speak against the possibility of maneuvering things atom by atom. It is not an attempt to violate any laws; it is something, in principle, that can be done; but in practice, it has not been done because we are too big". Fifty years later, if we are "small enough" to store the "Encyclopædia Britannica on the head of a pin," we are still "too big" to carry out Feynman program at the atomic scale, although we are getting closer. Getting closer, however, requires passing from nanotechnology to manipulating and controlling quantum systems, and this is no longer a question of scales, as quantum mechanics obeys its own laws. For example, observing a quantum system disturbs its state, which complicates a number of "standard" control tasks, most notably measurement-based feedback.

The enormous technological progress in all the experimental fields in which control at quantum level is of interest (ranging from physical chemistry to quantum optics, from spectroscopy to nanomechanics and superconducting quantum circuits) are motivating the development of new analytic and computational tools. If quantum physics has been for a century a descriptive science, we are now assisting to a paradigmatic shift towards quantum engineering. In this context, systematic control design methods (of both theoretical and practical nature), tailored to the quantum mechanical setting, are strongly needed and will be even more in the near future.

The *rationale* behind this Special Issue is therefore to present an overview of the state of the art of the field and to stimulate researchers in control theory to get involved, by gathering together samples of control-oriented research currently going on. While dedicated special issues have appeared in recent years in various physics journals (see for example *New Journal of Physics*, vol. 11, October 2009, or *Journal of Physics B*: At. *Molecular and Optical Physics*, vol. 44, August 2011), this is the first time a thematic issue on these topics appears on a major control journal.

Of the 29 submissions we received in response to the call for papers, 14 appear in this Special Issue. They cover various aspects of quantum control, spanning from controllability to optimal control, from open-loop control methods to feedback, in the different—and subtle–incarnations that this concept assumes passing from the classical to the quantum world. The tools used for the investigation are also widely different: from geometric to stochastic methods, passing through linear and nonlinear system-theoretic tools many of which should be familiar also to control scientists with a limited background in quantum physics.

To conclude this guest editorial, we would like to thank the IEEE TAC Editorial Board, its past and current Editor-in-Chief, Christos Cassandras and Panos Antsaklis who were supportive of this Special Issue from day one to its completion, and Editorial Assistant Elizabeth Kováks for her constant assistance in editorial matters. Finally, and most importantly, we would like to express our gratitude to all authors who contributed with their submissions and to the reviewers who took care of screening those papers in a very professional way.

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REFERENCES

[1] R. P. Feynman, "There is plenty of room at the bottom. An invitation to enter a new field of Physics," Transl.:Transcript of the talk given at the 1959 Annual Meeting of the American Physical Society. *Caltech Eng. Sci.*, vol. 23, no. 5, pp. 22–36, 1960.

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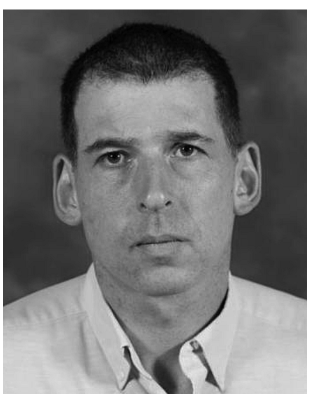

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