

Virtual Facility for Quantum Control

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Just as in the classical world, it is control that turns scientific knowledge into useful technology, managing production lines or optimizing the flow of traffic, quantum control is essential for substantial advancement of quantum technologies towards practical applications. This builds on the established experience that quantum optimal control allows to improve relevant figures of merit by one to two orders of magnitude without requiring any other changes; examples are found in areas as diverse as optical spectroscopy, photochemistry, magnetic resonance and quantum information processing. In today's efforts to engineer quantum technologies from the bottom up, quantum optimal control has already allowed for the realization of significant milestones.

Within this framework, it is natural to include this structure among the other VIs hosted by QUTE-Europe as there is in fact a consensus among practitioners that the design of quantum technologies, which are based on interference and entanglement as major but rather elusive resources, will not be possible or at least be very difficult without quantum optimal control.

Its application is in particular believed to be crucial in order to reach the required precision given the sensitivity, power, timing and accuracy of instruments as well as the ever-present interaction with the environment that may destroy the quantum resources. Quantum control will enable goals in computation, metrology, sensing and simulation by identifying how external control knobs must be tuned to allow given hardware with all its imperfections to accomplish the required tasks in the best possible way. Quantum control is also important for quantum communication and information security, for example by improving the operation of quantum repeaters or the frequency conversion of photons as information carriers, providing a natural bridge to the VIs for Quantum Communication and Quantum Information Sciences.

Finally, quantum control bundle all European activities on the control of open systems, a current challenge at the frontier of quantum physics. Quantum control is an important tool in that field as it allows for clarifying what quantum tasks can be accomplished with what precision in the presence of decoherence. It can also aid in environment engineering, i.e., in utilizing the environment to achieve what would be unattainable in a closed quantum system. This is relevant for activities under the umbrella of all QUTE-EUROPE VIs.

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