Quantum Simulation and Computation With and For Condensed-Matter Physics

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Quantum simulation and computation set out to harness the power of quantum mechanics to solve problems out of the reach of classical computers. Condensed-matter systems are not only among the most promising building blocks for carrying out such quantum computations, but they are also one of their first fields of application.

This Minicolloquium tackles both aspects.

On the one hand, the physical realization of condensed-matter devices for quantum simulation and computation, be they superconducting Josephson junctions in cavities, nitrogen-vacancy centers in diamond, quantum dots in semiconductors, and so forth, is a formidable challenge for experimental physicists, while it raises deep theoretical questions on the nature and consequences of the coupling to the solid-state environment, which leads to decoherence through relaxation and dephasing, a major hurdle towards large-scale quantum computers.

On the other hand, with the control of only a few tens of qubits or a few tens of quantum particles, the simulation of problems hitherto very difficult to solve on classical computers, such as condensed-matter Hamiltonians (like the Hubbard Hamiltonian) or quantum chemistry problems, becomes accessible, and fundamental questions about the behavior of open quantum systems can be answered, be it at or away from equilibrium.

We welcome experimental and theoretical contributions in both fields.