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Quantum Simulations with Ultracold Bosons in Optical Lattices and Superlattices

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Ultracold quantum gases in optical lattices have opened a new window for understanding strongly correlated many-body systems. They especially allow for ab-initio tests of fundamental condensed matter theories. In the presentation, I will discuss several examples, where static phases and non-equilibrium evolutions of ultracold quantum gases are compared to theoretical simulations. Among the examples that will be discussed are the measurement of the critical temperature for superfluidity in the vicinity of the quantum phase transition from a superfluid to a Mott insulator and the observation of a reentrant phase transition between superfluid and Mott insulating phases in a columnar superlattice. Finally, I will report on experimental and theoretical results that shed light on the question how isolated, strongly interacting quantum systems, can locally appear as if the system has equilibrated globally.