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Quantum simulation of spin models and the discrete Truncated Wigner Approximation: from Rydberg atoms to trapped ions ASIER PINEIRO ORIOLI, JUERGEN BERGES, Institute for Theoretical Physics, Heidelberg University, Germany, ADRIEN SIGNOLES, HANNA SCHEMPP, SHANNON WHITLOCK, MATTHIAS WEIDEMUELLER, Physikalisches Institut, Heidelberg University, Germany, ARGHAVAN SAFAVI-NAINI, MICHAEL WALL, JOHANNES SCHACHENMAYER, ANA MARIA REY, JILA, NIST and University of Colorado, Boulder (CO), USA — Accurate description of the dynamics of quantum spin models is a theoretically challenging problem with widespread applications ranging from condensed matter to high-energy physics. Furthermore recent experimental progress in AMO experiments allows for the physical realization of these models in a variety of setups, such as Rydberg systems and trapped ion experiments, with an unprecedented degree of control and flexibility. Therefore, it is vital to develop efficient theoretical methods capable of simulating the many-body dynamics of such systems. In this work, we employ and extend the recently developed discrete Truncated Wigner Approximation (dTWA), an approximation based on the phase space description of quantum mechanics, to compute the dynamics of two types of spin models: the long-range XY model, which can be realized with Rydberg atoms, and a coupled spin-boson model, which is relevant to trapped ion experiments. Comparisons to experimental results and to available exact solutions to benchmark the method show that the dTWA is capable of capturing important features of the spin evolution and can also help uncovering some underlying non-equilibrium processes.

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