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Adiabatic preparation of Rydberg crystals in a cold lattice gas: Influence of atomic relaxations DAVID PETROSYAN, Inst of Elec Structure & Laser, FORTH, Greece, KLAUS MOLMER, Department of Physics and Astronomy, Aarhus University, Denmark, MICHAEL FLEISCHHAUER, Department of Physics and Research Center OPTIMAS, University of Kaiserslautern, Germany — Strong, long-range interactions between atoms in high-lying Rydberg states make them attractive systems for the studies of ordered phases and phase transitions of interacting many-body systems. Different approaches have been explored, both theoretically and experimentally, for the preparation of crystalline order of Rydberg excitations in spatially-extended ensembles of cold atoms. These include direct (near-)resonant laser excitation of interacting Rydberg states in a lattice gas, and adiabatic preparation of crystalline phases of Rydberg excitations in a one-dimensional optical lattice by adiabatic frequency sweep of the excitation laser. We show, however, that taking into account realistic relaxation processes affecting the atoms severely complicates the prospects of attaining sizable crystals of Rydberg excitations in laser-driven atomic media. Our many-body simulations well reproduce the experimental observations [Schauß *et al.*, Science **347**, 1455 (2015)] of spatial ordering of Rydberg excitations in driven dissipative lattice gases, as well as highly sub-Poissonian probability distribution of the excitation number. We find that the excitations essentially form liquid rather than crystal phases with long-range order.

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