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Steady-state antiferromagnetic order and quasi-crystalisation of Rydberg excitations in optically driven atomic ensembles MICHAEL HOENING, Department of Physics and Research Center OPTIMAS, University of Kaiserslautern, Germany, DAVID PETROSYAN, Institute of Electronic Structure and Laser - FORTH, 71110 Heraklion, Crete, Greece, MICHAEL FLEISCHHAUER, Department of Physics and Research Center OPTIMAS, University of Kaiserslautern, Germany — We study resonant optical excitations of spatially frozen atoms in 1D trapping potentials and lattices to strongly-interacting Rydberg states. In the steady-state of strong uniform driving, correlations of Rydberg excitation probabilities exhibit exponentially decaying spatial oscillations with the period approaching one collective excitation per Rydberg blockade distance (superatom). For few atoms per blockade distance, the system is well described by a rate equation model with hard sphere superatoms. For higher densities approaching a continuous limit, we find via numerical simulations that the superatoms develop soft boundaries. For the case of an additional lattice we derive an effective master equation with non-local damping. We give analytic expressions for the many-body steady state and the correlation length of the Rydberg quasi-crystal or antiferromagnetic order and discuss conditions when it can approach infinity.

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