

Open quantum dynamics of cooperatively coupled atoms and light

Robert Bettles², Lewis Williamson¹, Mark Lee¹, Magnus Borgh³, Simon Gardiner², and
Janne Ruostekoski¹

¹*Lancaster University, Physics Department, Lancaster, United Kingdom*

²*Durham University, United Kingdom*

³*University of East Anglia, United Kingdom*

We simulate the coupled quantum dynamics of closely-spaced atoms and light by solving the quantum many-body master equation. In the forward scattering of light from planar arrays and uniform slabs of cold atoms we identify quantum many-body effects that are robust to position fluctuations and strong dipole-dipole interactions. This is obtained by comparing the full quantum solution to a semiclassical model that ignores quantum fluctuations. We also evaluate various time correlation functions that illustrate the emergence of quantum effects in the light-mediated many-body interactions between the atoms.