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Spontaneous Emission in a System of Atomic Matter Wave Emitters[1] MICHAEL STEWART, LUDWIG KRINNER, ARTURO PAZMINO, JOONHYUK KWON, DOMINIK SCHNEBLE, Stony Brook University — One of the most fundamental examples of an open quantum system is the exponential decay of an excited two-level atom, described by the Wigner-Weisskopf model. However, the Markov approximation underlying this model can be violated under certain conditions, and recent experiments on optical decay in photonic band-gap (PBG) materials have indeed started to find deviations from its predictions. We present an experimental realization [2] of a model [3,4] for an "artificial atom" emitting atomic matter-wave rather than optical radiation, in which the vacuum coupling and the excited-state energy can be controlled at will. The experiments are performed using an optical lattice geometry, which provides arrays of such artificial atoms. We are able to observe Markovian and strongly non-Markovian dynamics in this system, including exponential and partly reversible oscillatory decay, atom re-absorption, as well as a bound state for emission below the band edge of the mode continuum, which is a direct analog of the long-predicted atom-photon bound state in PBG-materials.

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[2]L. Krinner, arxiv 1712.07791
[3]I. de Vega et. al, Phys. Rev. Lett. 101, 260404, 2008
[4]M. Stewart et. al, Phys. Rev. A 95, 013626, 2017

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