Erratum: Atomic-waveguide quantum electrodynamics [Phys. Rev. Research 2, 043213 (2020)]

Stuart J. Masson and Ana Asenjo-Garcia

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A numerical integration issue has affected the quantitative results presented in Fig. 3(b), Fig. 11, and the inset to Fig. 6(b), which overestimated the amount of scattering into free space. The main conclusions of the paper remain valid, and the correct results actually demonstrate that the waveguide mediates interactions more efficiently than was previously thought. We thank Alejandro González-Tudela and David Fernández for bringing this issue to our attention. Additionally, we found a typo in Fig. 5. Here, we replot the figures that were affected.

I. BAND GAP PHYSICS [FIG. 3(b)]

For two emitters coupled to the atomic waveguide with resonance frequencies above the band edge of the waveguide, we showed damped Rabi oscillations occur between the two emitters. These Rabi oscillations are actually significantly less damped than presented in Fig. 3(b) of the paper, as shown. The analysis of the physics here is unchanged as mediating interactions in this way is actually more efficient than initially presented.

FIG. 3(b). Coherent long-range interactions between impurity qubits mediated by the atomic waveguide. Evolution of the excited-state population of qubits 1 (red) and 2 (green) after fully inverting qubit 1 at the initial time. The Rabi oscillations reveal strong coupling mediated by photonic bound states. The resonance frequency of the qubits lies $4.5\Gamma_0$ from the band edge of the atomic waveguide, with the qubits (of spontaneous emission rate $\Gamma_0^q = 0.001\Gamma_0$) placed in between two array atoms at $\rho_q = 0.4d$ and separated by a distance $8d$, for a chain of $N = 199$ atoms of lattice constant $d = 0.05\lambda_0$.

FIG. 11. Loss during collisions in atomic-waveguide QED. (a), (b) Scaling of lost two-photon population $\gamma = 1 - \langle \hat{\sigma}_{ee}^{(2)}(t_f) \rangle / \langle \hat{\sigma}_{ee}^{(2)}(0) \rangle$, with interatomic distance for initial wave-vector $\pm k_{ID}$ values evenly distributed between $0.6\pi/d$ and $0.9\pi/d$. Continuous lines are guides to the eye and are found as fits to a power law $\gamma(d) \simeq Ad^B$. (c) Exponents B from power law fits in (b). (d) Scaling of lost two-photon population $\gamma = 1 - \langle \hat{\sigma}_{ee}^{(2)}(t_f) \rangle / \langle \hat{\sigma}_{ee}^{(2)}(0) \rangle$, with initial wave-vector $\pm k_{ID}$ for different d . In all cases, initial wave packets have centers 60 sites apart, and propagate in a chain of (a) $N = 200$ and (b)-(d) $N = 120$ atoms until the peaks reach their initial positions.

II. LOSS DURING PHOTON COLLISIONS [FIGS. 6(b) AND 11]

We showed the scaling of loss of two counterpropagating photons in an atomic waveguide in the inset to Fig. 6(b), and in more detail in Fig. 11. Loss in these systems is slightly smaller than initially published. This predominantly impacts points with low d and high k_{ID} , where loss is low and this error is significant. As shown in Fig. 11, this amended data shows that a power law fits much better to all data, and the exponent varies less with d . As k_{ID} increases, we now see that the exponent slightly increases rather than the previously reported decrease.

III. CHIRAL QUANTUM OPTICS [FIG. 5]

In the paper, we show that an emitter can decay chirally into the waveguide. In Fig. 5(b), the dependence on the position of the emitter within a unit cell was plotted incorrectly, as the unit cell was shifted by $0.5d$ for the $\rho = 0.4d$ lines. The analysis given of the dependence in the published version is correct. In addition, Fig. 5(a) is a snapshot taken at $\Gamma_0 t = 64$ rather than $\Gamma_0 t = 80$ as originally stated.