Erratum: Atom-field dressed states in slow-light waveguide QED [Phys. Rev. A 93, 033833 (2016)]

Giuseppe Calajó, Francesco Ciccarello, Darrick Chang, and Peter Rabl

(Received 14 June 2016; published 24 June 2016)

DOI: 10.1103/PhysRevA.93.069905

In Sec. V of our original paper we have introduced the nonlinearity parameter

$$\Delta_{\rm nl}(N_e) = \frac{|N_e E_-^{(1)} - E_-^{(N_e)}|}{g|N_e - \sqrt{N_e}|}. \tag{1}$$

This parameter was then plotted in Fig. 9 for $N_e = 2$ and the detunings $\delta = 0$, $\delta = 2J$, and $\delta = 3J$. In all three cases the nonlinearity goes rapidly to zero for $g \lesssim J$. Although these results are correct, the plot shows only the nonlinearity parameters for the mostly photonlike states with $\delta = 2J$ and $\delta = 3J$, instead of the more relevant cases of the fully hybridized state at the band edge with $\delta = -2J$ or the atomlike state inside the band gap with $\delta = -3J$.

In Fig. 1 we show again the same plot of the nonlinearity parameter, but now including the cases $\delta = -2J$ and $\delta = -3J$ (we recall that in Fig. 9 we focus on the lowest dressed state). It can be seen that although for $\delta = -2J$ the nonlinearity (compared to the Jaynes-Cummings nonlinearity) vanishes at small g, it is still much stronger than for the resonant case $\delta = 0$. This is consistent with the observation that for $\delta = -2J$ the wavelength of the second photon, λ_2, can be much larger than the wavelength of the first bound photon, λ_1 (see discussion in Sec. V C in the original paper). In contrast, for $\delta = 0$ one finds $\lambda_1 \approx \lambda_2$. Note that the approximate scaling of the nonlinearity parameter for $g \to 0$ can be understood from the simplified assumption $E_-^{(2)} \approx E_-^{(1)} - 2J$, which would correspond to a single-photon bound state plus an additional very loosely bound photon at the band edge. By recalling that $E_-^{(1)} \simeq -2J - [g^4/(4J)]^{1/3}$ [see Eq. (27) in the original paper], we obtain $\Delta_{\rm nl}(2) \sim \sqrt[3]{g}$.

For $\delta = -3J$, which for $g \to 0$ corresponds to an atomlike state inside the band gap, the nonlinearity parameter diverges. Note that this divergence is a consequence of the chosen normalization for $\Delta_{\rm nl}(N_e)$ and can again be understood from the approximation $E_-^{(2)} \simeq \delta - 2J$ for small g.

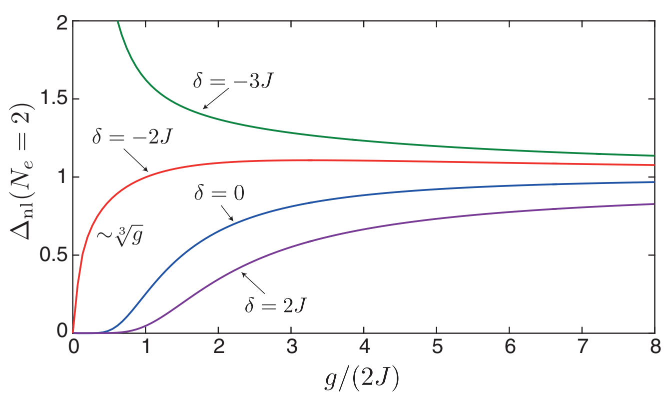

FIG. 1. Nonlinearity parameter $\Delta_{\rm nl}(N_e)$ as defined in Eq. (1) is plotted for $N_e = 2$ and different atom-photon detunings δ.

