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Reply to the Comment on 'Quantum theory of collective strong coupling of molecular vibrations with a microcavity mode' (2015 *New J. Phys.* 17 053040)

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We thank Luis A Martínez-Martínez and Joel Yuen-Zhou for bringing some corrections to our article [1, 2] to our attention. These corrections affect coherence elements of the reduced density matrix, but not the population dynamics that were studied in the article. Consequently, none of the presented results or conclusions are modified.

The corrections are as follows: (i) in the paragraph between equations (5) and (6), the inline equation for the bath correlation function should correctly read $\phi_{ij}(\tau) = \sum_k \lambda_{ik} \lambda_{jk} \text{Tr}_b[(\tilde{b}_{ik}(\tau) + \tilde{b}_{ik}^\dagger(\tau))(\tilde{b}_{jk}(0) + \tilde{b}_{jk}^\dagger(0))\rho_b]$, and

(ii) the list of $\{pq, rs\}$ terms corresponding to ω_{sr} in the last row in table 1 should be expanded to read $\{++, ++\}, \{--, --\}, \{dd', d''d'''\}, \{\pm\pm, \mp\mp\}, \{\pm\pm, dd'\}, \{dd', \pm\pm\}$. These terms should be included in equations (12) and (13). In addition, equations (13c) and (13d) had sign mistakes. The corrected equations are

$$\partial_t \rho = -\mathrm{i}[H_s, \rho] + \frac{\gamma_a}{4}\mathcal{L}_{\sigma_{+-}}[\rho] + \frac{\gamma_e}{4}\mathcal{L}_{\sigma_{-+}}[\rho] + \frac{\gamma_\phi}{4}\sum_{p=+,-}\mathcal{L}_{\sigma_{pp}}[\rho] + \gamma_\phi \mathcal{L}_\mathcal{D}[\rho] \tag{12a}$$

$$+ \frac{\gamma_\phi}{2}\sum_d (\sigma_{++}\rho\sigma_{dd} + \sigma_{dd}\rho\sigma_{++}) + \frac{\gamma_\phi}{2}\sum_d (\sigma_{--}\rho\sigma_{dd} + \sigma_{dd}\rho\sigma_{--}) \tag{12b}$$

$$+ \frac{\gamma_\phi}{4}(\sigma_{++}\rho\sigma_{--} + \sigma_{--}\rho\sigma_{++}) \tag{12c}$$

$$\partial_t \rho = -\mathrm{i}[H_s, \rho] + \frac{\gamma_a}{4N}\mathcal{L}_{\sigma_{+-}}[\rho] + \frac{\gamma_e}{4N}\mathcal{L}_{\sigma_{-+}}[\rho] \tag{13a}$$

$$+ \frac{\Gamma_a}{2N}\sum_d (\mathcal{L}_{\sigma_{d-}}[\rho] + \mathcal{L}_{\sigma_{+d}}[\rho]) + \frac{\Gamma_e}{2N}\sum_d (\mathcal{L}_{\sigma_{d+}}[\rho] + \mathcal{L}_{\sigma_{-d}}[\rho]) \tag{13b}$$

$$- \frac{\Gamma_a}{4N}\sum_d ([\sigma_{d-}\rho, \sigma_{d+}] + [\sigma_{+d}\rho, \sigma_{-d}] + \text{H.c.}) \tag{13c}$$

$$- \frac{\Gamma_e}{4N}\sum_d ([\sigma_{d+}\rho, \sigma_{d-}] + [\sigma_{-d}\rho, \sigma_{+d}] + \text{H.c.}) \tag{13d}$$

$$+ \frac{\gamma_\phi}{4N}\sum_{p=+,-}\mathcal{L}_{\sigma_{pp}}[\rho] + \gamma_\phi \sum_i \mathcal{L}_{\mathcal{D}c_i^\dagger c_i \mathcal{D}}[\rho] \tag{13e}$$

$$+ \frac{\gamma_\phi}{2N}\sum_d (\sigma_{++}\rho\sigma_{dd} + \sigma_{dd}\rho\sigma_{++}) + \frac{\gamma_\phi}{2N}\sum_d (\sigma_{--}\rho\sigma_{dd} + \sigma_{dd}\rho\sigma_{--}) \tag{13f}$$

$$+ \frac{\gamma_\phi}{4N}(\sigma_{++}\rho\sigma_{--} + \sigma_{--}\rho\sigma_{++}). \tag{13g}$$

Reference

[1] del Pino J, Feist J and Garcia-Vidal F J 2015 Quantum theory of collective strong coupling of molecular vibrations with a microcavity mode *New J. Phys.* **17** 053040
[2] Martínez-Martínez L A and Yuen-Zhou J 2018 Comment on 'Quantum theory of collective strong coupling of molecular vibrations with a microcavity mode' *New J. Phys.* **20** 018002