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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)

To cite this article: Javier del Pino *et al* 2018 *New J. Phys.* **20** 018001

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RECEIVED  
27 November 2017ACCEPTED FOR PUBLICATION  
12 January 2018PUBLISHED  
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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  $\omega_{sr}$  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

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

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

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

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

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

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

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

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

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

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

## Reference

- [1] del Pino J, Feist J and Garcia-Vidal FJ 2015 Quantum theory of collective strong coupling of molecular vibrations with a microcavity mode *New J. Phys.* 17 053040
- [2] Martínez-Martínez LA 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