

ERRATUM

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# Erratum: Generating continuous variable entangled states for quantum teleportation using a superposition of number-conserving operations (2015 *J. Phys. B: At. Mol. Opt. Phys.* **48** 185502)

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The erratum has been written to correct a few misprints in equations (A.3) and (A.4) of appendix A, in our manuscript [1].

These equations, including the intervening text, should read as follows:

The general expression can be written as

$$\begin{aligned}
 & \langle n, m | \hat{D}_a(\xi) \hat{D}_b(\eta) | n-l, m-l' \rangle \\
 &= \exp\left[-\frac{1}{2}(|\xi|^2 + |\eta|^2)\right] \langle n, m | \exp(\xi \hat{a}^\dagger) \\
 & \quad \times \exp(-\xi^* \hat{a}) \exp(\eta \hat{b}^\dagger) \exp(-\eta^* \hat{b}) | n-l, m-l' \rangle \\
 &= \exp\left[-\frac{1}{2}(|\xi|^2 + |\eta|^2)\right] \langle n, m | \exp(\xi \hat{a}^\dagger) \\
 & \quad \times \exp(-\xi^* \hat{a}) \exp(\eta \hat{b}^\dagger) \exp(-\eta^* \hat{b}) \hat{a}^l \hat{b}^{l'} | n, m \rangle \\
 & \quad \times \sqrt{\frac{(n-l)!(m-l')!}{n! m!}} \\
 &= \exp\left[-\frac{1}{2}(|\xi|^2 + |\eta|^2)\right] \sqrt{\frac{(n-l)!(m-l')!}{n! m!}} \\
 & \quad \times \left(-\frac{\partial}{\partial \xi^*}\right)^l \left(-\frac{\partial}{\partial \eta^*}\right)^{l'} \\
 & \quad \times \langle n, m | \exp(\xi \hat{a}^\dagger) \exp(-\xi^* \hat{a}) \\
 & \quad \times \exp(\eta \hat{b}^\dagger) \exp(-\eta^* \hat{b}) | n, m \rangle \\
 &= \exp\left[-\frac{1}{2}(|\xi|^2 + |\eta|^2)\right] \sqrt{\frac{(n-l)!(m-l')!}{n! m!}}
 \end{aligned}$$

$$\begin{aligned}
 & \times (-\xi)^l (-\eta)^{l'} \left(-\frac{\partial}{\partial |\xi|^2}\right)^l \left(-\frac{\partial}{\partial |\eta|^2}\right)^{l'} \\
 & \times \langle n, m | \exp(\xi \hat{a}^\dagger) \exp(-\xi^* \hat{a}) \\
 & \quad \exp(\eta \hat{b}^\dagger) \exp(-\eta^* \hat{b}) | n, m \rangle. \tag{A.3}
 \end{aligned}$$

We now need to evaluate the term  $\langle n, m | \exp(\xi \hat{a}^\dagger) \exp(-\xi^* \hat{a}) \exp(\eta \hat{b}^\dagger) \exp(-\eta^* \hat{b}) | n, m \rangle$  for all  $m, n$ .

$$\begin{aligned}
 & \langle n, m | \exp(\xi \hat{a}^\dagger) \exp(-\xi^* \hat{a}) \\
 & \quad \exp(\eta \hat{b}^\dagger) \exp(-\eta^* \hat{b}) | n, m \rangle \\
 &= \langle n, m | \sum_{s=0}^{\infty} \frac{\xi^s \hat{a}^{\dagger s}}{s!} \sum_{t=0}^{\infty} \frac{(-\xi^*)^t \hat{a}^t}{t!} \\
 & \quad \times \sum_{s'=0}^{\infty} \frac{\eta^{s'} \hat{b}^{\dagger s'}}{s'!} \sum_{t'=0}^{\infty} \frac{(-\eta^*)^{t'} \hat{b}^{t'}}{t'!} | n, m \rangle \\
 &= \sum_{s,t,s',t'=0}^{\infty} \frac{\xi^s (-\xi^*)^t \eta^{s'} (-\eta^*)^{t'}}{s! t! s'! t'!} \langle n, m | \hat{a}^{\dagger s} \hat{b}^{\dagger s'} \hat{a}^t \hat{b}^{t'} | n, m \rangle \\
 &= \sum_{s,t,s',t'=0}^{\infty} \frac{\xi^s (-\xi^*)^t \eta^{s'} (-\eta^*)^{t'}}{s! t! s'! t'!} \sqrt{\frac{n! m!}{(n-s)!(n-t)!}} \\
 & \quad \times \sqrt{\frac{n! m!}{(m-s')!(m-t')!}}
 \end{aligned}$$

$$\begin{aligned}
& \times \langle n-s, m-s' | n-t, m-t' \rangle \delta_{st} \delta_{s't'} \\
& = \sum_{s,s'=0}^{\infty} \frac{(-|\xi|^2)^s (-|\eta|^2)^{s'}}{(s! s'!)^2} \left( \frac{n!}{(n-s)!} \right) \left( \frac{m!}{(m-s')!} \right) \\
& = L_n(|\xi|^2) L_m(|\eta|^2),
\end{aligned}
\tag{A.4}$$

where  $L_n(x)$  are the Laguerre polynomials.

## Reference

- [1] Dhar H S, Chatterjee A and Ghosh R 2015 *J. Phys. B: At. Mol. Opt. Phys.* **48** 185502