Erratum: Robust Extraction of Tomographic Information via Randomized Benchmarking [Phys. Rev. X **4**, 011050 (2014)]

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We found errors in the proof of Lemma C.1. However, the statement of Lemma C.1 is still correct, and we give a simpler and correct proof of Lemma C.1 here:

Proof.—Ruskai *et al.* [1] prove that $\check{\mathcal{E}}$ is completely positive (CP) if and only if

$$(\lambda_1 + \lambda_2)^2 \leq (1 + \lambda_3)^2 - \tau_3^2 - (\tau_1^2 + \tau_2^2) \left(\frac{1 + \lambda_3 \pm \tau_3}{1 - \lambda_3 \pm \tau_3} \right), \quad (1)$$

$$(\lambda_1 - \lambda_2)^2 \leq (1 - \lambda_3)^2 - \tau_3^2 - (\tau_1^2 + \tau_2^2) \left(\frac{1 - \lambda_3 \pm \tau_3}{1 + \lambda_3 \pm \tau_3} \right), \quad (2)$$

$$(1 - (\lambda_1^2 + \lambda_2^2 + \lambda_3^2) - (\tau_1^2 + \tau_2^2 + \tau_3^2))^2 \geq 4(\lambda_1^2(\tau_1^2 + \lambda_2^2) + \lambda_2^2(\tau_2^2 + \lambda_3^2) + \lambda_3^2(\tau_3^2 + \lambda_1^2) - 2\lambda_1\lambda_2\lambda_3), \quad (3)$$

where in Eqs. (1) and (2), if $|\lambda_3| + |\tau_3| = 1$, then τ_1 and τ_2 must be 0 for the map to be CP.

Notice that if these conditions are satisfied for a completely positive and trace preserving (CPTP) map $\check{\mathcal{E}}$, then they are also satisfied for the map $\check{\mathcal{E}}^-$, which is the same as $\check{\mathcal{E}}$, except with $\tau_1 \rightarrow -\tau_1$, $\tau_2 \rightarrow -\tau_2$, $\tau_3 \rightarrow -\tau_3$. Hence $\check{\mathcal{E}}^-$ must also be CPTP. Now the convex combination of CPTP maps is also CPTP, so $1/2(\check{\mathcal{E}}^- + \check{\mathcal{E}}) = \check{\mathcal{E}}'$ is CPTP.

- [1] M. B. Ruskai, S. Szarek, and E. Werner, *An Analysis of Completely-Positive Trace-Preserving Maps on M_2* , [Linear Algebra Appl.](#) **347**, 159 (2002).