

## On the cross norm criterion for separability

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## COMMENT

## On the cross norm criterion for separability

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### Abstract

The computable cross norm (CCN) criterion for separability is neither weaker nor stronger than the positive partial transpose (PPT) criterion.

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In [1] the present author introduced a computable separability criterion. In a recent paper [2] Akhtarshenas and Jafarizadeh commented on the results of [1]. They write in the abstract of their paper 'Recently, a computational criterion of separability induced by the greatest cross norm was proposed by Rudolph (2002 Preprint quant-ph/0202121). There, Rudolph conjectured that the new criterion is neither weaker nor stronger than the positive partial-transpose criterion for separability. We show that there exists a counterexample to this claim, that is, the proposed criterion is not equivalent to the positive partial-transpose criterion [2].' There is no conjecture in [1]. To clarify the key point raised here, consider an example.

**Example 1.** Consider the set of complex Hermitian  $n \times n$  matrices. We can define a matrix  $A$  to be *greater* than a matrix  $B$  if  $A - B \geq 0$ . Clearly the statement that a matrix  $A$  is neither greater or smaller than another matrix  $B$  does not in general entail that  $A = B$ . For example consider the matrices  $A = \begin{pmatrix} 1 & 0 \\ 0 & 0 \end{pmatrix}$  and  $B = \begin{pmatrix} 0 & 0 \\ 0 & 1 \end{pmatrix}$ . In other words the relation  $\geq$  is a partial but not a total ordering.

Now let me pass to separability criteria. A separability criterion (A) is called *weaker* than a separability criterion (B) if all entangled states violating (A) also violate (B). As above, the relation '*weaker*' is a partial but not a total ordering for separability criteria. We have the following theorem (it is left to the reader to apply it to [2]).

**Theorem 2.** '*Neither weaker nor stronger*' does not mean '*equivalent*'.

### References

- [1] Rudolph O 2002 Further results on the cross norm criterion for separability *Preprint quant-ph/0202121*
- [2] Akhtarshenas S J and Jafarizadeh M A 2003 *J. Phys. A: Math. Gen.* **36** 1509–13