Measurement-device-independent measure of steerability and witnesses for all steerable states

Huan-Yu Ku[1]

[1] *Department of Physics, National Cheng Kung University, Tainan 70101, Taiwan*

The fact that nonlocality implies steering enables one to certify steerability by using a Bell inequality violation. Such a certification is device-independent (DI), i.e., one makes no assumption neither on the underlying state nor on the measurements. However, not all steerable states can violate a Bell inequality. Inspired by the work of Cavalcanti, Hall, and Wiseman [Phys. Rev. A 87, 032306 (2013)], we systematically construct a collection of steering witnesses in a measurement-device-independent (MDI) scenario, i.e., only one more assumption is required compared with the DI scenario—the input of the measurement is a set of isolated quantum states. We further show that any steerable state can be detected by an properly chosen witness. Besides, we introduce an MDI measure of steerability and show such a measure is a standard measure, i.e., it is a steering monotone, by proving it is equivalent to the steering robustness proposed by Piani and Watrous [Phys. Rev. Lett. 114, 060404 (2015)].

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[1] E. G. Cavalcanti, M. J. W. Hall, and H. M. Wiseman, *Entanglement verification and steering when Alice and Bob cannot be trusted*, Phys. Rev. A **87**, 032306 (2013).

[2] M. Piani and J. Watrous, *Necessary and Sufficient Quantum Information Characterization of Einstein-Podolsky-Rosen Steering*, Phys. Rev. Lett. **114**, 060404 (2015).