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Experimental non-classicality of an indivisible quantum system

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ABSTRACT

In quantum mechanics (QM) not all properties can be simultaneously well defined. An important question is whether a joint probability distribution can describe the outcomes of all possible measurements, allowing a quantum system to be mimicked by classical means. Klyachko et al. [PRL 101, 020403 (2008)] derived an inequality which allowed us to answer this question experimentally. The inequality involves only five measurements and QM predicts its violation for single spin-1 particles. This is the simplest system where such a contradiction is possible. It is also indivisible and as such cannot contain entanglement. In our experiment with single photons distributed among three modes we obtained a value of 3.893(6), which lies more than 120 standard deviations below the classical bound of 3.081(2). Our results illustrate a deep incompatibility between quantum mechanics and classical physics that cannot at all result from entanglement.