

TWO-SLIT DIFFRACTION, ENTANGLEMENT, AND NONLOCALITY

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ABSTRACT

Recently we've had interesting discussions with Jeff Kimble and Carl Caves, who both expressed the somewhat surprising opinion that there was nothing very quantum about the two-slit diffraction experiment. We objected to this position, stating that two-slit diffraction manifestly exhibits quantum nonlocality at the single particle level. To this, Kimble issued the challenge that this sense of nonlocality was qualitative and could not be quantified in the sense of Bell's inequalities. Responding to this challenge, we present a reinvestigation of two-slit diffraction from a quantum informatic point of view. We demonstrate constructively that the experiment exhibits the nonlocality of two-particle entanglement and EPR pair behavior, which can be quantified in terms of Bell's inequalities -- ruling out local hidden variables and hence any reasonable classical model. In addition, we show how which-path information can be used to make a quantum eraser, which calls into question whether quantum computers are reversible -- even in principle.