Optimal States for Bell inequality Violations using Quadrature Phase Homodyne Measurements

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I. INTRODUCTION

There has been recently active interest in tests of quantum mechanics [6] versus local realism in a high efficiency detection limit. Several authors [9, 11, 15] including ourselves have considered detection schemes quadrature phase homodyne measurements. Such schemes use strong local oscillators and hence have very high detection efficiency [12]. This removes one of the current loopholes [4, 7, 8, 10] and potentially allows a strong test of quantum mechanics to be performed.

The original idea of Gilchrist et. al. [9] was to use a circle or pair coherent state [1, 13, 14] produced by non-degenerate parametric oscillation with the pump mode adiabatically eliminated. Using highly efficient quadrature phase homodyne measurements, the Clauser Horne strong Bell inequality [2, 3, 5] could be tested in an all optical regime. A small (approximately 1.5%) but significant theoretical violation was found for this extremely ideal system. While the mean photon number for the system may be low (approximately 1.12), the use of homodyne measurements allow a macroscopic current to be detected.

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