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Title: Quantum Metrology with Linear Optics: Qutrit and Ququart Cases

Abstract:

Any lossless quantum computational process can be expressed as a composition of unitary operators. This sets the task of constructing a particular experimental setup corresponding to any given unitary operator. As it has been proven before (Reck, Zeilinger, Bernstein, & Bertani, 1994), any finite-dimensional unitary matrix can be realized by the means of linear optics alone. In our study we demonstrate how this can be practically achieved in the laboratory. We devise an experimental realization of the quantum metrological algorithm using only symmetric 50:50 beam splitters and mirrors. The algorithm is based on the quantum Fourier transformation and allows for the precision measurement of the input qudit state's relative phases. In the optical setting the qudit is represented by d coherent beams. In turn, each element of the d-dimensional state vector is a complex amplitude of a corresponding beam. The initial relative phases directly depend upon the particular geometrical angles, which can be changed via precision movement. We construct base-3 (qutrit) and base-4 (ququart) optical schemes and apply them to measure these angles. Among other things, we implement machine learning algorithms to compensate the imprecision in adjustment of the optical elements.