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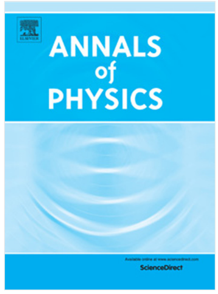

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Two-qudit geometric phase evolution under dephasing

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Abstract

In this work, we study a bipartite system composed by a pair of entangled qudits under dephasing, showing how the dynamics can be decoupled into two main sectors. In one of them, the concurrence of the effective state needed to compute the geometric phase generally decays to zero at asymptotic times. Of course, an evolution restricted to this sector can occur or not, depending on the initial state. Among the possibilities, there is a maximally entangled qutrit state (MES) that undergoes a restricted evolution. In this case, instead of decaying to zero, the concurrence as well as the geometric phase signal a transition to an effective two-qubit MES at asymptotic times.

Next, we obtain the analytic solution to the master equation for a general initial two-qutrit state, and identify a whole class of decoherence free states. The associated observables, evolving in the presence of the environment, are robust against decoherence regardless of the coupling constants and operating weights. Among them, we obtained all the MES states which are robust against decoherence. The enhanced stability properties around them provides a strategy to minimize the effects of the environment on fractional topological phases.

Keywords: Geometric phases, decoherence, qudits, entanglement.

1 Introduction

It is well known that the history of a cyclic evolution can be retained in the form of a geometric phase (GP). This was first put forward by Pancharatnam in classical optics [1] and later by Berry in Quantum Mechanics [2]. Since then, great progress was achieved in this field, ranging from nonadiabatic extensions [3] to investigations aimed at implementing geometric quantum computation based on nuclear magnetic resonance (NMR) [4], Josephson junctions [5], ion traps [6], and quantum dots [7]. One main goal of quantum computation is to investigate efficient circuits to synthesize quantum operations [8, 9, 10]. The circuit complexity for qubit systems was investigated within different approaches, including formulations based on the shortest path in a curved geometry [11, 12, 13, 14].