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Change of the Pancharatnam phase under unitary transformation and application to a model three-level Γ-type system specified by a pair of dipole-coupled excited states

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Interdependence of total, dynamic and geometric (Pancharatnam) phases of the state vector of a quantum system that are determined in different representations is considered. One finds that the phases calculated using two different bases of the Hilbert space, which are related by a time-dependent unitary transformation, are not invariant under this transformation; rather they are connected by nontrivial and well defined relations. We determine the general relationships between the phases in different representations and then apply, and verify these transformations in the case of the physically interesting model of the three-level Γ-type system specified by a pair of dipole-coupled excited states.

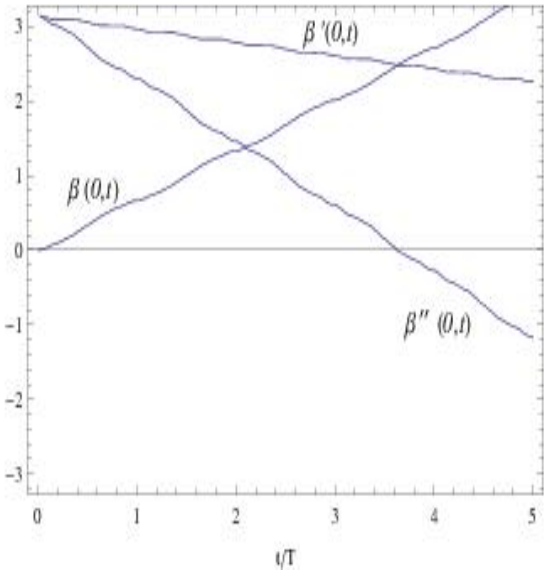

FIG. 1: Comparison of the numerically calculated geometric phases $\beta(0,t)$ and $\beta'(0,t)$, in radians, for two different bases of the Γ-type three-level system, unprimed and primed, respectively. The modifying term $\beta''(0,t)$ as a function of dimensionless time t/T (where $T \equiv 2\pi/\omega_0$ is the optical period) is represented by the curve labeled $\beta''(0,t)$. One finds that the sum $\beta(0,t)+\omega_1 t+\beta''(0,t)$ coincides with $\beta'(0,t)$ testifying to the validity of the relevant equation.

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