

Abstract

In this dissertation we discuss several aspects of a two level system (qubit) in the context of quantum mechanics and quantum field theory. The presence of geometrical phases in the evolution of a qubit state is shown. We study geometric structures, which are correlated to an unitary time evolution and its interesting gauge structure. They can be very useful in quantum computational processes.

We illustrate the quantum field theoretical formulation of boson mixed fields, and oscillation formulas for neutral and charged fields are found. We show that the space for the mixed fields is unitary inequivalent to the state space where the unmixed field are defined, and we also derive the structure of the currents and charges for the charged mixed fields.

Phenomenological aspects of meson mixing in the presence of the decay are discussed. In particular, we show that the effective Hamiltonian is non-Hermitian and non-normal in the Wigner-Weisskopf approximation and we use the biorthonormal basis formalism to diagonalize such an Hamiltonian. Finally, the presence of CP and CPT violations in meson mixing is shown.