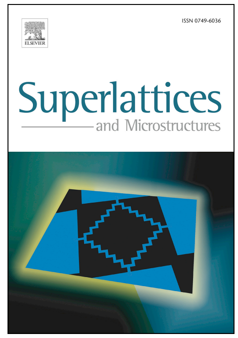
Accepted Manuscript



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PII: S0749-6036(17)31088-1

DOI: 10.1016/j.spmi.2017.06.044

Reference: YSPMI 5093

To appear in: *Superlattices and Microstructures*

Received Date: 5 May 2017

Revised Date: 14 June 2017

Accepted Date: 14 June 2017

Journal Logo

Superlattices and Microstructures 00 (2017) 1–10

Interplay between Landau-Zener transition dynamic and quantum phase transition in dissipative spin chain with Dzyaloshinsky-Moriya interaction

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Abstract

The paper investigates the transition dynamic of a two-level system coupled uniformly to a general XY dissipative spin-chain environment with the Dzyaloshinsky-Moriya interaction. The collective effect of the spin-chain environment is studied and we obtained the exact expression of the final occupation of the system. It is observed that the increase of the decay parameter favors a shortcut to adiabaticity. In the absence of decay, the transition probability oscillations are modulated in time by the renormalized Landau-Zener (LZ) parameter that we derived. We found that in the vicinity of the critical point of the environment, depending on the strength of the system-environment coupling, the decay of the population transfer can be tailored by tuning the other parameters of the model. The critical point and thus the occurrence of the phase transition are observed to be independent of these parameters. It is shown that this quantum state transition is related to the occurrence of the quantum phase transitions in the chain. The adiabatic change for the magnetization observed in some magnetic molecules may be due to the number of spin involved in the chain, the anisotropy parameter of the chain or the external magnetic field strength.

Keywords:
decoherence, qubit, spin chain, phase transition, LZ transition
PACS: 03.67.Mn, 03.65.Yz, 75.10.Pq, 64.60.av

1. Introduction

With the advances in nanotechnology enabling controlled miniaturization and optimization of future nanodevices, qubit-spin systems modeled by avoided level crossings are gaining increased attention in the scientific community. It has created opportunities for the fabrication of new nanoscale systems as witness by the emerging fields such as coherent electronics, spintronics and quantum computation. In these excited domains, scientists consider realistic quantum physical systems where the main source of decoherence stems from the coupling to the environment [1]. These systems allow access to many different aspects of Landau-Zener (LZ) tunneling [2] including decoherence, relaxation and tunneling [3–5].

However, the qubit implementation (engineering application) requires its isolation from its environment. Several theoretical proposals have been developed to minimize the coupling between the qubit and its surrounding environment [6–11]. Understanding and controlling this coupling are therefore a major subject in the field of quantum

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