Counterdiabatic driving

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1 Introduction

Our Hamiltonian would be controlled using a control parameter called λ. Our aim would be drive the system without any transition.

2 Adiabatic gauge potential: derivation

Let Hamiltonian $H_0(\lambda(t))$ satisfy the following equation

$$H_0(\lambda(t))|\psi\rangle = i\partial_t|\psi\rangle \tag{1}$$

Let us go to rotating frame so as to diagonalize our Hamiltonian. Required unitary transformation $U(\lambda)$ would depend on parameter λ. Wave function in moving frame is $|\tilde{\psi}\rangle = U^\dagger|\tilde{\psi}\rangle$. In this basis, Hamiltonian is diagonal: $\tilde{H}_0 = U^\dagger H_0 U = \sum_n \epsilon(\lambda)|n(\lambda)\rangle\langle n(\lambda)|$. [1]

How does the wave function evolve in new basis?

$$i\partial_t|\tilde{\psi}\rangle = (\tilde{H}_0(\lambda(t)) - \dot{\lambda}\tilde{\mathcal{A}}_\lambda)|\psi\rangle \tag{2}$$

3 Free interacting fermions in an external potential

$$H_0 = -J\sum_{j=1}^{L-1}(c_j^\dagger c_{j+1} + c_{j+1}^\dagger c_j) + \sum_{j=1}^{L} V_j(\lambda)c_j^\dagger c_j \tag{3}$$

$$\mathcal{A}_\lambda^* = i\sum_{j=1}^{L-1}\alpha_j(c_j^\dagger c_{j+1} - c_{j+1}^\dagger c_j) \tag{4}$$

A Spin 1/2 particle in a time-dependent magnetic field

I would include a derivation from lecture notes to gain an intuition her. I also plan to understand Berry's paper and reproduce some of his calculations in this appendix.

[1] Note that expectation value should remain same in both basis, i.e.$\langle\tilde{\psi}|\tilde{H}_0|\tilde{\psi}\rangle = \langle\psi|H_0|\psi\rangle$