
Exercises for
Advanced Quantum Theory

SS 2020, Andreas Mielke

Exercise 1

Consider a general Hamiltonian which depends on a set of parameters \vec{R} , i.e. $H = H(\vec{R})$. Assume that one moves the system adiabatically on a closed curve C in the parameter space. Let the system be at the beginning in an eigenstate $\psi_n(\vec{R})$ of $H(\vec{R})$. Calculate the Berry phase this state picks up when the system is moved adiabatically on the curve C . Show that the Berry phase is independent of an arbitrary gauge transformation that multiplies $\psi_n(\vec{R})$ with an \vec{R} -dependent phase factor $\exp(i\alpha(\vec{R}))$.

In case this first task seems too difficult, take as a preparation first a look at exercises 2 and 3.

Exercise 2

Multiply the states ϕ_{\pm} in equations (3.91,92) in the script by an arbitrary phase that depends on the parameters ϕ and θ and show that the Berry phase β_{\pm} in (3.94) does not change.

Exercise 3

Show that the Berry phase in the case of the Aharonov Bohm effect is independent of gauge transformations that change the vector potential \vec{A} .