

Exercises for Physics 472

Problem Set 1; Due 4pm Friday September 5

1–2) Griffiths 4.59, 4.61

3) Aharonov-Bohm ring

Consider a one-dimensional system in the form of a ring of circumference L threaded by a magnetic flux Φ . The Schrödinger equation for a particle of charge q is

$$E\psi(x) = \frac{1}{2m} \left(\frac{\hbar}{i} \frac{d}{dx} - \frac{q}{c} A_x(x) \right)^2 \psi(x), \quad \Phi = \int_0^L A_x(x) dx,$$

where x is a coordinate describing the arc length around the ring, and the wavefunction obeys the boundary condition $\psi(x + L) = \psi(x)$. Note: You may assume that $\mathbf{B} = 0$ along the circumference of the ring.

- a) Find the energy eigenvalues and eigenfunctions. Hint: exploit gauge invariance to make the problem easier.
- b) Determine the electric current as a function of Φ for a single particle in the ground state.