PHY 5410: Homework Week 9

11.6 (**a**) Using the Bohr–Sommerfeld quantization rule, determine the energy levels of a charged, spinless particle which is under the influence of a homogeneous magnetic field.

(**b**) Show that the magnetic flux enclosed in a semi classical Bohr-Sommerfeld orbit is a multiple of $\hbar c/e$.

12.2 Study the influence of the spin–orbit interaction

$$H_2 = \frac{1}{2m^2c^2}\boldsymbol{S}\cdot\boldsymbol{L}\frac{1}{r}\frac{dV(r)}{dr}$$

on the energy spectrum of a three-dimensional isotropic harmonic oscillator. Discuss the degeneracy of the energy levels without and with the spin–orbit interaction. Note: $\psi_{nlm}(\boldsymbol{x}) = R_{nl}(r)\,Y_{lm}(\vartheta,\varphi)$.

16.2 An electrically charged linear harmonic oscillator in the ground state is suddenly acted upon by a homogeneous electric field E, constant in time from then on. Determine the probability of exciting the particle into the nth state by means of the "sudden approximation". Hint: The potential corresponding to the electric field takes the form $\varphi(x) = -eEx$. Determine first the wave functions for the harmonic oscillator under the influence of this potential. The matrix elements occurring in the transition probability can be computed with the help of the generating function for the Hermite polynomials.