Homework #4, PHY 215C

Due: May2, 2017

Problem 1. 2nd Order t-dependent perturbation theory. 15 points.

The 2nd order term for the change in a wavefunction coefficient from given initial and final states is, in usual notation,

$$d_f^{(2)}(t) = (-\frac{i}{\hbar})^2 \sum_m \int_{t_o}^{t} dt' \int_{t_o}^{t'} dt" H_{fm}^1(t') H_{mi}^1(t") e^{i(\omega_{fm}t' + \omega_{mi}t")}.$$

Consider our favorite system, a 1D harmonic oscillator with

$$H^1(t) = -q\mathcal{E}Xe^{i\omega t}e^{\varepsilon t},$$

that is, periodically driven but turned on slowly from $t = -\infty$. ε is a small number, the inverse of a very long time scale. Do the integrals and sums to discover what energy denominators appear, and what terms in the sum remain. In practice one would not want to consider this expression beyond t=0 because the real exponential begins to diverge.

Problem 2. Cross section for the Yukawa potential. 20 points.

(i) Carry through the integral to obtain Shankar's result in Exercise 19.3.1.

(ii) Identify a natural energy scale for this problem (from constants that appear) and express the result as a function of particle energy rather than wavevector k. Point out the low energy and high energy limits.

Problem 3. Differential cross section for a hard core potential. 25 points.

Do Exercise 19.3.2 in Shankar. In part (1), plot the differential cross section versus θ for a couple of relevant energies, and plot versus energy at an interesting angle or two. Recall that $q = q(E, \theta)$. If you don't have a favorite plotting program, now is a great time to find one.