Physics 7810 Ultrafast Optics

Homework Set #5

1) From the diffusion equations for the optically excited density

$$\frac{\partial n}{\partial t} - D\frac{\partial^2 n}{dx^2} = 0$$

derive the equation given in class,

$$\Gamma_D = \frac{2\pi^2 D}{\Lambda^2}$$

for the decay of a transient grating signal.

2) An alternative approach to calculating the comb spectrum of a pulse train is to consider the excitation of a narrow resonance such as atomic absorption line. If the coherence time is sufficiently long such that the resonance remembers the phase of the previous pulse when the next one in the train arrives, the effect of the pulses can either be constructive, increasing the excitation level, or destructive, decreasing the excitation level. Calculate the frequencies for which the interference is constructive for a pulse train with a pulse-to-pulse slip of $\Delta\phi_{ce}$ and show that they correspond to the frequencies of the comb lines.

3) The initial period of a wave packet oscillation is given by the energy spacing between the excited Rydberg levels. Show that in the limit of $\Delta n << n$, the corresponding period is equal to the classical orbit time (in atomic units) $\tau_n = 2\pi n^3$.