Homework 2 of Nonlinear Optics (Due: January 15, 2008)

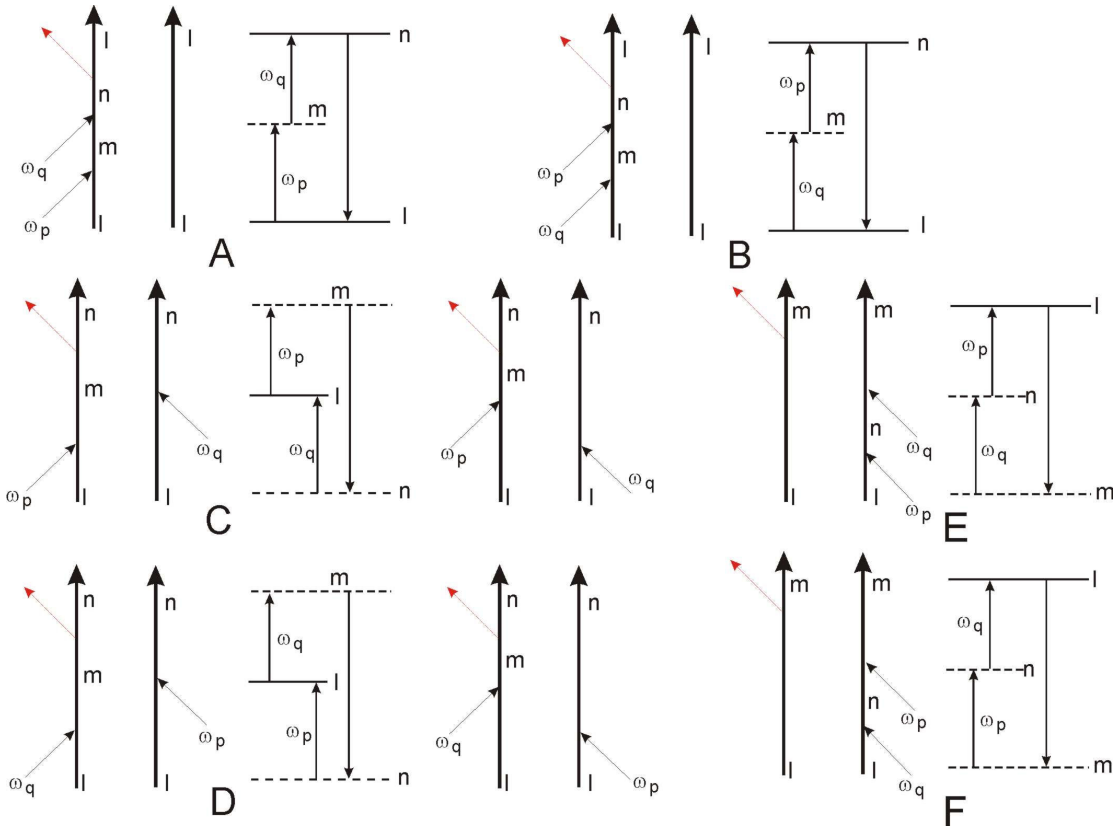
1. **SHG in KDP (40%)**

a). Calculate the *type*-I phase matching angle for SHG in KDP using 1.06 μm output of a Nd:YAG laser. Use the Sellmeier equations for refractive index. Estimate the resulting effective nonlinearity in terms of *pm/V*.

b). For a beam radius $w_0 = 100\mu m$, calculate the aperture length defined as $l_a = \sqrt{\pi}\, w_0 / \rho$ where ρ is the Poynting vector walk-off angle. Estimate the maximum effective crystal length l_{eff} when considering also the effect of diffraction.

2. Double-side Feynman Diagrams (60%)

Considering a material system with an electronic ground state |l> and two electronic excited states |m> and |n>, which form a complete set for the material electronic states. By using the double-side Feynman diagrams, derive a general form of the second-order susceptibility in terms of a summation over the complete set. The double-side Feynman diagrams and their corresponding energy-level diagrams are shown below:



All other diagrams can be generated from the first figure by using a variety of

permutations as described in my lecture. Find the expression in the limit of nonresonant excitation condition (*i.e.*, all of the frequencies $\omega_p, \omega_q, \omega_p + \omega_q$ differ significantly from any resonance frequency of the material system).