Nonlinear optics
PHYS 568
MW 1300-1415 PAIS 1140

This coming Spring 2023, Nonlinear Optics (phys 568) will be given out of the usual every-2-years sequence.

While the book of Robert Boyd may still serve as a useful background/reference, I will post on my Web site the complete text of this course, paralleled with powerpoint presentations. Glancing at the table of content of any nonlinear optics book, there seem to be as many unrelated theories of nonlinear optics as chapters. First a classical chapter where the polarization is expanded in a power series. Then a quantum mechanical perturbation treatment. Then another chapter suggests that it is the index of refraction that should be expanded in a power series of the intensity. Then it is suggested that the power expansion is sometimes invalid. Finally, you may be led to believe that continuous radiation and short pulses are two different worlds, as there is generally a chapter on short pulse nonlinear optics.

It is the purpose of this course to show that all these apparently unrelated aspects can be put under a single umbrella. The main actor in all these interactions is the electron. Successive approximations from the more general response of the electron in time varying high electric field, to linear optics, is a journey that will bring us through all the aspects of nonlinear optics. The classical situation treated in the first chapter(s) of most nonlinear optics books results from a stationary weak field approximation of a more general interaction, with all real atomic level off-resonance with the radiation frequency.

While different aspects of nonlinear optics may be taught in a different order, *the material covered will be the same as that of previous nonlinear optics classes.*

My approach is analogous to one used in analytical geometry. Some of you may have been exposed in high-school to a similar method in your course of analytical geometry. The old school taught only cartesian coordinates, in which circles, ellipses hyperbolae are totally unrelated objects. Going from cartesian to projective coordinates one realizes that circles, ellipses and hyperbolae are just one object. Teaching analytical geometry in particularizing from the general projective coordinates towards the more narrow minded cartesian gives one a much richer and elegant understanding of geometry.

The last chapter of the class will deal with quantum aspects of nonlinear optics, with a study of solitons, noise in measurements, and squeezing.

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