PHYS 555 - Nonlinear Optics  
Spring 2005, Tu-Th 5:30-6:45  
[www.optics.unm.edu/sbahae/courses/](http://www.optics.unm.edu/sbahae/courses/)

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Reference books:  
- Handbook of Nonlinear Optics, R.L. Sutherland, Dekker  
- Optical Electronics in Modern Communications, 5th ed. by A. Yariv, Oxford  
- OSA’s Handbook of Optics, IV, McGraw Hill  
- The Principles of Nonlinear Optics, Y. R. Shen, Wiley

Grading:  
- 2 midterm exams: 25% each, final presentation: 25%, homework: 25%

Office hours:  
- Tuesdays 2:00-3:00 p.m., or by appointments.

Grader:  
- Amarin Ratanavis (amarin@unm.edu), TA Office Hours: Tuesdays 4-5 pm, Rm.1112

• Introduction (historical overview, applications of NLO)

• Nonlinear Susceptibilities ($\chi^{(2)}$ and $\chi^{(3)}$ processes, nonlinear refraction and absorption)

• Classical Anharmonic Oscillator Model

• Properties of Nonlinear Susceptibilities (symmetries, Kramers-Kronig dispersion relations)

• Wave Propagation in NLO Media (coupled amplitude equations for $\chi^{(2)}$ processes, phase matching, second harmonic generation, sum and difference frequency generation, optical parametric processes, cascading nonlinearities)

• Quantum Mechanical Treatment of Nonlinear Susceptibilities

• $\chi^{(3)}$ Processes (electronic, vibrational and rotational effects, optical Kerr effect, self-focusing, wave-mixing, bistability, phase-conjugation, beam coupling, solitons)

• Photo-Refractive Nonlinearities

• Stimulated Light Scattering (stimulated Raman, Brillouin, and Rayleigh scattering)
Peter Franken’s pioneering experiment on second-harmonic generation (1961)


FIG. 1. A direct reproduction of the first plate in which there was an indication of second harmonic. The wavelength scale is in units of 100 Å. The arrow at 3472 Å indicates the small but dense image produced by the second harmonic. The image of the primary beam at 6943 Å is very large due to halation.