Ottica Moderna mod.A: Ottica non Lineare e Spettroscopia

The course was thought and is taught as an introduction to the immense field of classical nonlinear optics and nonlinear spectroscopies. Two general models are presented: the anharmonic classical oscillator, suitable for the description of parametric processes, and the Maxwell-Bloch equations, necessary in the case of resonant processes.
Experimental evidence of the nonlinear interaction of the radiation field with matter in the 0.1 – 10 eV energy range are presented both in terms of "first evidence" and of "recent advances".
Some relevant spectroscopic techniques based on NLO are discussed in details.

- **NonLinear Optics (NLO)**

the Lorentz oscillator model for the non-resonant optical parametric interactions – series expansion of the material polarization and its limit – symmetry properties of the dielectric susceptibility tensor – solution of the coupled-wave equations for all the second-order optical interactions – phase-matching and quasi-phase-matching techniques – the nonlinear refractive index and two-photon absorption – the nonlinear Schrodinger equation in one-dimension – linear and nonlinear dispersion – self-phase modulation – optical phase conjugation – optical bistability – pulse compression – temporal solitons – stimulated light scattering – two-level-atom approximation and the optical Bloch equations – Rabi oscillations – the Maxwell-Bloch equations – self-induced transparency – power broadening – comparison of the different models for the optical susceptibility

- NonLinear Spectroscopy (NLS)

multi-photon absorption – saturation spectroscopy – Doppler-free laser-induced birefringence and dichroism – heterodyne polarization spectroscopy – Coherent Anti-Stokes Raman spectroscopy – double-resonance and pump-probe spectroscopy – frequency combs – quantum beats and photon echoes

- Reference textbooks:

R.W. Boyd *Nonlinear Optics (II ed), Academic Press 2003*
W. Demtroder*, Laser Spectroscopy (IV ed), Springer 2008*