Fundamentals of femtosecond and nonlinear optics

1. Electromagnetic waves, plane waves. Intensity of light. Monochromatic waves and phase velocity. Fourier decomposition of waves, wave packet, pulse front and group velocity.
2. Characteristics of dispersion. Pulse propagation in a dispersive medium. The effect of the dispersion coefficients on the temporal shape of the pulse. The effect of the GDD for pulses with Gaussian temporal envelope.-
3. Dispersion characteristics of glass slabs, gases, metallic and chirped mirrors, prism pairs and grating pairs.
4. Femtosecond laser oscillator – principle of operation, mode-locking and its types, fundamental properties of Ti:sapphire oscillators, and a typical Ti:sapphire laser cavity.
5. Femtosecond pulse amplification, principle of CPA, typical setups of amplifiers, their characteristics, limiting factors, principle of OPA/OPCPA.
6. Focusing short laser pulses. The aberration free case. The effect of chromatic aberration, spherical aberration, astigmatism and coma.
7. Measurement of angular dispersion – definition of angular dispersion and its effects on the spatial shape of the pulses, 1D and 2D schemes for measuring angular dispersion, examples for optical elements and systems having angular dispersion.
8. Measurement of material dispersion and CEP – definition of material dispersion and CEP, linear optic methods for measuring material dispersion and CEP, principle of the f – to- 2f method.
9. Linear and nonlinear optical methods for pulse characterization in the time-, in the frequency and in the time-frequency domain.
10. Self- phase modulation and its effect on the pulses.
11. Basics of nonlinear optical frequency conversion: induced polarization and index ellipsoid

Bibliography

W. Demtröder: Laser spectroscopy, Springer-Verlag, Berlin, 2003
J.C. Diels, W. Rudolph: Ultrashort laser pulse phenomena, Academioc Press, New York, 2006