

Topic

Ultrafast nonlinear optics in hollow-core photonic crystal fibers

- *Introduction*
- *Self-phase modulation*
- *Objectives*
- *Equipment*
- *Applications*

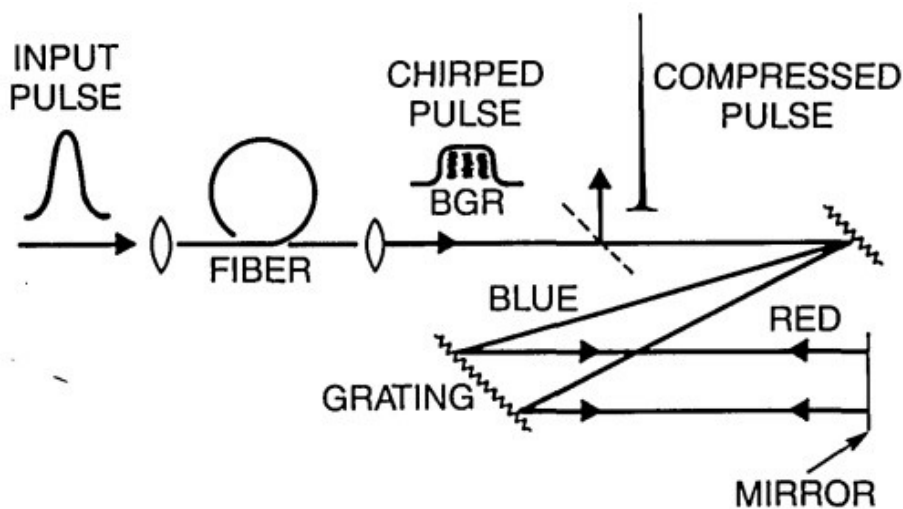


Introduction

Ultrashort pulse lasers are important experimental tools for investigating fast-evolving atomic and molecular dynamics in physics, chemistry and biology.

Ultrashort pulses can be generated by extracavity compression techniques SPM(Self-phase modulation)+ODL(optical delay line). High energy

pulse compression technique is based on hollow fibers or capillaries filled with noble gases. Hollow-core photonic crystal fibers are interesting medium for nonlinear spectral broadening and possible use for high energy pulse compression.



I'm afraid we need to use...MATH

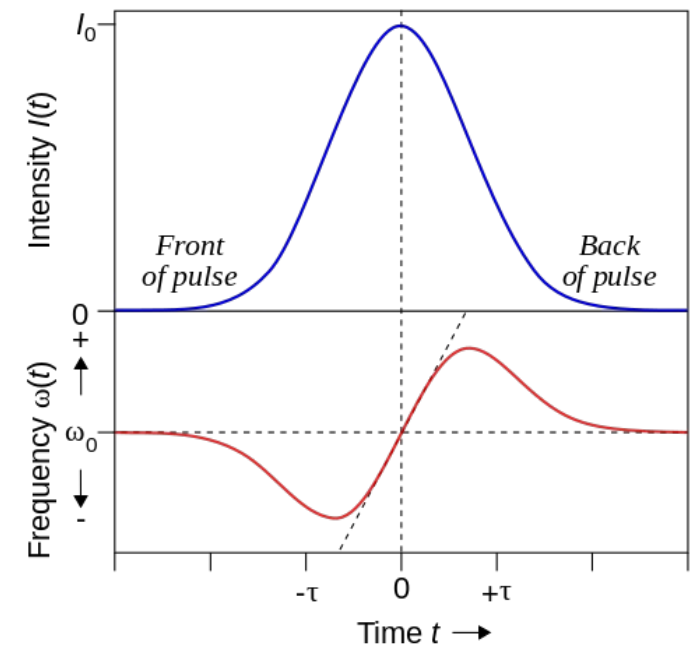
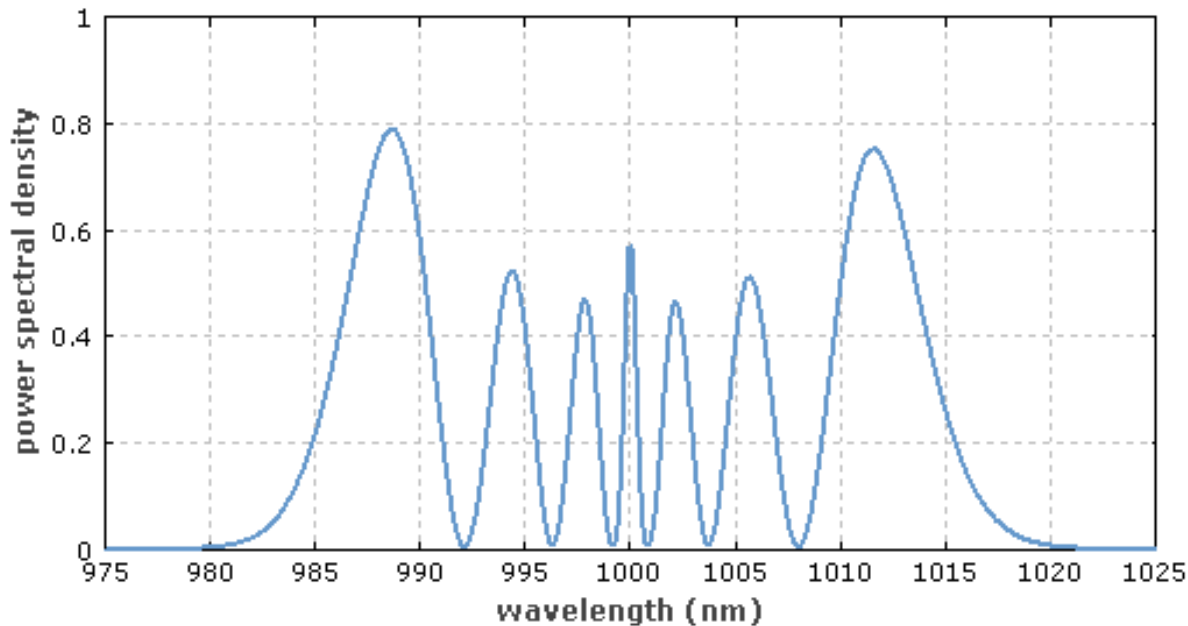
$$\vec{P} = \vec{P}^{(1)} + \vec{P}^{(2)} + \vec{P}^{(3)} + \dots$$

$$\vec{P}^{(1)}(\omega) = \epsilon_0 \chi^{(1)}(\omega) \vec{E}(\omega)$$

$$\vec{P}^{(2)}(\omega_1 + \omega_2) = \epsilon_0 \chi^{(2)}(\omega_1, \omega_2) \vec{E}(\omega_1) \vec{E}(\omega_2)$$

$$\vec{P}^{(3)}(\omega_1 + \omega_2 + \omega_3) = \epsilon_0 \chi^{(3)}(\omega_1, \omega_2, \omega_3) \vec{E}(\omega_1) \vec{E}(\omega_2) \vec{E}(\omega_3)$$

$$n(I) = n_0 + n_2 \cdot I$$



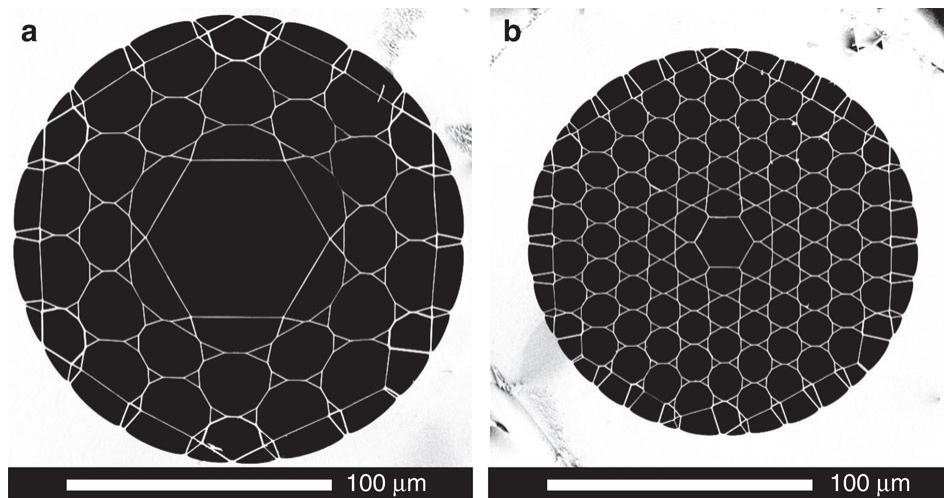
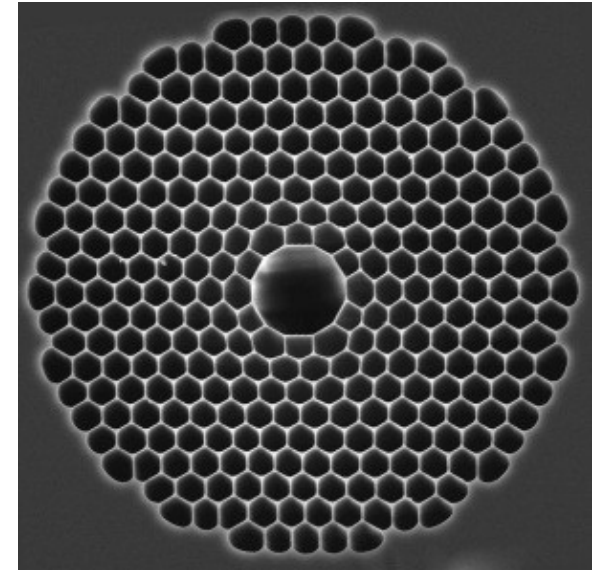
$$\omega(t) = \frac{d\phi(t)}{dt} = \omega_0 - \frac{2\pi L}{\lambda_0} \frac{dn(I)}{dt}$$

$$I(t) = I_0 \exp\left(-\frac{t^2}{\tau^2}\right)$$

$$\omega(t) = \omega_0 + \frac{4\pi L n_2 I_0}{\lambda_0 \tau^2} \cdot t \cdot \exp\left(-\frac{t^2}{\tau^2}\right)$$

Objectives

Self-phase modulation due to nonlinear optical Kerr effect in gas-filled hollow-core photonic crystal fibers will be investigated and possible use for laser pulse shortening will be analyzed. Spectral broadening will be investigated in different gases Ar, Kr...

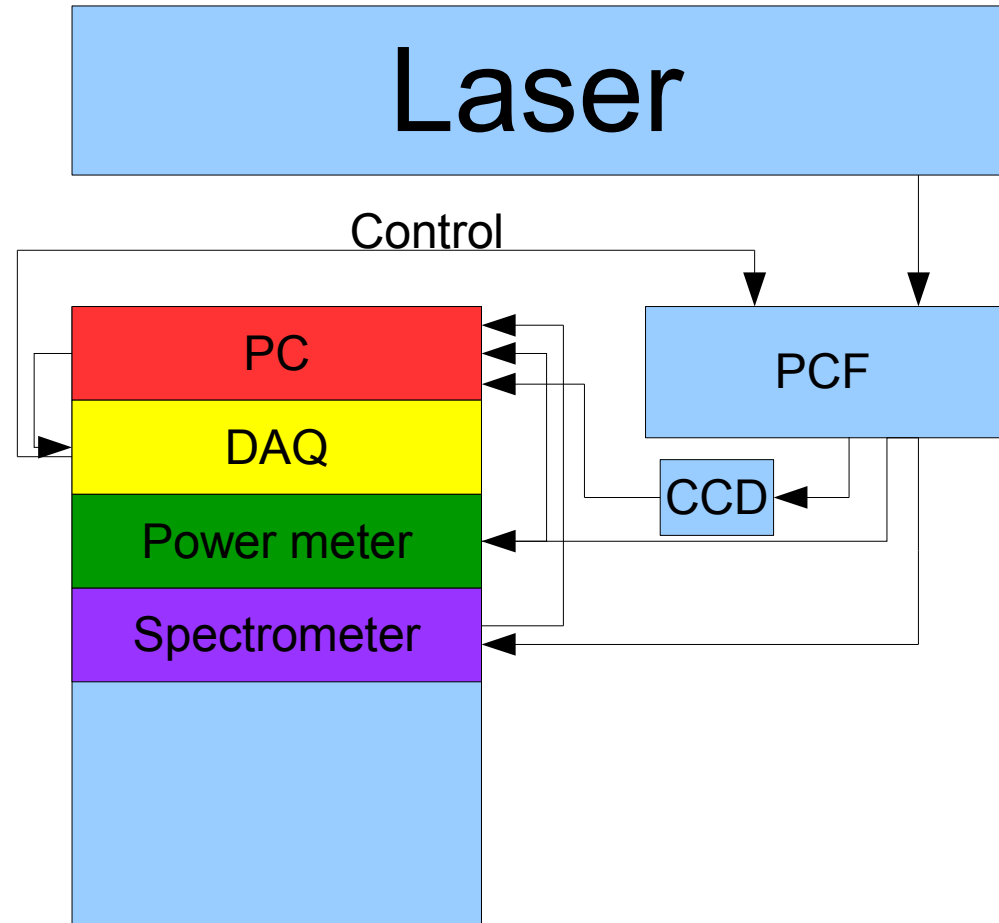


and liquids under various (pressure and temperature) conditions. Also linear, circular and elliptic polarizations cases will be probed.



Equipment

- PC
- DAQ card
- Power meter
- Fiber spectroscopy
- Photonic-crystal fiber
- CCD
- Optical mounts
- Optical elements



Applications

- Photonic-crystal fiber
- Ultrafast spectrometry
- Bright X-ray generation
- Multiphoton microscopy
- Particle acceleration
- Attoscience

