Supercontinuum generation in a nonlinear optical fiber

**Goals**

Explore spectral supercontinuum generation via propagation of ultrashort laser pulses in a nonlinear medium

Supercontinuum — intense spectral broadening of light

→ governed by Generalized NonLinear Schrodinger Equation (GNLSE)[1]

\[
\frac{\partial u}{\partial z} + \frac{i}{2} \frac{\partial^2 u}{\partial T^2} - \frac{\beta_2}{2} \frac{\partial^3 u}{\partial T^3} = i \gamma \left[ u |u|^2 + \frac{i}{\omega_0} \frac{\partial}{\partial T} (|u|^2 u) - T_R |u|^2 \right]
\]

→ $u$ - pulse envelope
→ $\beta_2$ - Taylor coefficients of propagation constant $\beta(\omega)$
→ $\gamma$ - nonlinear coefficient

Behaviour of supercontinuum is examined against:

→ Pulse average power
→ Pulse wavelength
→ Pulse width

**Experimental setup**

<table>
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<th>Experimental results and numerical simulations</th>
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<tr>
<td><img src="image1" alt="Supercontinuum behaviour for $\beta_2&gt;0$ and $\beta_2&lt;0$" /></td>
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**Experimental results and numerical simulations**

- **Photonic crystal fiber:**
  - ![Experimental results](image2)
  - **Lublin fiber 030904 p4:**
    - ![Experimental results](image3)

**Femtosecond pulses**

→ generated via mode-locking technique in a femtosecond pulse laser[2]

Pulse parameters:

- Wavelength
- Pulse width (extracted from autocorrelation function)
- Pulse average power

**Dispersive effects**

| ![Dispersive effects](image4) |

<table>
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- Group velocity dispersion (GVD)
- Third order dispersion (TOD)
- Selfphase modulation
- Self steepening
- Raman scattering

**References:**

[1] Nonlinear Fiber Optics, Govind P. Agrawal