List of presentations

PHYS 607 – Nonlinear Fibre Optics

Prof. Luc Thévenaz, Prof. Brès – Decembre 2022

Typical duration is 15-20 minutes per presentation, including questions, so the presentation should not include more than max. 10-12 slides. Since these presentations are a complement to the lecture, you are requested to attend the full session.

I. **Polarization in nonlinear cross-phase modulation**
Demonstrate that the efficiency of cross-phase modulation depends on polarization and is non-zero whatever are the states of polarization of the 2 interacting waves.

II. **Soliton solution**
Demonstrate the soliton solution from the nonlinear Schrödinger equation.

III. **All optical regeneration**
Explain the principle of the SPM based Mamyshev 2R regenerator and important design considerations for such regenerator.

IV. **Optical demultiplexing (sampling)**
Explain how XPM or FWM can be used for demultiplexing a time multiplexed data stream. Show that FWM based demultiplexing can result in a narrowing of the sampling window with respect to the initial sampling pulse under certain conditions. Compare the two approaches.

V. **Phase conjugation in 4-wave mixing**
Show that a wave phase-conjugated with respect to an incident wave can be generated through 4-wave mixing. Show how it can be used for dispersion compensation.

VI. **Phase sensitive parametric amplification**
Explain the principle and show it can lead to noise free amplification.

VII. **Raman amplification**
Show the different pumping schemes (forward or backward pumping) with advantages and drawbacks and explain why the Raman amplification generates a low excess noise.

VIII. **Brillouin amplification**
Describe and explain the paradox that Brillouin amplifiers show a large excess noise, but Brillouin lasers can generate extremely coherent light, much more coherent than the pumping light.

IX. **Smith's model**
Explain the Smith model leading to the calculation of the threshold for Brillouin and Raman amplified spontaneous emissions. Mention the recent updates (e.g. Le Floch, Kovalev, …).

X. **Slow light pulse broadening**
In the case of a Lorentzian gain spectral distribution, determine the amount of pulse broadening as a function of delay and deduce that a pulse cannot be delayed more than its width without experiencing too much broadening.

XI. **Fibre gyroscope**
Explain the principle of operation for the optical fibre gyroscope based on a Sagnac loop interferometer and show how the optical nonlinearities set a limit to the accuracy. Explain the strategies to minimize these limitations.

XII. Light polarisation controlled by light

Describe a couple of solutions to actively control the polarisation of a lightwave by another lightwave (e.g. using Brillouin, Raman and Kerr effects).

XIII. Optical parametric oscillators

Describe the functioning of an optical parametric oscillator based on the Kerr effect, explain the threshold and the tunability of such oscillator.

XIV. All optical regeneration (2R) based on parametric amplification

Explain how either higher order FWM output or FWM saturation in a parametric amplifier can be used to regenerate (2R) a signal. Describe how noise (such as phase noise of the pump, sometimes intentionally used to increase Brillouin Threshold) influences the various techniques.