

THESIS TOPICS: 2024-2025

Title: Photonic Reservoir Computing based on multi-mode fiber optics

Description:

Neuromorphic photonics has emerged as one of the leading candidates for emulating the computational abilities of the brain. Reservoir computing has been introduced as a generic name for a new research field in the domain of machine learning. Reservoir computing can be used to solve complex classification and recognition problems. The central part of the reservoir computing system is a vast, distributed nonlinear network, the reservoir, with input ports to inject data and output ports to detect the state of the network. Due to the rather simple (and energy efficient) training, the reservoir is left as it is. This implies that many physical systems can be used as reservoir. Photonics provides ultrafast and complex dynamics and photonic systems are therefore very promising candidates for hardware implementations of such reservoir computers.

In this project, you will investigate a novel approach for reservoir computing using mode mixing in standard multi-mode fiber-optical components to perform useful computations. The studied fully photonic reservoirs can contain many nodes and will operate at the fast dispersion timescale of the underlying waveguide, leading to extreme speed-up of processing speed compared to state-of-the-art. This system will be studied numerically using existing code to model propagation in multi-mode fibers, and it will be studied experimentally using standard telecom components and equipment. You will showcase the power of this approach by focusing on relevant challenges in optical telecommunications.

The candidate should be interested in fast complex dynamics of photonic systems and in machine learning. The work will be both experimental and numerical.

Link to current research project: aphy.research.vub.be

Location: VUB - Etterbeek

Promotor 1

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Promotor 2

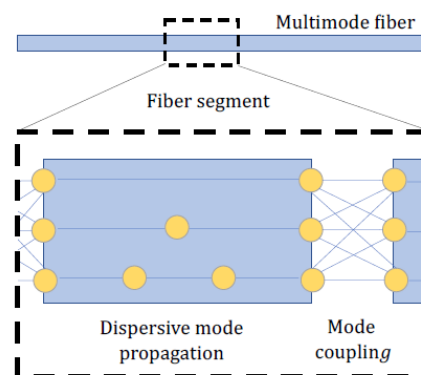
Name: Guy Van der Sande

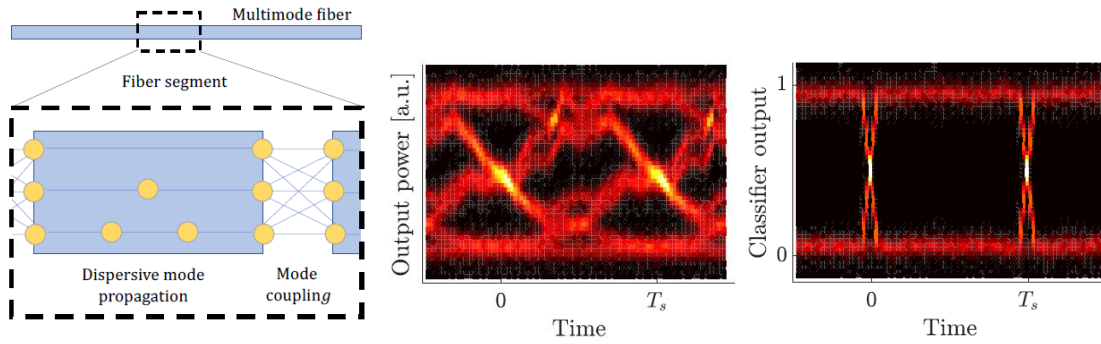
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(left) Schematic figure of a multi-mode fiber as photonic reservoir computer. The fiber modes, indicated by yellow circles, are the neural nodes of the reservoir. These modes are coupled through dispersion and mode coupling when propagating through a section of the fiber. (middle) Fiber output power when a fast intensity-modulated signal is applied at the input. The signal is clearly distorted, causing the eye-diagram to close. (right) Output of the reservoir computer after training, showing (for the same input signal as in the middle figure) a clear improvement in the eye-diagram.