

Reconstruction of phase-space topology in fiber four-wave mixing

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Abstract: We propose an experimental technique aimed to reveal a fundamental four-wave mixing process resulting in a complete reconstruction of the phase-space topology. The analysis is accompanied by training of a neural network on the experimental data.

The interplay between the Kerr nonlinearity and the second order dispersion eventuates in the four-wave mixing (FWM) process: energy exchange between evolving discrete spectral components. The ideal FWM dynamics is governed by a set of differential equations [1] and remains still a renowned problem to capture experimentally due to the impact of the cascaded FWM [2]. With a setup based on iterated initial conditions (Figure 1 (a), [3]) we reveal fundamental features of the process (Figure 1 (c1)): Fermi-Pasta-Ulam recurrence, separatrix boundary between two different regimes of dynamics and existence of a stationary wave.

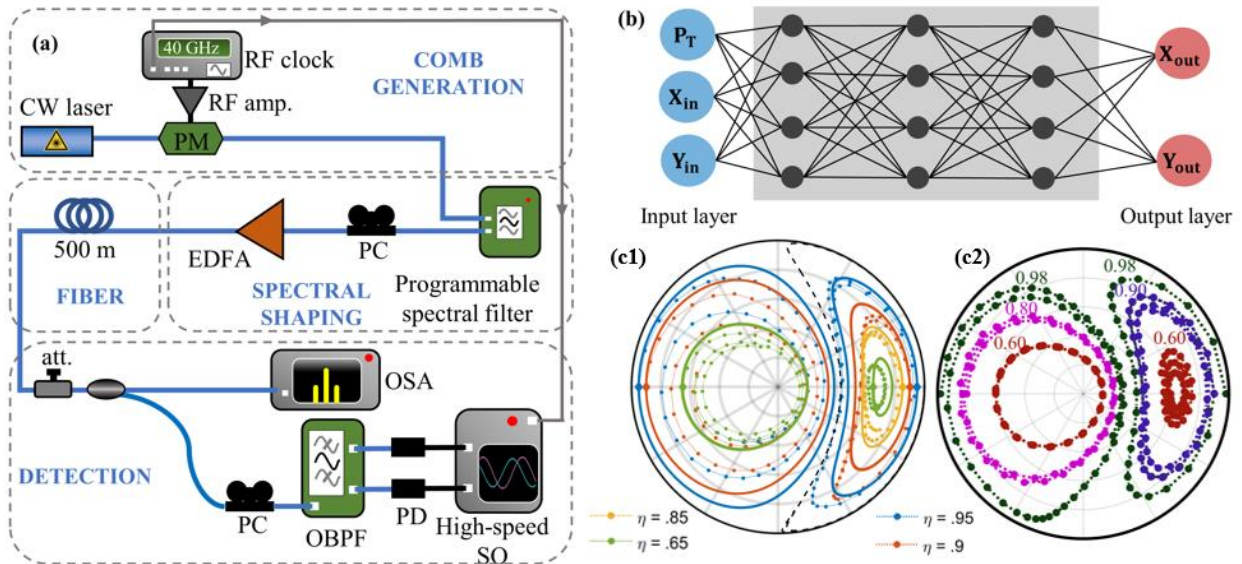


Figure 1 : (a) Experimental setup. (b) Feed-forward neural network architecture. (c) Phase-plane portraits for several initial conditions propagating over 25 km for theory and experiment (solid and dashed lines, respectively, in panel 1), and over 50 km for neural network reconstruction (panel 2).

A complementary approach is based on machine learning algorithms: we train a simple feedforward neural network (Figure 1 (b)) on a set of randomly selected disconnected experimental measurements, that allows us to have a handy instrument capturing the typical dynamics as well as experimental features (Figure 1 (c2)) [4].

References

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