Turbulence in a random fibre laser

Iván R. Roa González, Antonio M.S. Macedo, Giovani L. Vasconcelos, Ernesto P. Raposo, Anderson S.L. Gomes

Universidade Federal de Pernambuco

We are particularly interested in describing complex phenomena in which the stationary distribution of the time series of the main dynamical variable (the signal) exhibits large deviations from Gaussian statistics, possibly showing long and heavy tails. This kind of phenomena is present in many areas of physics, biology, and economics. However, our interest is focused on spectral fluctuations in random lasers. We shall attempt to describe these phenomena as a composition of distributions with distinct pace/time scales which arise from a hierarchical dynamics with a coupling between contiguous scales. The model to be used, denominated H-Theory, was recently proposed by our research group and consists of a set of coupled stochastic differential equations, whose stationary solution leads to a parametric family of distributions represented by Fox H-function.

We obtained an extensive sequence of 150,000 intensity fluctuations measurements, was collected for each excitation power in the regimes below, near, and above the threshold. The Er-RFL output was directed to a 0.1 nm resolution spectrometer with a liquid-N2 CCD camera sensitive at 1540 nm. The spectra for each power were acquired with integration time 100 ms. We performed an optimal statistical characterization of the time series using the assumptions of the H-theory. In particular, transfer of energy between different space/time scales and fluctuations in the energy transfer rates between contiguous scales. So in the present meeting, we describe the results obtained with the experiment [1]. [1] González, I. R. R. et al. Turbulence hierarchy in a random fibre laser. Nat. Commun. 8, 15731 doi: 10.1038/ncomms15731 (2017).