Experimental evidence of microwave envelope chaos using an integro-differential optoelectronic system

Yanne Chembo, Kirill Volyanskiy, Maxime Jacquot, & Laurent Larger

FEMTO-ST Institute (UMR CNRS 6174), Optics department, 16 route de Gray, 25030 Besançon cedex, France
yanne.chembo@femto-st.fr

A very wide variety of systems have been shown to display a chaotic behavior since the pioneering work of Lorentz in the early sixties. This ubiquity has been experimentally evidenced in a very wide range of frequencies, ranging from the low frequency of mechanical oscillators to the ultra-high frequencies of amplitude/phase chaos in lasers.

In this communication, we experimentally evidence a spectrally interesting chaotic dynamics, where a 3 GHz microwave is driven to a state where only its slowly varying complex envelope becomes chaotic. In the Fourier domain, the system has a quasi-white spectrum within a very narrow bandwidth (16 MHz) around the central frequency of the carrier.

This dynamics is generated using a narrow-band optoelectronic oscillator. The corresponding model is an integro-differential delay differential equation, and it enables to analyze the essential dynamical features of the system. Beyond the interest to be devoted to this oscillator for its fondamental interest, it also appears to be the idoneous tool for many applications. In particular, we will explain how it could be used to implement chaos cryptography in free-space microwave telecommunication networks, or to improve the performances of wideband radar systems.