C2N Laboratory
https://www.c2n.universite-paris-saclay.fr/

QD Team
https://www.qdgroup.universite-paris-saclay.fr/

Contact: **Melanie LEBENTAL**
Email: **melanie.lebental@cnrs.fr**
Address: **10 Bd Gobert, Palaiseau**

Chaotic graphs in silicon photonics

Chaotic systems have a particular quantum behavior and several conjectures remain to be demonstrated concerning their spectrum and their wave functions [1]. Graphs can be chaotic or not and allow a relatively simple theoretical study of the classical and quantum limits [2]. These experiments are easier to carry out in photonics and the formalism fits well to the **wave-particle duality of light**. We have therefore produced graphs (chaotic or not) where light circulates in silicon waveguides (Fig. 1a) and we study their spectrum (Fig. 1c) and their wave functions (Fig. 1b).

The first objective is to verify the validity of the conjectures according to different types of graphs. In a second step, we will inject **non-classical light** (squeezed light or entangled photons for instance) to know if entanglement is sensitive to chaos.

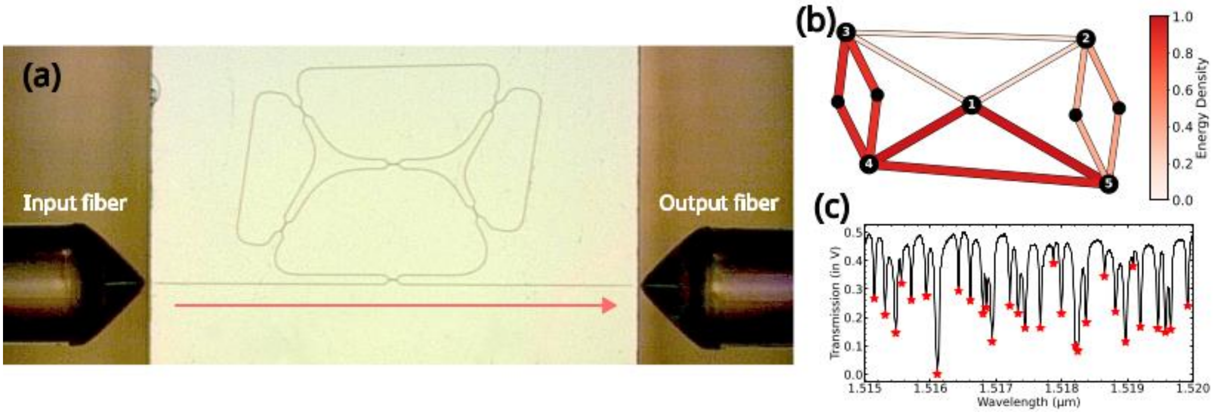

Figure 1 : (a) Photo of a device with a silicon chaotic graph on the characterization setup. Laser light is injected into the waveguide from the left using a lensed fiber, and the transmitted light is collected on the right using another lensed fiber.
(b) Example of a numerical wave function of the graph in (a). (c) Experimental spectrum of the chaotic graph in (a). Resonances are indicated by red stars.

The silicon graphs are fabricated in the C2N cleanroom. Their design requires numerical simulations performed under the supervision of Xavier Chécoury (C2N). The experiments are carried out on a dedicated characterization setup at C2N and the theory is developed in collaboration with Barbara Dietz (Dresden). **The student may be involved in one or several of these tasks, depending on his/her preferences.**

[1] *Quantum chaos: An introduction*, H.-J. Stöckmann, Cambridge University Press (1999).
[2] *Closed and open superconducting microwave waveguide networks as a model for quantum graphs*, B. Dietz et al., Physical Review E vol. 109, 034201 (2024). Arxiv:2401.16031