INTERNSHIP and THESIS PROPOSAL

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Non-Euclidean Photonics & Quantum chaos

Quantum chaos is a research field dedicated to semi-classical physics [1], ie. the relationship between a quantum system and its classical counterpart. The predictions are investigated in any wave system, namely quantum, acoustic, microwaves, optics,… One of the major hypothesis is the localization of eigenmodes on classical periodic trajectories.

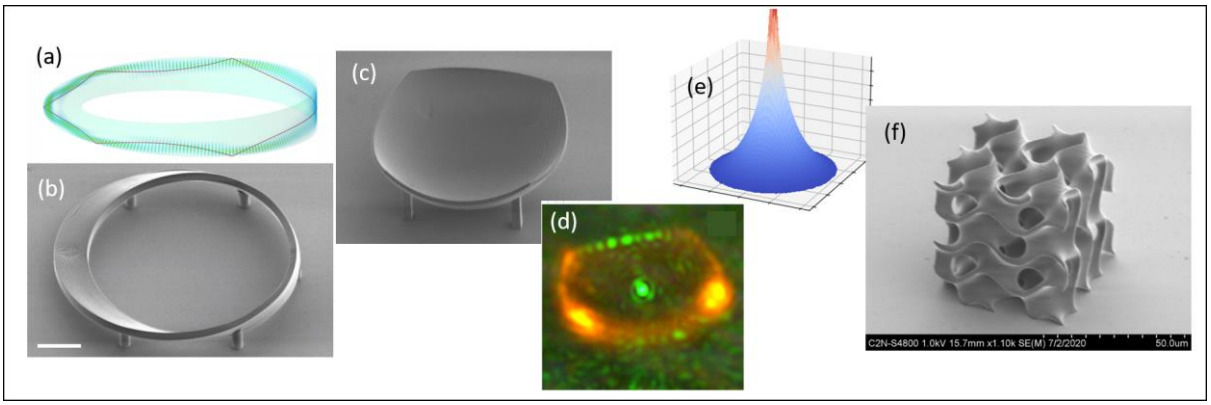

Figure: (b,c,f) Scattering Electronic Microscope (SEM) images of resonators fabricated in C2N by DLW. The typical scale is 100 µm. (a) High-Q wavefunction of a Möbius strip resonator calculated by 3D FDTD simulation, which is located on the periodic geodesic in red line. (b) Möbius strip microlaser. (c) Spherical square microlaser. (d) Optical microscope image of a spherical square under pumping. The pump laser is green, while the laser emission from the microlaser is yellow/orange. (e) Plot of a pseudosphere. (f) Surface of high genus (ie. number of holes).

Recently, we demonstrated the fabrication of surface-like microlasers by Direct Laser Writing (DLW). The laser modes were indeed located along periodic geodesics [2] (a geodesic is the shortest path between two points on a surface, like the straight line in Euclidean space). It opens the way to a new domain, called Non-Euclidean Photonics. In spherical squares, for instance, the geodesics are stable (Fig. bc). During the internship, the student will investigate microlasers based on a pseudosphere, a surface with constant negative curvature (Fig. e), where geodesics are unstable and the classical dynamics is chaotic [3].

The microlasers are fabricated by Dominique Decanini, the FDTD simulations are performed by Xavier Chécoury, the experiments are carried out by Mélanie Lebental, and the theory is developed by Barbara Dietz. The student will be involved in some of these tasks according to his/her likings.

[1] H.-J. Stöckmann, *Quantum chaos, an introduction*, Cambridge University Press (1999).
[2] Y. Song et al. *Möbius strip microlasers: a testbed for non-Euclidian photonics*, Physical Review Letters, vol. 127, 203901 (2021). Editor's suggestion. Arxiv:2011.12088
[3] H. Girin et al. *Exploring non-Euclidean photonics: pseudosphere microlaser*, Axiv: 2410.07034 (2024).