Laser dynamics

This research activity aims at understanding different aspects of laser dynamics, with a special focus on two-frequency lasers. We are interested in reducing the phase and intensity noise of solid-state or semiconductor lasers, in order to develop low-noise laser oscillators. We also study the spatial properties of laser fields, and the vectorial properties of the intracavity modes. All these activities have both a fundamental interest, and the potential for practical applications. For instance, our studies on synchronization and on laser noise are important for the implementation of ultrastable oscillators. Low intensity noise sources are mandatory in the future microwave-photonics systems, but also in cold atoms experiments and in coherent optics. The themes developed in this research domain have several connections other studies of the team in **Microwave photonics** and **TeraHertz and metrology**.

Low-noise laser sources

Synchronization in vectorial lasers

Transverse effects

The excitation of high-order transverse modes in laser cavities has been studied for a long time, since some modes have very interesting characteristics. For instance, Laguerre-Gauss modes carry orbital angular momentum, Bessel beams have a very low divergence, and so on. It has been suggested that it is possible to selectively excite these modes in an optically-pumped plano-concave resonator, by a proper positioning of the pump focal spot in the transverse plane. Our work has shown that the excitation of high-order modes having circular or elliptical nodal lines is possible only in presence of a partial degeneracy of the cavity. In this case, a superposition of modes of different order is generally obtained, resulting in a transverse profile that is not shape-invariant when the beam propagates [Bar14]. The effects of partial degeneracy result also in the emission of so-called “geometric modes”, whose properties can be understood, to a certain extent, using ray optics [Bar17].

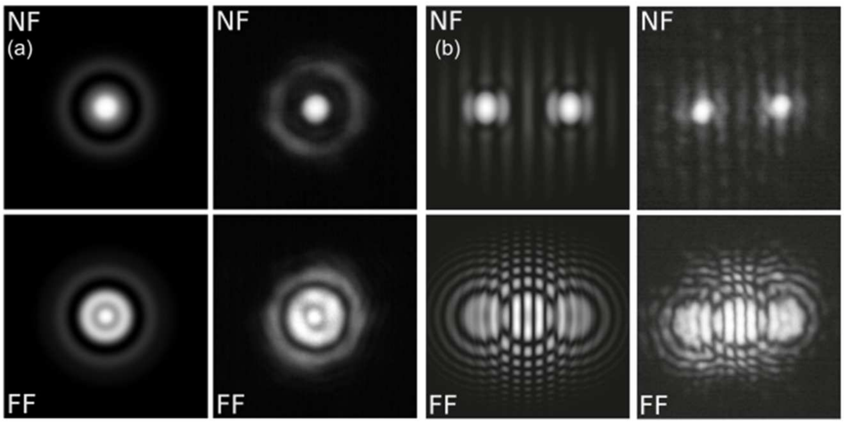

Fig. 6: (a) Experimental and simulated stationary intensity transverse profiles (NF: near field, FF: far field) of a Nd:YAG plano-concave laser, close to a cavity degeneracy [Bar14]. (b) Experimental and simulated stationary intensity transverse profiles of a geometric mode [Bar17].

Selected publications:

[Bar14] N. Barré, M. Romanelli, and M. Brunel, "Role of cavity degeneracy for high-order mode excitation in end-pumped solid-state lasers," Opt. Lett. 39, 1022 (2014).

[Bar17] N. Barré, M. Romanelli, M. Lebental, and M. Brunel, "Waves and rays in plano-concave laser cavities: I. Geometric modes in the paraxial approximation," Eur. Journ. Phys., in press (2017).

Laser control by electronic spin injection

PhD theses (*past* / ongoing) **:**

Jérémy Thévenin, « Accrochages de fréquences dans les lasers vectoriels à état solide : étude du verrouillage de modes passif et de la réinjection décalée en fréquence », 2012.

Nicolas Barré, « Étude de la sélection des structures transverses stationnaires dans les lasers », 2014.

Kevin Audo, *« Lasers solides bifréquences auto-régulés en bruit d'intensité »*

Aurélien Thorette, *«Structures de polarisation dans les lasers et réinjection : application à la génération de faisceaux opto-hyper »*

Alexandre Joly

Gaelle Breval

Collaborations:

Institut Foton-OHM

Laboratoire CIMAP (Université de Caen)

Laboratoire Aimé Cotton (Palaiseau)

Laboratoire de Photonique et Nanostructures LPN (Marcoussis)

Thales Research and Technology (Palaiseau)

UMR CNRS/Thales

Groupe d'Optique Non Linéaire Théorique (Université Libre de Bruxelles)

Contacts :

				
M. Alouini	M. Brunel	G. Loas	M. Romanelli	M.Vallet

FOTON-DOP team

Head of the team : François BONDU
Tel : +33 223 235 156
francois.bondu@univ-rennes1.fr

Website: http://foton.cnrs.fr/v2016/spip.php?rubrique111

Institut FOTON - Équipe DOP
Université de Rennes 1 – CNRS UMR 6082
Campus de Beaulieu – Bat 11B
263 avenue du Général Leclerc
F-35042 RENNES CEDEX
FRANCE