

CEA - Saclay 91191 Gif-sur-yvette Cedex
Service de Physique de l'Etat Condensé
SÉMINAIRE

Mercredi 9 mars 11h15

Orme des Merisiers SPEC Salle Itzykson, Bât.774

Lasers, Anti-lasers and PT-symmetric Laser-Absorbers

D. Stone

Yale University,

New Haven (USA)

A laser is an optical device that transforms incoherent input energy (the pump), into coherent outgoing radiation in a specific set of modes of the electromagnetic field, with distinct frequencies. There is a threshold pump energy for the first lasing mode, and above that energy the laser is a non-linear device and non-linear interactions strongly affect the emission properties of the laser. Surprisingly, the theory of non-linear multimode lasing was quite rudimentary until recently. We describe a new formalism, based on non-hermitian states of the electromagnetic field, which provides a quantitative and tractable description of arbitrarily complex laser systems, including extremely open and non-linear examples, such as random lasers. Our reformulation of laser theory emphasizes that a laser cavity is a certain kind of scattering system, with a non-unitary amplifying scattering matrix due to the presence of gain. This approach suggested the possibility of constructing a time-reversed or “anti-laser”, which we term a coherent perfect absorber (CPA); a device in which the gain medium of the laser is replaced with a loss medium such that the cavity will perfectly absorb the incoming (time-reversed) modes of the corresponding laser. Recently we have experimentally demonstrated such a device in a simple silicon cavity, which acts as an absorptive interferometer, in which narrow-band absorption can be both increased to ~ 99% and reduced to ~30%. Finally, the same point of view leads to hybrid devices, containing both gain and loss media, which can function simultaneously as a laser and a perfect absorber for distinct modes of the electromagnetic field. This happens as a result of a spontaneous symmetry breaking transition, which destroys the parity-time-reversal symmetry of the eigenstates of the corresponding S-matrix.

The seminar will be given in English. A coffee break will be served at 11h00.

Contact : patrice.bertet@cea.fr/elisabeth.bouchaud@cea.fr - Tel : +33 1 69 08 55 29 / 41 03
<http://iramis.cea.fr/spec/>