



FWF SFB INFRARED OPTICAL NANOSTRUCTURES

IR-ON SEMINAR

Lasers, Anti-lasers and Laser-absorbers

A. Douglas Stone

Dept. of Applied Physics – Yale University

Monday July 11th, 2011, 14:00

Technische Universität Wien, Seminarraum des Instituts für Photonik

Gußhausstraße 27-29, 1040 Wien, Raum CBE G02

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.

Host: Stefan Rotter

contact: ironsfb@tuwien.ac.at

FWF Der Wissenschaftsfonds.