Guía docente
32071 - AOBEC - Simuladores Cuánticos, Condensados de Bose-Einstein y Gases Cuánticos Ultrafríos

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Unidad responsable: Escuela Técnica Superior de Ingeniería de Telecomunicación de Barcelona
Unidad que imparte: 10041 - UB-FQ - (CAS) pendent.

Titulación: DOCTORADO EN FOTÓNICA (Plan 2007). (Asignatura optativa).
MÁSTER UNIVERSITARIO EN FOTÓNICA (Plan 2009). (Asignatura optativa).
MÁSTER UNIVERSITARIO ERASMUS MUNDUS EN INGENIERÍA FOTÓNICA, NANOFOTÓNICA Y BIOFOTÓNICA (Plan 2010). (Asignatura optativa).

Curso: 2015 **Créditos ECTS:** 2.5 **Idiomas:** Inglés

PROFESORADO

Profesorado responsable: Anna Sanpera

Otros: Maciej Lewenstein
(V.Ahufinger i A.Polls)

METODOLOGÍAS DOCENTES

Presencial teaching + activities

OBJETIVOS DE APRENDIZAJE DE LA ASIGNATURA

The objective of this course is to give an introduction into the recent developments in the field of atom optics which exploits the duality particlewave of individual atoms. This field emerged in the 80's with the cooling and trapping of individual atoms to very low temperatures. At these temperatures, it is possible to implement mirrors, beam splitters, diffraction gratings and interferometers for atoms, in close analogy of optics, thus the name atomoptics. Moreover, the achievement of BoseEinstein condensation in 1995 has opened the possibility to develop a coherent source of atoms, in analogy with the sources of coherent radiation (lasers). The phenomena of condensation, has, however, a quantum statistical origin, which leads to many different physical processes that will be discussed. In this course we will give an overview of the state of the art and discuss possible applications.

CONTENIDOS

1. Introduction and Motivation The importance of quantum optics and BEC, physical systems where BEC is present (e.g. Helium, Neutron Stars,etc..), overview of the field.

2. Basic concepts on cooling and trapping of atoms. Laser cooling, Doppler cooling, Beam deceleration, Sub-Doppler cooling: Polarization gradient or Sisyphus cooling, Below the recoil limit: Velocity Selective Coherent Population Trapping, Evaporative cooling.

3.Atomic traps: Optical traps, magnetooptical traps, magnetic traps. Optical lattices

4. Bose Einstein Condensation What is a BEC?, How to create a BEC, Ideal gas of bosons, Weakly interacting bosons, Gross-Pitaevskii equation, BogoliubovdeGennes equations, hydrodynamic theory.

5. Ultracold gases in optical lattices: Basic concepts From weakly interacting systems to stronglcy correlated systems

6. Quantum simulators

SISTEMA DE CALIFICACIÓN

Delivery of homework proposed during the lectures Short oral presentation of a subject present in the contents but worked by the student.

NORMAS PARA LA REALIZACIÓN DE LAS PRUEBAS.

The usual in university teaching

BIBLIOGRAFÍA

Básica:
- Metcalf, H.J.; van der Straten, P.. Laser cooling and trapping. Heidelberg: Springer, 1999. ISBN 0387987479.
- Meystre, P. Atom optics. Berlin [etc.]: Springer Verlag, 2001. ISBN 0387952748.
- Foot, C.J. Atomic physics. Oxford: Oxford University Press, 2005. ISBN 0198506953.
- Fox, M. Quantum optics: an introduction. Oxford ; New York: Oxford University Press, 2006. ISBN 0198566727.

Complementaria:
- Legget, A.J. "Bose-Einstein condensation in the alkali gases: some fundamental concepts". Reviews of modern physics [Recurs electrònic] [en línea]. Vol. 73, issue 2 (2001), p. 307-356 [Consulta: 18/11/2011]. Disponible a: http://rmp.aps.org/abstract/RMP/v73/i2/p307_1.
- Bongs, K.; Sengstock, K. "Physics with coherent matter waves". Reports on progress in physics [Recurs electrònic]. Vol. 67, num. 6 (2004), p. 907-963.
- Pethick, C.J.; Smith, H. Bose-Einstein condensation in dilute gases. 2nd ed. Cambridge ; New York: Cambridge University Press, 2008. ISBN 052184651X.
- Pitaevskii, L.P.; Stringari, S. Bose-Einstein condensation. Oxford: Clarendon Press, 2003. ISBN 0198507194.