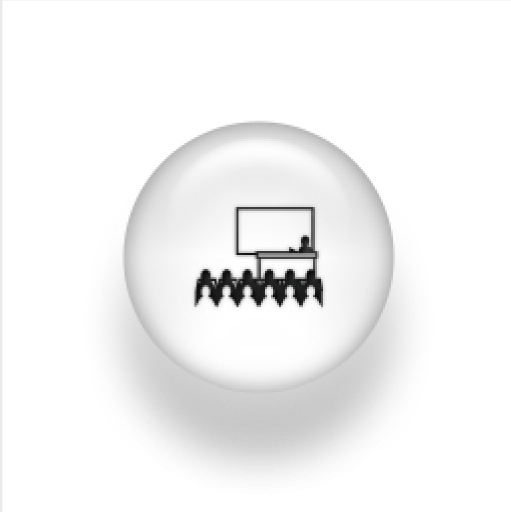
Quantum transport of cold atoms

Wenesday, 5th October 2011. 12:00-13:00



Fernando Sols
Universidad Complutense de Madrid

ABSTRACT:

Cold atom devices permit the exploration of novel forms of quantum transport that are difficult or impossible to realize in traditional electron transport setups. Under the action of an external driving, long-term coherent atom motion can be quite sensitive to the initial switching conditions even in the presence of interactions [1]. If the driving violates space- and time-inversion symmetry simultaneously, then coherent motion of a Bose-Einstein condensate in a given direction can be induced [2], as has been recently observed [3]. For weak driving, this coherent quantum ratchet stems from the interference between first- and second-order processes, as revealed by precise analytical work [4]. A different scenario is that of a leaking condensate passing through an interface which separates regions of subsonic and supersonic flow. On the supersonic (normal) side of the event horizon, we find the bosonic analog of Andreev reflection in superconductors [5]. On the other hand, the analog of Hawking radiation is emitted into the subsonic side, even at zero temperature. We study a double barrier structure which is predicted to emit resonant, highly non-thermal Hawking radiation [6].

[1] C. E. Creffield, F. Sols, Phys. Rev. Lett. 100, 250402 (2008); Phys. Rev. A 84, 023630 (2011).

[2] C. E. Creffield, F. Sols, Phys. Rev. Lett. 103, 200601 (2009).

[3] T. Salger, S. Kling, T. Hecking, C. Geckeler, L. Morales-Molina, M. Weitz, Science 326, 1241 (2009).

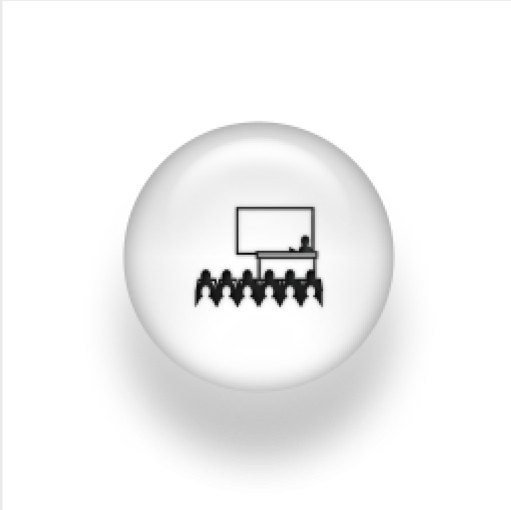
[4] M. Heimsoth, C. E. Creffield, F. Sols, Phys. Rev. A 82, 023607 (2010).

[5] I. Zapata, F. Sols, Phys. Rev. Lett. 102, 180405 (2009).

[6] I. Zapata, M. Albert, R. Parentani, F. Sols, New J. Phys. 13, 063048 (2011).

Quantum transport of cold atoms

Wednesday, 23 February 2011. 12:00-13.00



Prof. Fernando Sols
Departamento de Física Teórica, UCM

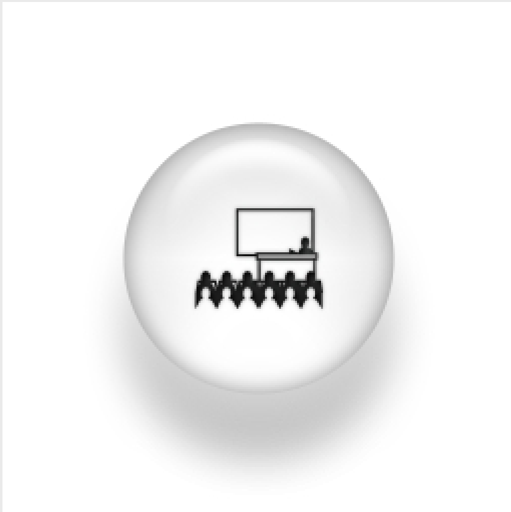
ABSTRACT:
Cold atom devices permit the exploration of novel forms of quantum transport that are difficult or impossible to realize in traditional electron transport setups. Under the action of an external driving, long-term coherent atom motion can be quite sensitive to the initial switching conditions even in the presence of interactions [1]. If the driving violates space- and time-inversion symmetry simultaneously, then coherent motion of a Bose-Einstein condensate in a given direction can be induced [2], as has been recently observed [3]. For weak driving, this coherent quantum ratchet stems from the interference between first- and second-order processes, as revealed by precise analytical work [4]. A different scenario is that of a leaking condensate passing through an interface which separates regions of subsonic and supersonic flow. On the supersonic (normal) side of the event horizon, we find the bosonic analog of Andreev reflection in superconductors [5]. On the other hand, the analog of Hawking radiation is emitted into the subsonic side, even at zero temperature. We study a double barrier structure which is predicted to emit resonant, highly non-thermal Hawking radiation [6].

[1] C. E. Creffield and F. Sols, “Controlled Generation of Coherent Matter Currents Using a Periodic Driving Field”, *Phys. Rev. Lett.* 100, 250402 (2008).
[2] C. E. Creffield and F. Sols, “Coherent Ratchets in Driven Bose-Einstein Condensates”, *Phys. Rev. Lett.* 103, 200601 (2009).
[3] T. Salger, S. Kling, T. Hecking, C. Geckeler, L. Morales-Molina, and M. Weitz, “Directed Transport of Atoms in a Hamiltonian Quantum Ratchet”, *Science* 326, 1241 (2009).
[4] M. Heimsoth, C. E. Creffield, and F. Sols, “Weakly driven quantum coherent ratchets in cold-atom systems”, *Phys. Rev. A* 82, 023607 (2010).

[5] I. Zapata and F. Sols, “Andreev Reflection in Bosonic Condensates”, *Phys. Rev. Lett.* 102, 180405 (2009).
[6] I. Zapata *et al.*, to be published.

Optical Response of Metallic Nanogaps: From Nanoelectronics to Nanoplasmonics

Wednesday, 12 January 2011, 12:00-13.00



Prof. Juan Carlos Cuevas
Departamento de Física Teórica de la Materia Condensada, UAM

ABSTRACT:
Metal nanostructures act as powerful optical antennas because collective modes of the electron fluid in the metal are excited when light strikes the surface of the nanostructure. These excitations, known as plasmons, can have evanescent electromagnetic fields that are orders of magnitude larger than the incident electromagnetic field. The largest field enhancements often occur in nanogaps between plasmonically active nanostructures, but it is extremely challenging to measure the fields in such gaps directly. These enhanced fields have applications in surface-enhanced spectroscopies, nonlinear optics, and nanophotonics.
In this talk I will show how using ideas coming from electronics one can indeed have experimental access to the local electric field in illuminated metallic gaps where the electrodes are separated by a subnanometer distance. In particular, I will show our recent results that demonstrate that when an atomic-scale gold gap is illuminated, the local field in the gap region can be enhanced by more than three orders of magnitude, as compared to the incident field [1]. I will also present theoretical simulations that reveal that these huge field enhancements originate from the excitation of hybrid plasmons involving charge oscillations in both electrodes [2].
[1] D.R. Ward, F. Hüser, F. Pauly, J.C. Cuevas, and D. Natelson, Nature Nanotech. 5, 732 (2010).
[2] A. García-Martín, D.R. Ward, D. Natelson, and J.C. Cuevas, to be published.