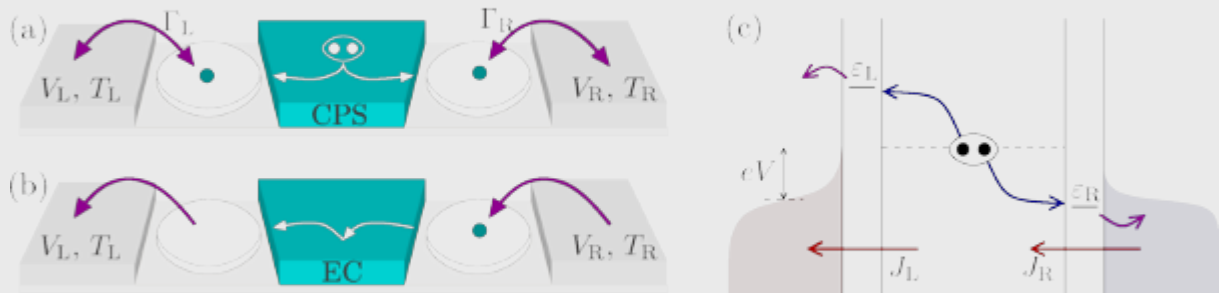


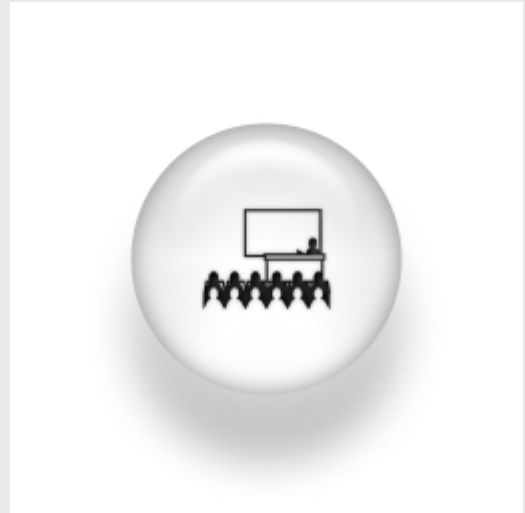
Cooling By Cooper Pair Splitting



Article: published in [Physical Review B](#) selected as an “Editor’s Suggestion” paper by [Rafael Sánchez](#) and [Alfredo Levy Yeyati](#), [IFIMAC](#) researchers and members of the Department of Theoretical Condensed Matter Physics.

The electrons forming a Cooper pair in a superconductor can be spatially separated preserving their spin entanglement by means of quantum dots coupled to both the superconductor and independent normal leads. We investigate the thermoelectric properties of such a Cooper pair splitter and demonstrate that cooling of a reservoir is an indication of nonlocal correlations induced by the entangled electron pairs. Moreover, we show that the device can be operated as a nonlocal thermoelectric heat engine. Both as a refrigerator and as a heat engine, the Cooper pair splitter reaches efficiencies close to the thermodynamic bounds. As such, our work introduces an experimentally accessible heat engine and a refrigerator driven by entangled electron pairs in which the role of quantum correlations can be tested. [[Full article](#)]

[Quantum transport of cold atoms](#)



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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).

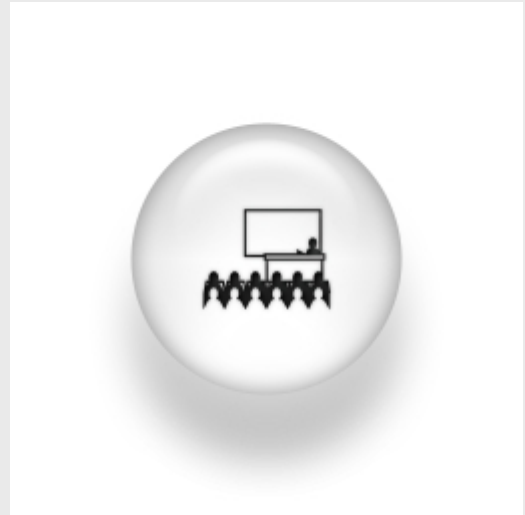
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[3] T. Salger, S. Kling, T. Hecking, C. Geckeler, L. Morales-Molina, M. Weitz, Science 326, 1241 (2009).

[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).



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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).

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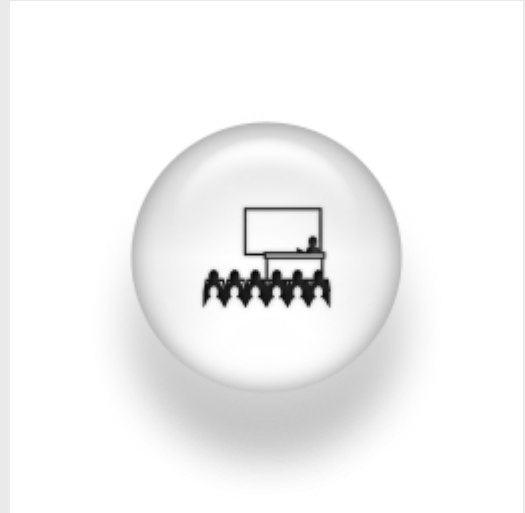
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Optical Response of Metallic Nanogaps: From Nanoelectronics to Nanoplasmonics

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].

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