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

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Mercredi 6 juin 11h15

Orme des Merisiers SPEC Salle Itzykson, Bât.774

Silicon transistors for mesoscopic physics

Xavier JEHL

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During this talk I will present some results recently obtained with multigate silicon transistors purposely designed for mesoscopic physics studies. For time reasons I will probably develop in details only one of the two following results (à la carte seminar!).

Atomic spectroscopy in the solid-state: a measurement of the valley-orbit splitting with two donors

The energy levels of a single donor in silicon are widely spaced due to the strong atomic-like electronic confinement. The ground state and first excited states produced by an arsenic donor atom are separated by the so-called valley-orbit splitting, which is significantly lower when the atom is in a nanowire (compared to when it is in bulk silicon) because it is sensitive to where the donor atom is positioned, nearby interfaces, and external fields. We fabricated a silicon nanowire with 2 phosphorus donors controlled by 3 voltage gates. In this compact device, the ground level of one donor atom acts as an energy filter that probes the levels of the other [1].

A hybrid metal/semiconductor electron pump for quantum metrology

Electron pumps driven in the GHz frequency range are likely to trigger a new "quantum" definition for the ampere. We study single-island hybrid metal/semiconductor transistor pumps which combine the simplicity and efficiency of Coulomb blockade in metals with the unsurpassed efficiency of silicon switches. We achieve pumping of up to 7 electrons per cycle at 1GHz and find an even/odd effect in the current plateaus at zero bias which is well explained by multi-charge pumping with trajectories enclosing several Coulomb lines. Long term measurements with a cryogenic current comparator show a relative uncertainty of 3 parts per million. Furthermore our design includes a back gate which allows to control the impact of single background charges in the nanowire transistors on the stability diagram of the metallic island.

[1] B. Roche et al., PRL 108, 206812 (may 2012) "Detection of a Large Valley-Orbit Splitting in Silicon with Two-Donor Spectroscopy" [2] X. Jehl et al., submitted to PRX (may 2012) " A gigahertz hybrid metal/semiconductor electron pump with a few part-per-million relative uncertainty and offset charge control"

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

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