**Seminars:**

*Ugo Boscain*

**Title:** Optimal Control for finite dimensional quantum systems

In this talk, I will show how to attack the population transfer problem for finite dimensional quantum systems using technique coming from of optimal control.

As examples I will consider the minimum time problem for a spin 1/2 particle driven by one magnetic field and the minimum energy problem for a 3-level molecule driven by two fields in the RWA. For this last example I will discuss the relations with the STIRAP techniques.

*John Gough*

**Title:** Coherent Control via Quantum Feedback Networks

We outline the quantum feedback network approach to modelling quantum components driven by quantum input processes where there is a specified connection architecture. This allows block-diagram design of quantum coherent feedback controllers, and we outline a number of recent theoretical and experimental developments in this direction.

*Antoine Heidmann*

**Title:** Quantum limits in optomechanical measurements

The development of very high finesse optical cavities together with low-mass micro-mechanical resonators opens the way to a new regime in which the dynamical properties of an optomechanical system are governed by the radiation pressure exerted by light on mirrors. This optomechanical coupling leads to quantum limits in ultra-sensitive interferometric measurements such as gravitational-wave detectors, but also to very efficient laser-cooling mechanisms and control of the mechanical resonator. Different consequences of radiation pressure have already been observed, such as the optomechanical correlations between the radiation pressure and the mirror motion, with applications both in high-sensitivity measurements and in quantum optics.
**Benjamin Huard**

Title: **Building a quantum limited amplifier from Josephson junctions and resonators**

In the last decade, superconducting circuits have proven to be state of the art quantum information processors. While these processors use the superconducting electric degrees of freedom, the information traveling from the circuit to a macroscopic measurement apparatus is carried by microwave photons. In order to measure these propagating bits of information, one needs to amplify the few photon microwave signals by several orders of magnitude to the proper power level required by commercial instruments. The price to pay for this amplification is the necessary degradation of information. Indeed, an extension of the no-cloning theorem imposes that a linear phase independent amplifier adds at least half a quantum of noise to the signal. This quantum limit is still far from being reached in the best commercial amplifiers where about 20 to 40 quanta of noise are added. I will present a new type of parametric amplifier based on a ring of four Josephson junctions. The key to reach quantum limited amplification is to minimize the number of information channels. I will describe the measured characteristics of some of our amplifiers and present applications and perspectives.

**Alexei Ourjoumtsev**

Title: **Feedback cooling of a single neutral atom**

I will present a series of experiments demonstrating feedback cooling of a single neutral atom trapped inside a high-finesse optical cavity. Based on the detection of single photons from a probe beam transmitted through the cavity, the position of the atom in the trap is estimated. Following this information, the trapping potential is switched between a high and a low value in order to counteract the atomic motion. This allowed us to increase the storage time by more than one order of magnitude, and to cool the atom down to 160µK. Feedback cooling therefore rivals state-of-the-art laser cooling but requires less optical access and exhibits less optical pumping.

Authors and affiliations:

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**Enrique Solano**

**Title:** Measuring the wavefunction in trapped ions

We briefly review some landmarks in quantum measurements of the internal and external degrees of freedom in trapped ions. We present also novel developments, some of which have been implemented in recent trapped-ion experiments.

**Andreas Wallraff**

**Title:** Quantum optics with superconducting circuits: exploring propagating microwave photons

Using modern micro and nano-fabrication techniques combined with superconducting materials we realize quantum electronic circuits. We create, store, and manipulate individual microwave photons on a chip. The strong interaction of photons with superconducting quantum two-level systems allows us to probe fundamental quantum effects of light and also to develop components for applications in quantum information technology. In particular, I will discuss experiments in which we demonstrate first and second-order correlation function measurements of microwave frequency single photon sources integrated on the same chip with 50/50 beam splitters. In the absence of efficient single photon counters at microwave frequencies, linear amplifiers and quadrature amplitude detectors are used for correlation measurements [1]. Our data clearly displays single photon coherence in first-order and photon antibunching in second-order correlation function measurements of the propagating fields [2]. I will also present first measurements in which we reconstruct the Wigner function of itinerant single photon Fock states and their superposition with the vacuum [3]. To perform these measurements we have developed efficient methods to separate the detected single photon signal from the noise added by the amplifier by analyzing the moments of the measured amplitude distribution up to 4th order. The techniques and methods demonstrated in this work may find application in future linear quantum optics and quantum information processing experiments.


Howard Wiseman

Title: Adaptive measurements for pleasure and profit

The theory of adaptive measurements at the quantum limit goes back almost 4 decades, but the last few years have seen a burst of experimental activity in the area. In this talk I will briefly review the field. I will first define what adaptive measurements are, and then cover how they let one

1. do some things better
2. do some things much better
3. do some things perfectly
4. do some things uniquely.