Superconducting qubits for quantum computing and for physics

The basic building block of the quantum computer is called a qubit; an individual quantum system that can be placed in a superposition between two states. A single qubit can thus represent two numbers, 0 and 1, simultaneously. A register of N qubits can represent 2^N numbers simultaneously, resulting in a massive parallelism which can be exploited for simulation and computing. Qubits can be implemented in different technologies, presently the two main technologies build on superconducting circuits or ion traps. In this talk I will discuss coherence of superconducting qubits and what is needed to build a quantum computer.

Superconducting qubits can also be used as artificial atoms and we will discuss how they can be used to study new physics. In particular, I will show how artificial atoms can be used to study vacuum fluctuations by placing the atom in front of a mirror. I will also show how these atoms can be coupled to sound such that they decay by emitting single phonons instead of single photons. Sound coupled atoms can also act as giant atoms, which leads to new physics in terms of large Lamb shifts and non-exponential decay.