

## **"Quantum information processing with photons and atomic ensembles"**

**In these lectures I will review theoretical proposals and experimental progress towards the storage and processing of quantum information using photons as "flying qubits" and collective atomic excitations as "stationary qubits". The concept of Stimulated Raman Adiabatic Passage (STIRAP) for single quantum systems will be introduced and its application to deterministic single photon sources and quantum gates discussed. The generalization to atomic ensembles then leads to the concepts of Electromagnetically Induced Transparency and dark-state polaritons. Their application to photonic quantum memories (storage of light) will be outlined. The role of decoherence in collective quantum memories will be discussed and it will be shown how decoherence can be suppressed in these systems below the level possible in quantum memories based on single atoms. Furthermore proposals to build quantum gates between qubits stored in delocalized collective excitations will be examined. Finally the possibility to employ atomic ensembles to build quantum repeaters will be discussed.**

**1st lecture: Stimulated Raman Adiabatic Passage and cavity-QED with individual atoms**

**2nd lecture: Atomic ensembles, EIT and storage of light**

**3rd lecture: Decoherence in collective quantum memories for photons**

**4th lecture: Quantum gates and quantum repeater based on atomic ensembles and light**