OPTICAL AND ELECTRICAL SPIN INJECTION IN SEMICONDUCTOR QUANTUM DOTS

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Numerous proposals for future spintronic and quantum information devices are based on manipulating or storing information in the form of electronic or nuclear spin polarization in semiconductor quantum dots (QD). This approach is very attractive since a long coherence time is expected, as a result of the inhibition of the classical spin relaxation mechanisms: the discrete energy levels in semiconductor quantum dots and the corresponding lack of energy dispersion lead to a slowdown of the spin relaxation processes compared to bulk or two-dimensional structures [1,2].

We have studied the spin dynamics of electrons, holes, neutral and charged excitons in undoped and doped QD by time-resolved photoluminescence. We will give a review of recent experimental results on optical spin injection in InAs/GaAs [1-9], GaAs/AlGaAs [10] and GaN/AlN [11] quantum dots.

An electron spin confined to a quantum dot is not subject to the classical spin relaxation mechanisms known for free carriers but it strongly interacts with the nuclear spin system via the hyperfine interaction. By analysing the polarization state of photons absorbed or emitted by the dot, we show how optical pumping of electron spins in individual self assembled InAs QDs leads to a strong nuclear polarisation that can be measured via a drastic change in the Zeeman splitting (the Overhauser shift) in magneto-photoluminescence experiments [7-9].
We will show that the nuclear magnetic field, in the order of a few Teslas, created through optical pumping is bistable [8-10] and can be controlled through a slight variation of an experimental parameter such as the excitation laser polarization or external magnetic field.

Finally we will present results on the electrical spin injection in Spin-LED quantum dots Device [12,13].

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