An electrically pumped quantum well exciton-polariton laser

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Semiconductor diode lasers play a major role in everyday life in our information society. These lasers generate coherent light by stimulated emission of photons. In contrast, laser-like operation can be obtained also by stimulated scattering of bosonic quasiparticles called exciton-polaritons into the ground state of strongly coupled light-matter systems in microcavities (see a schematics in Fig. 1) [1]. This polariton laser regime can be reached with pump thresholds orders of magnitude lower than conventional lasing. The exciton-polaritons decay by the leakage of photons from a cavity, which produces a monochromatic and coherent light output. While sub-threshold emission from polariton light emitting diodes has been reported by various groups [2-4], by utilizing a magnetic field as a tool and probe for polaritonic lasing, we report in this talk exciton-polariton laser operation under electrical pumping [5], which is essential for developing practical applications.

In order to characterize the three different operation regimes of our device, we performed polarization selective and magnetic field dependent emission. Figure 2 summarizes the energetic difference between the $\sigma^+$-polarized and $\sigma^-$-polarized light yielding the Zeeman splitting. In the linear non-lasing regime, the Zeeman splitting is a linear function of magnetic field, while an initial quenching of the Zeeman splitting is observed above the polariton threshold. For higher drive currents, a transition from strong to weak coupling is observed and one crosses the regular photon lasing threshold. As expected, no magnetic field dependent mode splitting can be observed in the photonic lasing case.

![Fig. 1](image1.png) Schematics of the strongly coupled quantum well microcavity diode structure that facilitates polariton lasing under electrical pumping.

![Fig. 2](image2.png) Magnetic field dependent Zeeman splitting of the quantum well microcavity sample in the regimes operating below threshold, above the polariton laser threshold and above the photon laser threshold.