Linear polarisation inversion: A signature of Coulomb scattering of cavity polaritons with opposite spins.

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The polariton-polariton Coulomb scattering plays a dominant role in the polariton dynamics in microcavities [1] under strong optical pumping. In particular, it is responsible for a variety of coherent effects observed under excitation of the lower polariton branch at the so-called magic angle, when the conditions for two-particle processes are most favourable. The knowledge of the interaction Hamiltonian is the keystone for building an adequate theoretical description of these experimental results. The interaction of two exciton-polaritons is believed to be dominated by exchange terms, of which one responsible for scattering of polaritons with parallel spins (U) is the strongest [2]. The term corresponding to interaction of polaritons with anti-parallel spins (U') has been calculated using a second-order perturbation theory [3], but to the best of our knowledge has never been detected experimentally. In this work, we derive a general expression for the polarisation of scattered polaritons and compare it with experimental data obtained under pulsed excitation with elliptically polarised light at the magic angle and time- and polarisation-resolved detection at zero angle. We use a general expression for the spin Hamiltonian allowed by axial symmetry of the structure: $\hat{H}_{SS}=\frac{1}{2}(U-U')\hat{I}+\frac{1}{2}(U+U')\hat{\sigma}_{z1}\hat{\sigma}_{z2}+U_{\perp}(\hat{\sigma}_{x1}\hat{\sigma}_{x2}+\hat{\sigma}_{y1}\hat{\sigma}_{y2})$, where $\hat{I}$ is the identity matrix, $\hat{\sigma}_1$ and $\hat{\sigma}_2$ are Pauli matrices of pseudo-spins of the two polaritons [4], and $U_{\perp}$ is a flip-flop term which is believed to be insignificant [3]. The main prediction of the theory is that the linear polarisation should change sign (say, become Y instead of the photo-generated X one) if $U'-2U_{\perp}>0$, as a result of coherent scattering of polaritons with different spins. This is indeed observed (see Fig.1). A more detailed comparison of the experiment and the model allows us to estimate U' as $U'\approx 0.04U$.

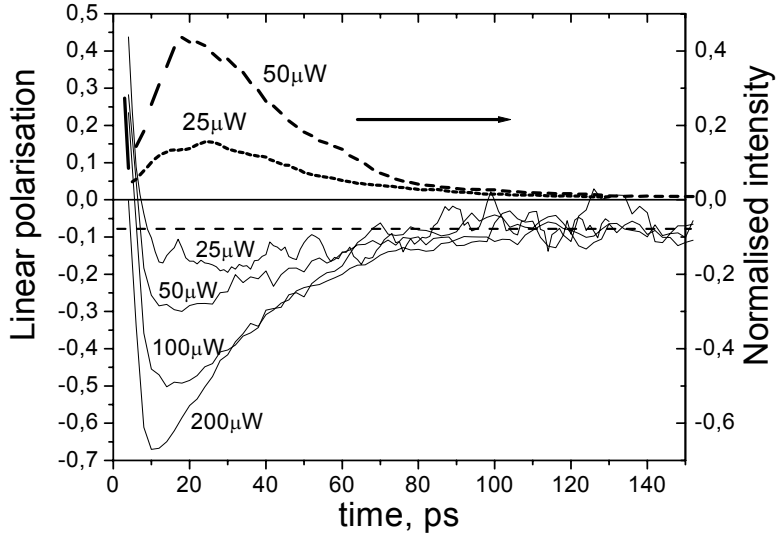

Fig.1. Linear polarisation of emission from an (AlAs/AlGaAs)/ GaAs microcavity with a GaInAs quantum well at zero-detuning, detected along the normal to the structure plane,

under excitation at 8^o (magic angle) with a 1.5-ps pulse of linearly polarised light. Increase of excitation power results in stimulated scattering which amplify the polarisation of emitted light at short time delays. The constant level ρ_L=–0.08 (dashed straight line) gives the polarisation of polaritons scattered from the bottleneck region.

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