REAL MAGNETIC FIELDS AND ARTIFICIAL HAMILTONIANS
TO CONTROL EXCITON-POLARITONS' SPIN

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The internal angular momentum, the spin of polaritons, is an important degree of freedom that can be used to control polaritons and its condensates. Polaritons inherit the spin property from excitonic component and from the point of view of spin structure are therefore bosons with a 1/2 pseudospin. Spin of polaritons is difficult to control through external parameters because polariton Zeeman splitting is usually very weak in standard semiconductor microcavities. However, spin effects can be magnified by increasing the sensitivity to magnetic field of either excitonic or photonic part of polariton in a specially designed structures.

To control the excitonic part, we propose structures based on II-VI semimagnetic semiconductors with magnetic ions incorporated into the crystal lattice. In the CdMgZnTe microcavity and CdMnTe material of the quantum well, the *s,p-d* exchange interactions between localized *d*-shell electrons of the magnetic ions and delocalized band electrons and holes allows to enhance magneto-optical properties of polaritons. I'll discuss many spectacular effect that are observed in semimagnetic exciton-polaritons and its condensates, such as giant Zeeman splitting, condensation induced by external magnetic field, giant spin Meissner effect, and spin polarized vortices. I'll demonstrate that the control over the condensate spin can be taken through external parameters such as excitation power and/or magnetic field.

The control over the polariton spin through photonic part is more difficult. Photons do not react directly to external magnetic field, so to study spin effects we propose a synthetic field resulting from H-V splitting of photonic modes which leads to the effects known as optical spin-Hall effect. I'll demonstrate a new type of a tunable birefringent microcavity filled with liquid crystal, where the H-V splitting can be tuned over extreme range from -20 meV to +50 meV. Moreover, when cavity thickness reaches the resonance condition for the photonic modes of different even-odd parities, a new coupling term becomes observable. The photon modes become circularly polarised and split, as described by the Rashba-Dresselhaus spin-orbit coupling and artificial magnetic field (Zeeman) terms in the Hamiltonian.

Our results demonstrate the wide range of method to control over polariton spins and are the first step to use the spin degree of freedom in realization of polariton simulators and logic operations based on polariton condensates.

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