Exciton Spin Dynamics in Hybrid Organic-inorganic Perovskites

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The hybrid organic-inorganic perovskites have emerged as a new class of semiconductors which make excellent solar cells with an efficiency over 20%. They are also highly promising semiconductors for the field of spintronics due to their large and tunable spin-orbit coupling, spin dependent optical selection rules, and predicted electrically tunable Rashba spin splitting. I will present our latest study of exciton spin dynamics on the solution processed polycrystalline $CH_3NH_3PbCl_xI_{3-x}$. With time-resolved Faraday rotation (TRFR) and optical Hanle measurements, we demonstrate the optical orientation and quantum beating of excitons in the perovskites, which confirms the spin-dependent optical transitions. The energy dependence of the Faraday rotation follows the exciton absorption band at low temperatures, confirming its excitonic origin. The TRFR in zero field reveals unexpected long spin lifetimes exceeding 1 ns at 4K, given that Pb and I exhibit large spin-orbit coupling, and usually lead to fast spin relaxation. Application of a transverse magnetic field causes quantum beating at two distinct frequencies, and the approximate linear relationships give two g-factors, which we tentatively assign to electrons and holes as g_e = 2.63, and g_h = -0.33. Temperature dependence and power dependence of the spin lifetimes reveal some clues to the spin relaxation mechanisms.

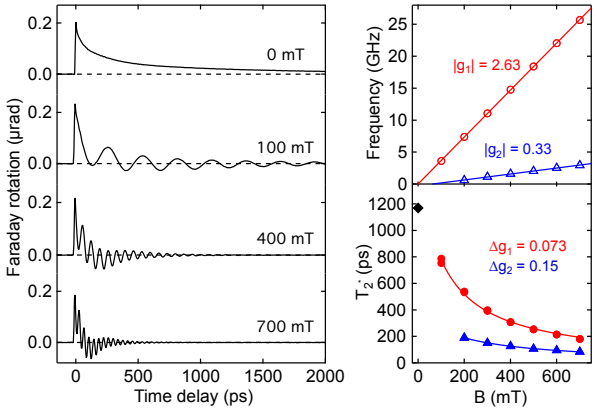

Figure 1: Left panel: Time-resolved Faraday rotation on perovskite film in different transverse magnetic fields, at 4 K. Right Panel: Oscillation frequencies and spin lifetimes vs. magnetic field for the two components.

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