Nature of the electron spin resonance in AlAs quantum wells

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The electron spin resonance (ESR) was first observed in two-dimensional electron systems (2DES) in 1983 [1] and has been intensively studied ever since. In conventional materials ESR is excited by the magnetic component of radiation. Contrary to the conventional mechanism, the spin-orbital coupling (SOC) in 2DES can give rise to the electric-dipole matrix element of ESR transition. SOC translates the movement of the electrons into the effective magnetic field inducing the transition. Despite numerous experimental efforts [2], the exact nature of SOC has remained a puzzle.

Due to the weakness of the effect, it was always measured in photoconductivity rather than in transmission. We report a direct transmission measurement of the ESR in AlAs quantum wells. Our experimental setup allows full control of polarization, providing new insights into the nature of the effect. The first success factor is the availability of different samples with anisotropic electron valley in- and out-of-plane of the QW. The second factor is the ability to apply magnetic field in Faraday (out-of-plane) and Voigt (in-plane) geometries. The obtained excitation conditions (see Figure) of ESR transition unambiguously point towards electro-dipole Dresselhaus type spin-orbit interaction.

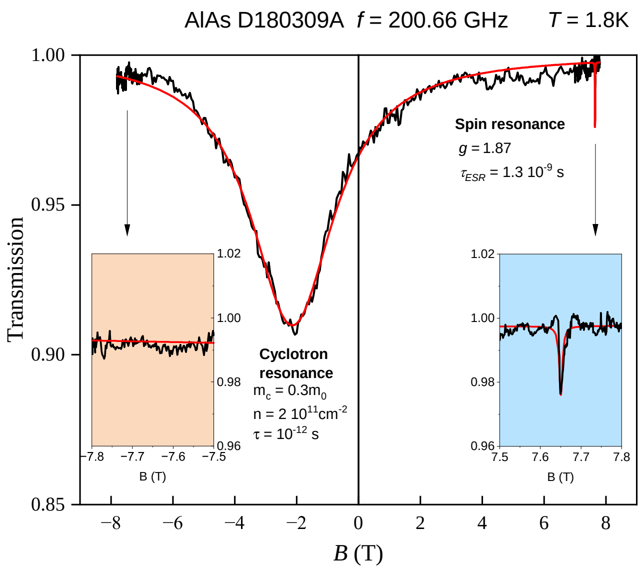

Figure 1: Transmission of the radiation at the frequency f =200.66 GHz and circular polarization.

[1] D. Stein, K. V. Klitzing, and G. Weimann, *Phys. Rev. Lett.* **51**, 130 (1983).

[2] M. Schulte, J. G. S. Lok, G. Denninger, and W. Dietsche, *Phys. Rev. Lett.* **94**, 137601 (2005).