Anomalous large apparent oscillation of effective g-factor in an InSb quantum well two-dimensional electron gas

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Investigations into the effect of magnetic fields on the effective g-factor (g^*) for electrons in low dimensional heterostructures is an area of vigorous study due to its applications in spintronic devices and quantum computing. Indium antimonide (InSb) is an extremely attractive candidate for spin dependent field studies due to its small band gap, light electron effective mass and the largest intrinsic electron g-factor, which induces spin dependent effects at much lower magnetic fields when compared to other binary compounds like GaAs. In the presence of a quantizing magnetic field the 2D density of states separates into spin split Landau levels (LL's) due to Zeeman splitting of the spin states. Resolvable spin split LL's can be observed <1T in moderate mobility InSb QW samples, (Fig.1) and large net spin populations can be achieved at modest fields.

We report magnetotransport measurements for 30nm $InSb/Al_xIn_{1-x}Sb$ QW 2DEGs with mobility up to $200{,}000 cm^2V^{-1}s^{-1}$ processed into 6 contact Hall bar geometries. Values for g^* extracted from Shubnikov de-Haas (SdH) oscillations at fields up to 8T can appear on first analysis to show enhancement of g^* (Fig.2) of up to an order of magnitude above the bulk value and around 5 times larger than anything previously reported in the literature for this material system [2]. The sign of g^* in this analysis is also calculated to oscillate between successive LL occupation, a trend which has not previously been reported in III-V compounds. These anomalous results are extracted from analysis that is employed widely throughout the literature on other material systems. However we discuss the subtle problems with this method of analysis which become starkly apparent when working with very high g* materials such as InSb.

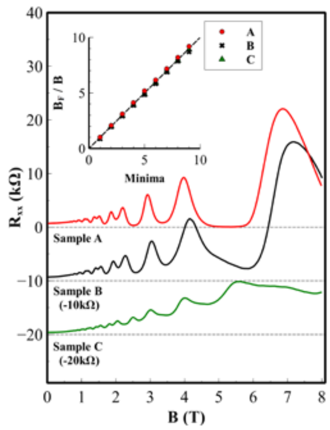

Figure 1: Longitudinal resistance (R_{xx}) as a function of B at 12mK. Samples B and C show non-ideal SdH through conduction via a parasitic conduction path. The inset shows the SdH minima

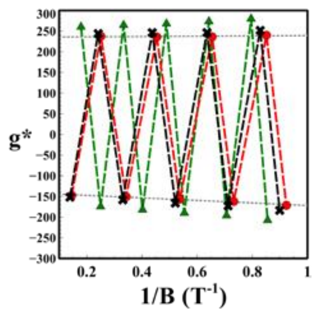

Figure 2: An apparent g* calculated for 3 samples using a non-parabolic approximation to the 2D density of states. The dotted grey lines guide the eye as to the minimum extent of the oscillation.

References

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