Characterization of Near Surface InAs Quantum Wells

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Introduction

Indium Arsenide (InAs) near surface quantum wells (NSQW) have become the focus of recent interest for their use in heterostructures with superconductors [1-3]. It has been posited that a topological superconductor could be hosted in a material with induced superconductivity, spin-orbit coupling, and in-plane magnetic field [4]. InAs NSQWs are a promising candidate as they can satisfy all these criteria to reach into the rich physics of topological superconductivity [5-6].

Experimental

The quantum well is created by MBE growth of a thin layer of InAs sandwiched by higher bandgap InGaAs materials to form a quantum well near surface on InP substrates [5]. In our experiment we studied Van der Pauw and gated-hall bar samples of two different wafers. The first sample has a top layer in the quantum well of $In_{.81}Al_{.19}As$ and the second sample has a top layer of $In_{.81}Ga_{.19}As$. These samples are referenced as JS129 and JS139 respectively.

The first experiments mapped out the magnetoresistance in both the transverse and longitudinal directions of the samples. From this data, we are able to extract gate dependence of carrier density and transport mobility. We are also able to see the quality of integer quantum hall states. Looking at the sweeps over various gate voltages we can also introduction of the second subband. A sample of this data is shown in Fig.1.

The next experiments looked at dependence of the magnetoresistance on the angle between the field and the normal vector of the 2DEG. This allows for characterization of the g-factor in our InAs. A sample of this data is shown in Fig.2.

We also looked at temperature dependence of quantum hall states where the gap can be extracted. The data for filling factor 3 is shown in Fig.3.

Lastly, we looked at spin polarization in samples by looking at magnetoresistance when swept perfectly parallel magnetic field not shown here. We are still investigating the trends we observed and cannot draw conclusions at this time. These experiments were carried out on the SCM-2 superconducting magnet.

Acknowledgements

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References

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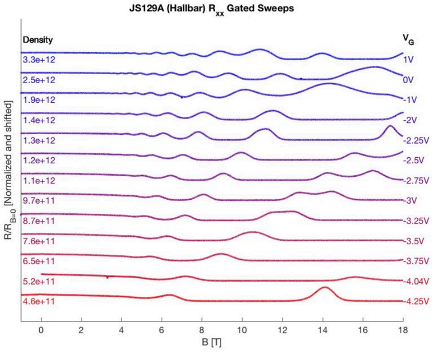

Fig.1 Longitudinal magnetoresistance shown with normalized and shifted resistance on the y-axis and Magnetic field in Tesla on the x-axis. Format highlights movement of quantum hall states with density.

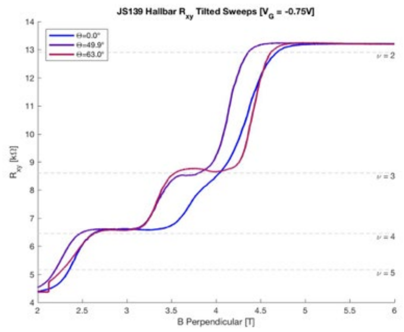

Fig.2 Hall resistance shown for three angles illustrating the angle dependence of the nu=3 quantum hall state (the emergence and disappearance of the plateau around B=3.5T

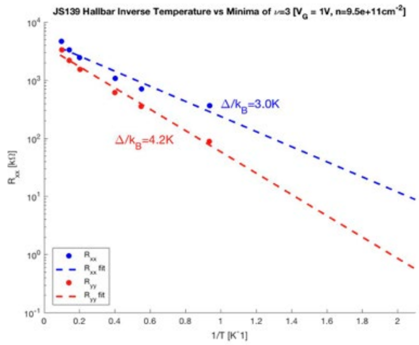

Fig.3 Minima in longitundinal resistance at the nu=3 quantum hall state as a function of 1/T. y-axis is log scale.