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Since the discovery of the fractional Quantum Hall effect (FQHE) nearly 30 years ago experimental research was concentrated on investigating fractional states in nonmagnetic materials. Typically GaAs-based systems have been studied where the small Zeeman energy E_Z causes several fractional Quantum Hall (FQH) ground states to be spin unpolarized. More recently, the FQHE was reported in a CdTe quantum well (QW) [1] - a systems exhibiting spin-polarized FQH states due to their large g-factors.

Magnetic manganese ions can easily be incorporated into CdTe based quantum structures, hence making this material system ideally suited for the search of fractional states in Diluted Magnetic Semiconductors (DMS). $Cd_{1-x}Mn_xTe$ is one of the most thoroughly investigated members of the class with all its spin dependent properties being strongly enhanced due to exchange interaction between mobile carriers and localized magnetic moments (s-d exchange). Therefore, the Zeeman splitting of electronic states can not only be gigantic but may also be engineered in magnitude, sign and field dependence.

Here we report on the observation of FQH states in the lowest Landau level (LL) of a 2DEG formed in a high quality 30 nm wide $Cd_{1-x}Mn_xTe$ quantum well. Our results present the first experimental observation of the FQHE in a diluted magnetic semiconductor ever. It thus demonstrates that the incorporation of magnetic ions into a quasi two-dimensional electron system does not inhibit the formation of FQH states.

Standard magnetotransport experiments were performed up to 19 T in a tilted magnetic field and at temperatures between 15 mK and 1 K. Due to the presence of Mn impurities the Zeeman energy is extremely high at low magnetic fields but is *reduced* when increasing the external field. We have designed our sample by adjusting the Mn concentration such that the Zeeman splitting vanishes at about 13.5 T. This gave us the unique opportunity to investigate spin effects in QH states emerging at these fields. By measuring activation energies at tilted magnetic fields we obtained the dependence on Zeeman energy of the excitation gaps at filling factors $\nu = 4/3, 5/3, 7/5$ and 8/5. A simple model within the framework of Composite Fermions (CFs) [2] provides an excellent fit of the gaps as a function of the total magnetic field if the exchange interaction between CFs and Mn-spins is taken into account. Our analysis suggests that – similar to electrons in a DMS – Composite Fermions are subject to s-d exchange interaction with Mn-spins. An analysis of the extracted CF masses m_{CF} in the vicinity of $\nu = 3/2$ will be discussed, as well as a quantitative comparison between model and experiment considering deviations coming from disorder effects or LL broadening [3].

[1] B. A. Piot *et al.*, *Phys. Rev. B* **82**, 081307 (2010)
[2] J. K. Jain, *Phys. Rev. Lett.* **63**, 199 (1989)
[3] C. R. Dean *et al.*, *Phys. Rev. Lett.* **100**, 146803 (2008); R. R. Du *et al.*, *Phys. Rev. Lett.* **70**, 2944 (1993)

73.3 Fri 9:45 Room F1

NMR probing of the spin polarization of the $\nu = 5/2$ quantum Hall state — •Michael Stern[1], Benjamin Piot[2], Yuval Vardi[1], Vladimir Umansky[1], Paulina Plochocka[2], Duncan Maude[2], and Israel Bar-Joseph[1] — [1]Department of Condensed Matter Physics, Weizmann Institute of Science, Rehovot, Israel — [2]Laboratoire National des Champs Magnétiques Intenses, CNRS-UJF-INSA-UPS, Grenoble, France

Since its discovery more than two decades ago, the fractional quantum Hall state at filling factor $\nu = 5/2$ has been raising fundamental questions concerning our understanding of strongly correlated two dimensional electron systems. Early on, Moore and Read have suggested that a weak residual attractive interaction in the second Landau level gives rise to pairing of the composite fermions, and to the formation of a gaped state. In the framework of this theory, the predicted excitation spectrum of the $\nu = 5/2$ state should consist of quasiparticles that obey non-Abelian braiding statistics. It was shown that this property may turn the $\nu = 5/2$ state into a platform for quantum computing by means of topological manipulations.

A central assumption of the Moore Read theory is that the electrons in the second Landau level are fully polarized and can, therefore, form pairs with p-type symmetry. Hence, confirming this point would provide a strong experimental evidence for the validity of the theory.

In this work, we use resistively detected nuclear magnetic resonance (NMR) to measure the Knight shift of the ^{75}As nuclei and determine the electron spin polarization of the fractional quantum Hall states of the second Landau level [1]. We measure the electron heating under radio frequency excitation, and show that we are able to detect NMR signal at electron temperatures down to 30 mK. We find that the $\nu = 5/2$ state is fully polarized, thus confirming a fundamental assumption of the Moore-Read theory. We discuss this conclusion in light of the results of our earlier photoluminescence measurements conducted on the same sample [2]. We suggest that the photoluminescence measurements probe the screening of the photoexcited valence hole by the $\nu = 5/2$ quasiparticles.

[1] M. Stern *et al.*, Phys. Rev. Lett., **108**, 066810 (2012).
[2] M. Stern *et al.*, Phys. Rev. Lett., **105**, 096801 (2010).

73.4 Fri 10:00 Room F1

Imaging fractional incompressible stripes in integer quantum Hall systems — Nicola Paradiso[1], •Stefan Heun[1], Stefano Roddaro[1], Giorgio Biasiol[2], Lucia Sorba[1], Loren N. Pfeiffer[3], Ken W. West[3], and Fabio Beltram[1] — [1]NEST, Istituto Nanoscienze-CNR and Scuola Normale Superiore, Pisa, Italy — [2]Istituto Officina dei Materiali CNR, Laboratorio TASC, Basovizza (TS), Italy — [3]Department of Electrical Engineering, Princeton University, Princeton, New Jersey 08544, USA

Despite a number of experimental and theoretical studies, the issue of fractional order within integer quantum Hall (QH) systems is still an open question. A number of experiments showed clear indications of fractional phases in constrictions [1,2], although even the simple problem of how an ideal integer edge can branch and give rise to fractional edges remains unclear. On the other hand, recent interferometry experiments [3] and out–of–equilibrium energy spectroscopy data [4] indicate that an integer edge can behave as a monolithic object and show no evidence of an inner structure. Whether such dual behavior depends on the specific device structure or is intrinsic, remains an unanswered question.

Here we use scanning gate microscopy (SGM) to demonstrate that fractional features were unambiguously observed in *every* integer quantum Hall constriction studied. The configuration of our samples is similar to that described in [5]. The SGM is operated in a ^{3}He cryostat with base temperature of 300 mK. Experiments were performed at bulk filling factor $\nu_b = 1$. We brought two counter–propagating integer–edge channels into proximity by means of a quantum point contact (QPC) and used the biased SGM tip to tune backscattering. From the measurement of the transmitted current as a function of tip position we can extract spatially–resolved information on the edge structure. In particular, plateaus are observed in source–drain differential conductance (G_T) maps whenever the tip induces an incompressible phase at the QPC center. According to the reconstruction model [6], the plateau width is approximately twice the width of the incompressible stripe. We present SGM maps which directly reveal the width of the most relevant fractional incompressible stripes, corresponding to filling factors 1/3 and 2/5, together with their particle–hole conjugates 2/3 and 3/5. We also discuss the impact of temperature on the visibility of fractional features. While at 300 mK the 1/3 pleateau is clearly observed, at a base temperature of 4.2 K it completely disappears.

In order to compare the measured widths of the fractional incompressible stripes with the predictions of the reconstruction model, it is necessary to estimate the local electron density gradient. SGM scans yield the latter value by measuring the slope of G_T near the plateaus. For each SGM scan we can thus compare the experimental value to that expected from Chklovskii's formula [6]. We show that both the absolute values and the trends of the reconstruction model predictions are in good agreement with the experimental data.

Our results may open up exciting developments. For instance, the ability to partition an integer edge and partially transmit one of its fractional components may be the key for the implementation of fractional quasi–particle Mach–Zehnder interferometers, currently one of the main goals in the field of coherent quantum transport.

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[4] C. Altimiras et al., Nature Phys. **6**, 34 (2009).
[5] N. Paradiso et al., Physica E **42**, 1038 (2010).
[6] D. B. Chklovskii et al., Phys. Rev. B **46**, 4026 (1992).

73.5 Fri 10:15 Room F1

Evidence for low-lying gapped excitations in the second LL — •Ursula Wurstbauer[1], Aron Pinczuk[1,2], Ken West[3], and Loren Pfeiffer[3] — [1]Department of Physics, Columbia University, New York, USA — [2]Department of Applied Physics & Applied Math, Columbia University, New York, US — [3]Department of Electrical Engineering, Princeton University, Princeton, USA

Physics in the second Landau level (SLL) is governed by competing phases resulting in striking phenomena. A highly intriguing state is the even denominator fractional quantum Hall (FQHE) phase at 5/2. Current theory proposes that the even-denominator FQHE state be described either as a Pfaffian or an Anti-Pfaffian many-body wave-function, where an incompressible quantum fluid is formed by weakly-paired, fully spin-polarized quasi-particles obeying non-Abelian excitations. This would make the 5/2 state a candidate for topological protected quantum processing. The excitation spectrum of the non-Abelian state should support three types of neutral excitations: spin-waves (SW) of a FQHE ferromagnet, modes in the charge degree of freedom and topological excitations ('pair-breaking' mode).

We report inelastic light scattering and optical emission measurements exploring the low-lying neutral excitation modes in the SLL. At 5/2 we find gapped modes with a roton minimum in the wave vector dispersion at an energy of 0.070meV and a gap energy of 0.17meV being the large momentum limit in the dispersion. An additional mode shows up at the bare Zeeman energy that could be the small wave vector SW. All these modes appear only in a very narrow filling factor range of less than +/-0.01 centered at 5/2.

A gapless continuum of low-lying excitations emerges at filling factors slightly away from 5/2 indicating a transition from an incompressible quantum Hall fluid to a compressible state. Striking anomalies in the optical emission spectrum due to recombination of an electron in the SLL with a valence hole exhibit the marked