Charged Excitons in the Quantum Hall Regime - A Sensitive Probe of an Incompressible Electron Liquid

Christian Schüller, Kay-Birger Broocks, Patrick Schröter, Christian Heyn, and Detlef Heitmann,
Institut für Angewandte Physik und Zentrum für Mikrostrukturforschung, Universität Hamburg, Jungiusstraße 11, 20355 Hamburg, Germany

Max Bichler[1] and Werner Wegscheider[2]
[1]Walter-Schottky-Institut der Technischen Universität München, Am Coulombwall, 85748 Garching, Germany
[2]Institut für Experimentelle und Angewandte Physik, Universität Regensburg, 93040 Regensburg, Germany

Vladimir A. Apalkov[3] and Tapash Chakraborty[4]
[3]Physics Department, University of Utah, Salt Lake City, Utah 84112-0830, USA
[4]Department of Physics and Astronomy, University of Manitoba, Winnipeg, Manitoba Canada R3T 2N2

We investigate two-dimensional electron systems (2DES) at temperatures below 1 K and high magnetic fields by optical spectroscopy [1-3]. The 2DES are realized in modulation-doped GaAs-AlGaAs single quantum wells. Via gate electrodes the carrier density of the 2DES can be tuned in a quite broad range between about 1×10^{10} cm^{-2} and 2×10^{11} cm^{-2}. In dilute 2DES, at very low electron densities, we observe the formation of negatively charged excitons - a bound state of two electrons plus one hole – in photoluminescence experiments. At finite magnetic fields, charged excitons, where the electrons form either a singlet (singlet excitons) or a triplet state (triplet excitons), are found to be stable. In this presentation we will report about the observation of a *dark* triplet exciton, which is observable at temperatures below 1 K and for electron filling factors <1/3, i.e., in the fractional quantum Hall regime, only [1,4]. In experiments where we have increased the density of the 2DES so that a uniform 2DES starts to form, we have found a strong energetic anomaly of the charged excitons in the vicinity of filling factor 1/3 [2]. This anomaly was found to exist in a very narrow parameter range of the density and temperature, only. We propose a model where we assume that localized charged excitons and a uniform Laughlin liquid coexist. The localized charged exciton in close proximity to the Laughlin liquid leads to the creation of a fractionally-charged quasihole in the liquid, which can account for the experimentally observed anomaly. Such a quasihole represents the elementary charged excitation of the incompressible liquid as proposed by Laughlin. Our experiments might be the first experimental proof of the existence of a fractionally-charged quasihole [3].

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