Dynamics of Magnetic-Field-Induced Electron Solids

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Abstract

Charge density waves are thought to be common in two-dimensional electron systems in quantizing magnetic fields.[1] Such phases are formed by the quasiparticles of the topmost occupied Landau level when it is partially filled. One class of charge density wave phases can be described as electron solids. In weak magnetic fields (at high Landau levels) solids with many particles per unit cell – bubble phases - predominate. In strong magnetic fields (at the lowest Landau level) only crystals with one particle per unit cell - Wigner crystals - can form. All electron solids are very fragile and their signatures have been detected so far only at low temperatures and in GaAs samples with extremely low amount of disorder. The experimental identification of these novel phases is facilitated by the fact that even a weak disorder influences their dc [2] and ac magnetotransport in a profound and a very specific way. In the ac domain, a range of frequencies appears where the electromagnetic response is dominated by magnetophonon collective modes. The effect of disorder is to localize the collective modes and to create an inhomogeneously broadened absorption line, the pinning mode. In recent microwave experiments pinning modes have been discovered both at the lowest[3] and at high[4] Landau levels. The dependence of the position and the width of the pinning mode on the electron density, magnetic field, and disorder proved to be unconventional. I will summarize these experimental findings and review a theoretical work on the subject.

[1] For review, see M. M. Fogler, in Lecture Notes in Physics, Vol. **595** "*High Magnetic Fields: Applications in Condensed Matter Physics and Spectroscopy,"* edited by C. Berthier, L.P. Lévy, and G. Martinez, pp. 98-138 (Springer-Verlag, Berlin, 2002).

[2] For Wigner crystals, see M. Shayegan, in *Perspectives in Quantum Hall Effect*, edited by S. Das Sarma and A. Pinczuk (Wiley, New York, 1997). For bubble phases, see J. P. Eisenstein *et al.*, Physica E **9**, 1 (2001); J. P. Eisenstein, Solid State Commun. **117**, 132 (2001).

[3] C.-C. Li *et al.,* Phys. Rev. B **61**, 10905 (2000); P. D. Ye *et al.*, Phys. Rev. Lett. **89**, 176802 (2002).

[4] R. M. Lewis *et al.,* Phys. Rev. Lett. **89**, 136804 (2002).