Problem Sheet 5

1. Carry out the analog of the Laughlin-Halperin argument of lecture 17 for a state with $\nu = 2/5$. What implicit assumptions are being made?

2. ($\cong$ Jain problem 5.) Referring to l.19, eqn. (1.), show that *provided* the magnetic length in the exponential factor is appropriately adjusted, the disk area covered by Ψ_ν is the same as that covered by $\Phi_\nu *$. (hint: Consider the highest power of z_i occurring.)

3. (a) For a phonon of frequency $\omega = 10\,\mathrm{GHz}$ propagating in a 2DEG of overall density $10^{11}\mathrm{cm}^{-2}$ in GaAs, which of the following is a good approximation? (q = wave vector of phonon, v_F = Fermi velocity of electrons, $l \equiv v_\mathrm{F}\tau$ = electron elastic mean free path)

   i. $\omega\tau \gg 1$

   ii. $ql \gg 1$

   iii. $qv_\mathrm{F} \gg \omega$

   (b) Show, by solving the collisionless Boltzmann question in the approximation $\omega = 0$, or otherwise, that when the conditions (ii)$-$(iii) are fulfilled the transverse conductivity of a free degenerate 2D Fermi gas is given by

$$\sigma(q,\omega) = \text{const.}\ (e^2/\hbar)(k_\mathrm{F}/q)$$

   What is the constant?

   (c) Under the conditions of part (a), is the result of part (b) still approximately true in a field of 0.1 T?

Solutions due by 9 a.m. on Mon. Nov 11.