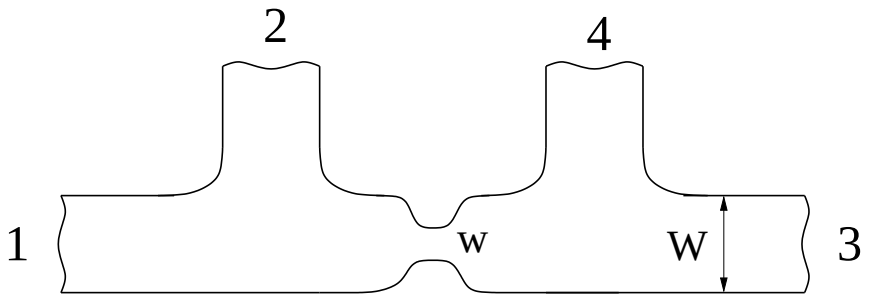
Department of physics, NTNU
TFY4340 Mesoscopic Physics
Spring 2010

Exercise 9

Assistance: Tuesday April 20.

Consider the 4–terminal device shown in the figure, with ideal contacts, and with a geometrical constriction of width w.



We assume that the perpendicular magnetic field B is strong, so that $l_B = \sqrt{\hbar/eB} \ll W$. Here, W is the typical channel width, except at the constriction. However, B is not sufficiently strong to create edge states in the constriction. In other words, we have $w < l_B$.

a) The Fermi energy is E_F. We assume that the number of edge states N is so large that we may ignore the zero point energy $\hbar\omega_c/2$. Write down an expression for N. (Outside the constriction, of course.)

b) Suppose n states ($n < N$) may transmit through the constriction. Ignore tunneling and back–scattering from impurities. Use the Büttiker–Landauer equations to find the longitudinal resistance $R_L = R_{13,24}$ (in terms of N and n), i.e., with current from 1 to 3 and the voltage measured between 2 and 4. (Set e.g. $V_3 = 0$.)

c) How will R_L depend on B. Compare with figure 50 in the "book" by Beenakker and van Houten, and/or the paper in Phys Rev B **37**, 8534 (1988).

d) Use the results of *b*) to find $R_{2t} = R_{13,13}$. Is this result as expected?