The Quantum Hall Effect Experiment takes place over two consecutive lab periods.

Day 1:

Since we want to eventually find a resistance, and the quantity actually being measured is a voltage drop across the sample, we need to first determine the current running through the sample.

The current source in this experiment consists of a large battery (~67 Volts) connected to a large resistor. The current source resistor (R_I) is very large compared to the sample resistance, so the current can be assumed to be constant.

In order to determine the current supplied by the four different configurations of the current supply (battery box alone and also connected to three different source resistors) we make use of a precision resistor. This resistor has approximately the same resistance as the sample, and is constructed to have a very stable value over time.

The current measurements are made as follows:

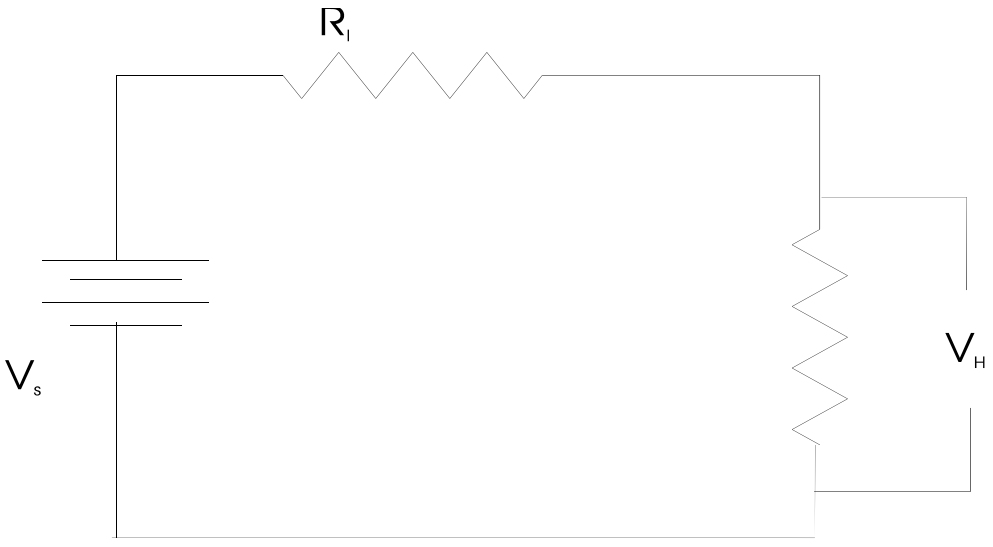
1. Measure the resistance of the precision resistor

The Precision resistor is wired between the inner and outer shell of the BNC connector. Use a banana plug adaptor to connect the precision resistor box to the “2 wire” inputs on one of the two Digital Multimeters.

Place the DMM in 2-wire ohms measurement mode, and record the measured value. Return the DMM to DC voltage measurement mode.

2. Connect the Current source.

Select a current source configuration to be measured. Using BNC cables and adaptors, arrange a circuit as follows:



Where V_s is the battery voltage, R_I is the Current source resistor, and V_H is the voltage measured by the DMM. Note that you are measuring across the precision resistor ONLY. Measuring across the precision resistor AND the R_I will simply yield the Battery voltage.

Record the current value for each current source configuration.
Note: While making these measurements, it is possible that the voltage reading will slowly change. It is up to you to determine the cause of this, and whether it will affect you final result. Keep in mind the very large (many megaohm) resistance you are dealing with).

Day 2

Filling the Dewar

1. Fill with liquid Nitrogen

Liquid nitrogen is much cheaper than liquid helium. It is more cost effective to cool the Dewar from room temperature to 77K with nitrogen, empty the Dewar, and then cool down to 4.2K with liquid helium.

-Insert the long (4') brass tube into the Dewar. It is better that we use a long tube so as to cool the Dewar from the bottom up, and we also want to use this tube to remove the nitrogen.

-Connect the Nitrogen supply Dewar to the brass fill tube using a length of latex tubing.

-Making sure there are no kinks in the tubing, slowly open the valve on the nitrogen Dewar, an wait for the Dewar to fill. You can check the amount of nitrogen in the Dewar by inserting a thin metal tube. When the (room temperature) tip of the tube hits the surface of the liquid nitrogen, the nitrogen will boil and force a small amount of liquid up the tube. By moving the tube up and down, you can determine the level of the liquid nitrogen by noting the point at which small drops fly from the top of the tube.

-When the Dewar is ~¾ full, turn off the flow of nitrogen, and remove the latex tubing from the nitrogen Dewar. You may need to use a heat gun to defrost the tubing.

-Attach the tubing to the inlet on the nitrogen jacket of the magnet Dewar. We will be recycling the liquid nitrogen to use as additional insulation.

-Insert a short piece of tubing into the other inlet on the magnet Dewar.

-Attach the tubing from the Helium gas tank (We use helium because nitrogen would liquefy) to the short piece of tubing.

-Use a bar clamp to seal the over pressure valve

-Seal the snorkel using a KF40 blank flange

-Slowly increase the helium gas pressure to force the nitrogen out of the magnet Dewar. Before the tubing frosts over, you will be able to see the nitrogen flowing.

-When the tubing begins to defrost, all nitrogen has been removed.

-Disconnect the helium gas.

-Remove the long brass tube.

2. Fill with helium (Your TA will explain this further)

-Connect magnet leads using wingnuts.

-Connect to persistent switch and level meter.

3. Making measurements.

-Before inserting the sample probe, note the numbers scratched on the sample holder, and where geometrically these numbers correspond to the sample.

-Slowly insert the probe into the magnet Dewar.

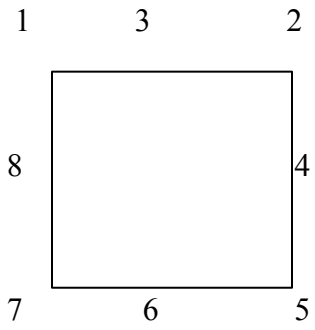
-Connect the DMM (In 2-wire ohms mode) to each of the contacts in turn. Always ground the sample before connecting or disconnecting. Note any contacts that are open—that is, have an infinite resistance. These contacts are bad and cannot be used.

-Return the DMM to voltage mode.

-You will need to make two different kinds of measurements: perpendicular (Hall resistance,Rxy) and parallel (magnetoresistance, Rxx). Perpendicular measurements mean that voltage is measured perpendicular to current, and parallel measurements, well, you figure it out.

To make a perpendicular measurement:

Imagine your sample looks like this:



A perpendicular measurement would be to run current from 6 to 2, and to measure voltage across 4 and 8. Note that the paths do not have to be exactly orthogonal, the two paths just have to intersect.

A parallel measurement would be current from 6 to 4, and voltage across 8 and 2. Again, not necessarily exactly parallel.

For a perependicular measurement:

-First, connect your current source. Select one current configuration and use a BNC cable to connect to pin 6 (you could also connect to pin 2, but the effect is the same regardless of direction). All ground switches should be grounded at this point.

-Next, connect one BNC cable to 4 and another to 8. These two cables will need banana plug adaptors so they can be connected to the top DMM. The center conductor of one cable should go to the top input of the DMM, and the center connector of the other should go to the bottom. The outer connector on both cables should be connected and input to the DMM ground.

-Now, flip all switches up EXCEPT the current sink (in this case, 2).

-Turn on polarity switch. Verify settings <<params TK>>

-Turn on ramp generator

-Turn on power supply.

3. Using the Computer interface.

-Create a folder on the desktop for your data.

-Double click on “qhe.vi”

-Refer to the manual on the website for further detail with regards to the program.

-When all parameters have been entered into the program, click the arrow in the upper left hand corner.

-Enter the current delivered by your current supply (this is one of the numbers you determined last week).

-Click on the Go button.

-Switch the ramp generator switch to “Up”.

-The ramp generator will automatically stop at the limit of the ramp.

-Click on the red stop sign in the upper left-hand corner.

-Change parameters, connections, etc.

-Continue as before, except now flip switch to “Down”

-Repeat as desired.

Shut down

-Turn of equipment in reverse order.