Experimental Physics - III

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Lecture - 15

Hall Effect as a Function of Magnetic Field

in our solstice physics laboratory, I will demonstrate Hall effect experiment. As I described the theory of this experiment. we will measure the; we will measure the Hall coefficient of n type germanium semiconductor.

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this is our sample here you can see this is our sample rectangular sample a piece of sample we have taken and Hall geometry I have shown you this experimental geometry. there will be four probe here you can see these this four connection we have taken. two are along this direction along x direction and two are along y direction perpendicular direction. 1, 2, 3, 4 four probes are there. these probes are getting contact it's on the sample.

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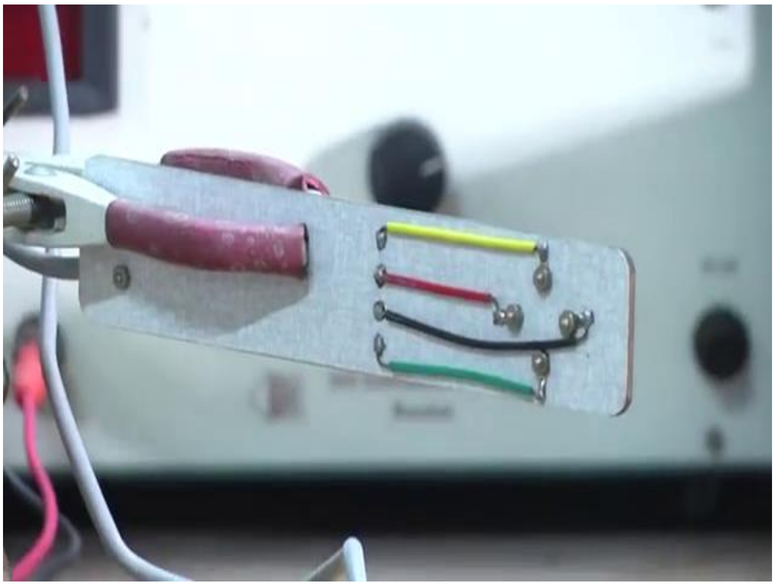

and this these are connected I think other side I can show you; other side I can show you. these four probe are connected with wires. this connection; this connection this side you can see this connection. this four probes are connected with this wires. this wire four wires are coming and two are for applying constant current and two are for measuring the Hall voltage.

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this is the; this is the constant current source n voltmeter both together it is there. here you can see we can display the millivolt and milliampere. So; that means, there are millivolt meter and milli ammeter both are in this box. we can choose here we can see these this is the current and this is the voltage. if you keep knob this side this is the current, this if I put the other side it will show the voltage

two out of this probe two are connected with the current and two are connected with the voltage means the voltmeter. millivolt meter inside it is in inside the box. two probes are connected with the voltmeter and two probes are connected with the constant current source.

now our aim is to measure the Hall voltage as a function of magnetic field then from the plot Hall voltage versus magnetic field, we will we will find the slope and from that slope you will get the Hall coefficient as I described in the theory class.

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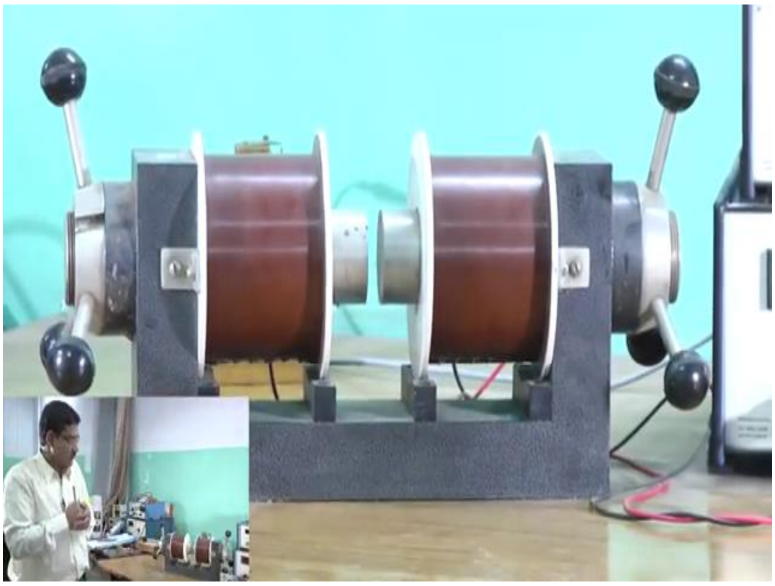

this is also I need magnetic field for this experiment. this is the electromagnet; this is the electromagnet we will use. here electromagnet as I described earlier see it has two coils, it is two coils and it has pole here we are using flat pole sometimes we use taper pole. we have kept at particular air gap we have kept at particular air gap and for that air gap what is the magnetic field for different coil current that calibration we have to do. we need a gauss meter.

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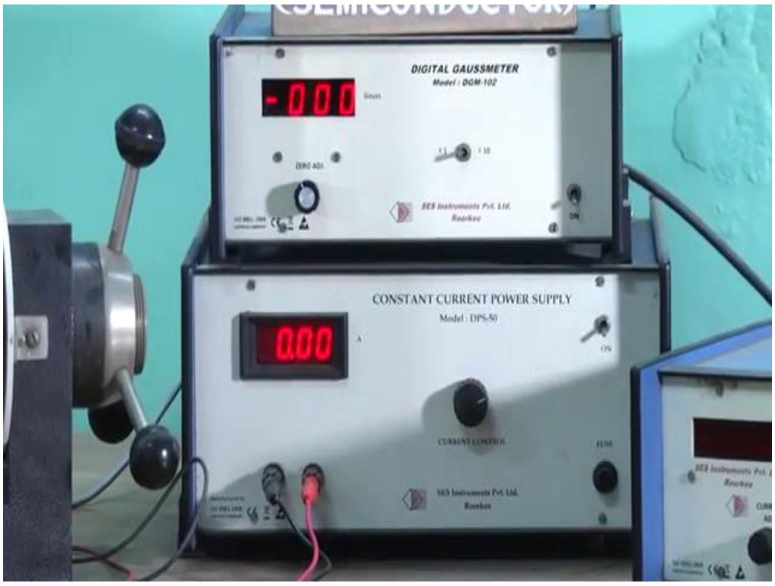

we have a gauss meter here, we have a gauss meter here and this gauss meter is its along with the Hall probe; along with the Hall probe.

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how to measure the magnetic field that I have described earlier classes, in earlier classes? this probe will be; this probe will be used for measuring the magnetic field.

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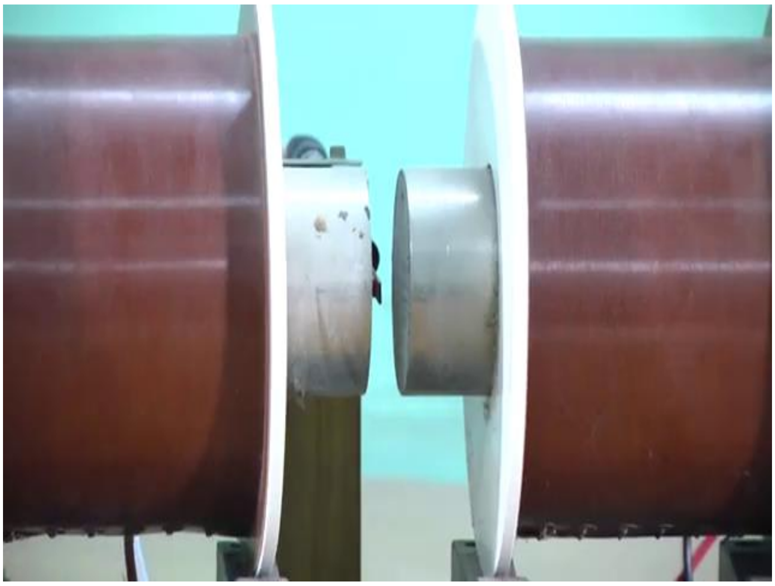

I have to place at the middle where we will put sample at that place, I have to put in perpendicular position generally perpendicular position. in middle and perpendicular position I think I have to take off slightly off. I had put it here it is in middle more or less or slightly I can make it yes its more or less in middle.

now, this is the constant current source, this is the constant current source for this electromagnetic for coil current these coils are connected to this power supply constant current power supply I think I will if I keep it here let me. what we have to do? First we have to do calibration. I will switch on; I will switch on the constant current power supply and the gauss meter.

here it is showing some value it is showing some value. I have to keep in middle and make it perpendicular because you know I have described. if this probe is not perpendicular to the magnetic field if it is tilted. you will not get the correct value. initially you have to adjust 0 adjustment is there make it 0. more or less more or less it is 0 more or less it is 0 0 current 0 magnetic field.

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Now, we will increase the magnetic will increase the current; will increase the current in step by step and magnetic field is here we will get the magnetic field reading. you note down current versus magnetic field. for this current what is the magnetic field? taking in 0.25 or 0.3 or 0.2 step and

note down. coil current and the corresponding magnetic field you can note down. this way you will you should take few data, I think around 10 to 15 data you can take. I have maximum here I can apply 4 ampere current. 4 in for a 4 ampere current is a when I increase the currents. it changes magnetic field is this out operands. I put multiplied by 1 and here multiplied by 10; that means, whatever here. this here scale I have changed to the in multiple of 10. it's the one.

it is out of. it is coming four digits in four digits. this here. this will be multiplying with 10 gausses; that means, 6720 gauss. this way you can do the calibration of the electromagnet using the gauss meters.

after calibration I know this I will not use this Hall probe; I will not use this Hall probe I will remove this Hall probe. now, I this gauss meter I am not going to use. I will use only this power supply coil current.

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for our measurement is now for a particular sample current for a particular sample current for a particular sample current, I will major Hall voltage as a function of magnetic field this my sample now I have to put in the I will put the sample inside the one has to be careful inside the I have to I think let me checked.

slightly height I have to increase slightly height I will increase, now this one I will increase slightly height and I have to make it perpendicular I will put inside the electromagnet, I will keep the sample in the middle more or less it is in the middle now this is the middle; yes, it is in middle more or less it is in middle

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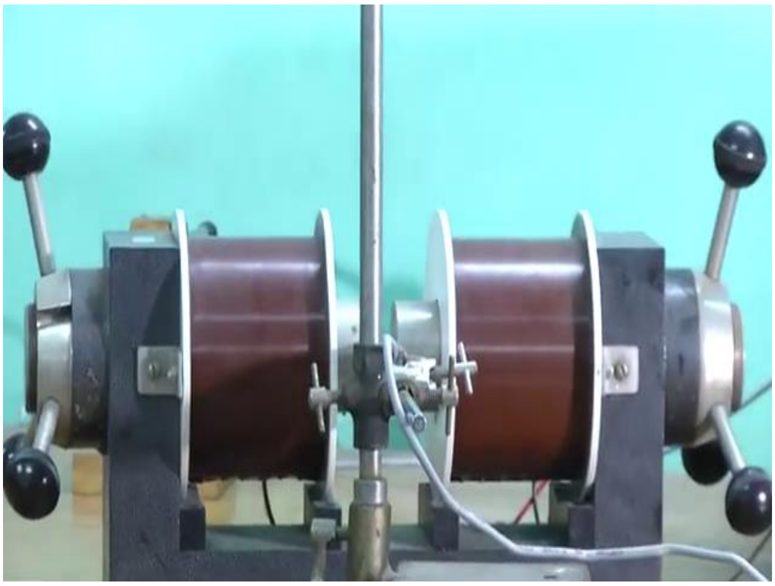

now sample is at the center of the Hall piece, now I will apply magnetic field I will apply magnetic field and measure the Hall voltage this for 0 magnetic field what is the. I have to first. what I have to do? there should not be any confusion between this current and this current this is for electromagnetic current we are telling coil current and here for experiment I have to pass constant current through the sample.

from here I am applying the constant current I have to select i x along the x direction. I will switch on this one. now, at present current is 0 now milliampere current is 0. I will apply some current say how much current I will put say 3 milliampere I am putting 3 milliampere

3 milliampere constant current passing through the sample along the x direction. Now along the y direction what is the voltage Hall voltage that I will measure because this already I have made that connection Now what is the voltage at 0 magnetic field I will note down. This voltage is minus 61.9 or minus 62 millivolt for 0 coil current corresponding0 magnetic field. these minus 62.0 millivolt that is the Hall voltage.

Now I will change I will keep this current constant. sometimes I should see I have put at 3. it’s a more or less at 3 at this constant sample current now I will change the magnetic field, I will change the magnetic field and note down and note down. You see it is the change in minus 56.2 for this coil current 0.36 corresponding magnetic field from the calibration curve you will find out

I am changing the magnetic field then noting down the; noting down the Hall voltage this is the minus 51.3 millivolt at 0.7 milli 7 ampere current corresponding magnetic field this way I will do the experiment Change the magnetic field go up to; go up to 4 go up to 4, 1 ampere what is the value? Minus 0.47 0.1. this way you do the experiment

Now for each data again what we do? We just change the direction of the magnetic field or current, then you see how voltage will be the just opposite just check it. Just I let me keep at one value say 2 ampere current corresponding magnetic field coil current and this sample current is fixed let me check it whether it is a constant or not yes see more or less it is 3 milliampere.

sometimes we have to check its more or less constant and for that this is the value. Now let me change the direction of the I think direction of the magnetic field then Hall voltage will be in will be reverse. let me switch on this current; switch on this current and check it change the polarity of the magnetic field and applying opposite direction. I have change the polarity I have change the polarity and now magnetic field is 0 now, I have applying this magnetic field.

I should get the Hall voltage in opposite direction, but I am not getting it is minus 96, I should get the Hall voltage in opposite direction if I just 1 minute 0, this is 62 now 64 just like change at there now it is minus 36. 66 opposite here yes it is opposite of course.

at 0 magnetic field it was minus 62, it was minus 62. Now when I am increasing field it is decreasing for one direction of magnetic field it is becoming minus 36 it is minus 36. 66 opposite here. at 0 magnetic field it was minus 62 it was minus 62 now when I am increasing field. it is decreasing. for one direction of magnetic field, it is becoming minus 36 it is minus 36.

60 opposite here. at density in the metal it is increasing. that is a conductivity is increasing resistivity decreasing resistance decreasing. that is why in case of semiconductor we see that resistivity decreases with temperature that is the (Refer Time: 18:47) resistance sorry change of resistance or change of resistivity of a metal and semiconductor of as a function of temperature.

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this concept is simple, but this is the intrinsic property of the material and experimentally we can easily verify. I will show I will demonstrate this experiment in our lab; thank you. Of a metal and semiconductor of as a function of temperature. this concept is simple, but this is the intrinsic property of the material and experimentally we can easily verify. I will show I will demonstrate this experiment in our lab; thank you.

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