Experimental Physics - III
Prof. Amal Kumar Das
Department of Physics
Indian Institute of Technology, Kharagpur

Lecture – 35
Nuclear g-factor (Contd)

(Refer Slide Time: 00:24)

This is the experimental setup or of NMR spectrometer.

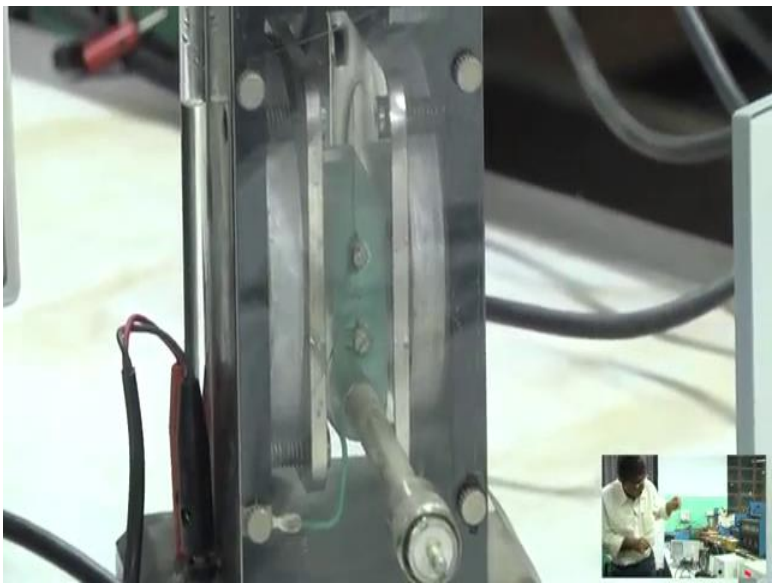
(Refer Slide Time: 00:34)

You can see here is retained NMR spectrometers. in this experiment as I told that, you need sample to put in the permanent magnet between in the constant magnetic field produced by a permanent magnet and that Helmholtz coil to a pair of Helmholtz coil will be pair of Helmholtz coil will be attached with this permanent magnet from where AC field will be modulated with the permanent magnetic field constant magnetic field.

(Refer Slide Time: 01:18)

Here you see this is our sample is a copper sulphate is the copper sulphate solution. this nuclear of nucleus of this copper have here spin half ok. This sample is used.

(Refer Slide Time: 01:44)



Now this we have to pit here you can see this two you see this side this is a one magnet and this other side this another this is the permanent magnet. It is not like pole pieces or something. there is a gap between these two magnetic material. this sample and inside probably you cannot see there is a you cannot see there is a Helmholtz coil as well as there is a tank circuit from the oscilloscope from the oscilloscope ok.

(Refer Slide Time: 02:20)

This is the frequency from here the frequency ok. This frequency meter it is generating this it has a RF oscillation and that RF oscillation we will put from here this tank circuit inside there is an induction coil.

(Refer Slide Time: 02:57)

And this sample when you are putting that we are putting at the centre of this at the centre of this permanent magnet and at the centre of the permanent magnet in both side there is a two oscilloscope to Helmholtz coil and these induction coil whatever we this is the part of the oscillators is called tank circuit.

This tank circuit this way this is here oscillator is here. this tank circuit that inductor. That I have to connect; I have to connect with this. I will connect here ok. One has to do slightly carefully one has to do slightly carefully yes I am doing yes.

Now, these are the oscillators, a part of that oscillator is the tank circuit. Tank circuit is nothing, but the induction coils are there. This inductions coil at the centre of this permanent magnet and with permanent magnet, the Helmholtz coil are attached a pair of Helmholtz coil are attached. Now, my sample is in the induction coil or in tank circuit and in magnetic field.

This sample now it is seeing this permanent magnetic field. Now it has a nuclear magnetic moment the sample have this is a nuclear magnetic moment, it is the equivalent to a single photon moment ok.

Now this energy level because of this permanent magnet, I have not put in a Helmholtz coil current or it is there. before applying before applying this Helmholtz coil current or

after applying Helmholtz coil current. This energy level are splitted because of this permanent magnet magnetic field is splitted.

Now, with this Helmholtz coil this splitting just because of variation of the because of variation of the slight magnetic field from the Helmholtz coil. A splitting just it will slightly it will vary; it will vary.

Now, if I put this radiation from this oscillator ok. in the induction coil basically I have that radiation reach to the sample by the by the induction coil actually it's a it send this AC signal and it produce the in magnet in. their due to this AC signal there will be current and because of that current there will be magnetic field because this is the coil magnetic field. That field is applied in the perpendicular direction of this original field. if this field is in this direction or this field is in this direction other one will be in this direction.

We are not talk. that is why we tell this radiation field electromagnetic radiation better with the you should tell this radiation field RF radiation field anyway. Now, this from RF oscillator the radiation are going to the sample now what will happen? energy level. There will be. this system this sample will absorb the radiation and it will jump from lower energy level to the upper energy level ok.

When it will jump. it will absorb the energy. It will absorb the energy and this when it will absorb. When this gaps exactly this gap exactly equal to the energy gap exactly equal to the radiation energy H 2 O ok. Now this gap is varying this gap is varying. Only this absorption will happen absorption will happen in a one complete cycle this absorption will happen when this gap is equal to the H 2 O.

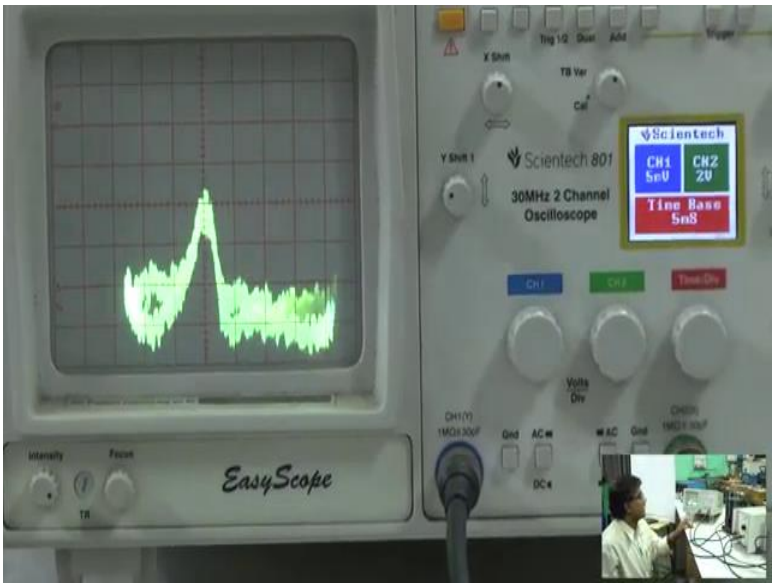
that absorption the energy it is basically taking the energy from this oscillator circuit and this oscillator circuit have this detector and amplifier which will detect the which will detect this absorption frequency and it will convert to the; it will convert to a signal instead of deep, the signal will be will show peak ok. that is the some mechanism is used to convert this deep to the peak ok.

Here now let me show them. here what we have used this frequency? From here this radiation we are giving to the. Here written Y. this radiation part it is going to the oscilloscope at one channel or Y in X Y mode why and here is this CRO X from here.

This is the single from magnetic field this Helmholtz coil this whatever current we are using. That current that signal their phase we can adjust using this we can adjust using this one not this one this one and the current we can vary using this one.

This magnetic field information we are giving to the CRO another channel or in X, these two it is there. Now what is the frequency that we can read from here, here what was is the switch is there it is on off where is the switch this one.

(Refer Slide Time: 11:03)



I have switched on. H we can see since system is ready for the measurement. We have to note down that this current I have applied this 105 milliampere ok. corresponding this magnetic field will be produced from the Helmholtz coil. This magnetic field is very small magnetic field AC field now this field is modulated with the permanent magnet ok.

Now, sample is there now here whatever you are seeing 18.74 mega Hertz that is the frequency of the radiation generated from the oscillator, it is going to the sample. Now sample absorb this radiation in resonance condition and we will get two peak here we can see we are getting. One can use phase shifter for instead, you can see instead of here in yes or we got four peaks, but here we are getting two peaks.

Similar arrangement why two peaks not four that I explained you ok. Now what we have we have to do. We have to make coincidence of these two peak just varying the phase what is the phase. Phase between these here these two signals are going in one is X and

another is Y. one of them this phase we are changing. Then these two will coincide that I am doing. just I am changing to get it coincidence ok.

Now it is coincide. one has to do nice retune the things as I told this coincidence on issue display at the middle at the middle of the display. It is almost at the middle of the display, but if it is not in the middle of the display slightly into you should play with this frequency higher frequency here this frequency of the oscillators. Is very sensitive you can see it is very sensitive when I am touching it you see when I am just touching it is the fluctuating. Slightly I would like to take slightly the side. let me you see such it has gone. Very you see it is shifted ok.

Frequency are different. it is telling when it will display at the middle, then that frequency one can take as a resonance frequency. I have to. I think this way I can show you yes I am shifting now it is an middle you know ok. Now we have to note down this frequency 18.74 mega Hertz.

(Refer Slide Time: 14:22)

Only I need this frequency and magnetic field what is the magnetic field. From permanent magnet, it is around 500 Gauss. in calculation will take this 500 Gauss now this expect then you can calculate if you know the frequency then calculate g factor ok.

This we can repeat this experiment just changing if I change the magnetic field what happens just check. It will be just I think if I change the magnetic field is changes ok.

What we will do? We will just use phase shift to make them coincidence to make them coincidence to make them coincidence now to bring it at the mid centre of the display. I have to use a frequency change I think. it is very sensitives it is I have to yes no other side yes it is at the centre of the; centre of the display. Now, it is 18.72 it is 18.72 not much variation.

Now, you can understand that field we are changing Helmholtz coil to change to 33, but this there is no much change of this frequency because as I told that field is negligibly small compared to the field of permanent magnet ok. this way just one should do this experiment take 3-4 sets of data and you will get this g factors take the average of this 3-4 from 3-4 set data whatever g factor you will get just take average of them and that will be the your result of g factor of nuclear g factor ok.

This is a very nice experiment and the principle of this experiment whatever I described here. The same principle it is used in this as laboratory also for NMR spectroscopy, but they are here we do not have any temperature variation, here our magnetic field we cannot vary. We need such arrangement. distance between the permanent magnet if we change. Field can be you can vary the field ok.

This more options will be attached with the system and more sophisticated electrons will be used to study the; to study the relaxation time. that is basically spin lattice interaction one can study from the NMR. That way it is a very good experiment for teaching lab which will help you to understand the principle not only for this measurement of your simple but for research alone can study various kind of samples for various characterization.

There here one parameter g factor we are reporting, but look many things can be done we have one NMR in our wishes lab. There are many others characterization also we do, but here our intention is to introduce the spectrometer. That in future one can use this instrument in research laboratory confidently.

I will stop here.

Thank you.