Chemical Crystallography

Prof. Angshuman Roy Choudhury
Department of Chemical Sciences
Indian Institute of Science Education and Research, Mohali

Lecture – 59
Review of Reciprocal Lattice

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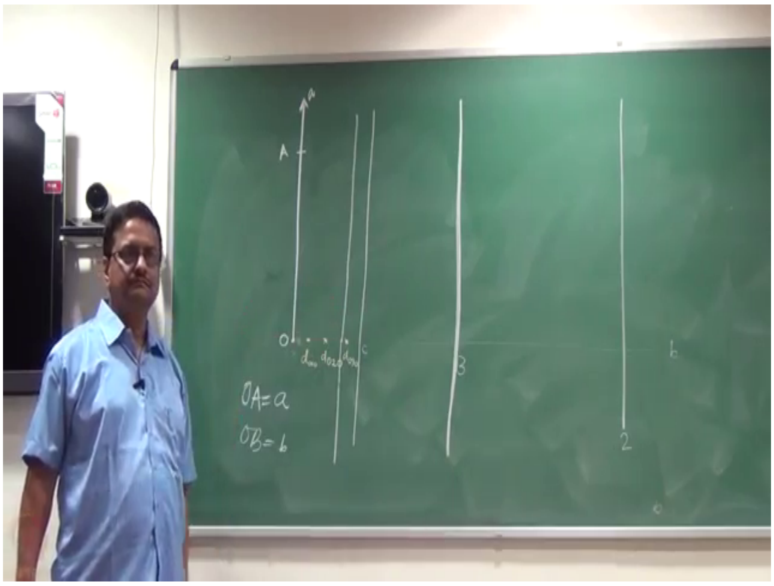

If I consider the second plane at half of it, what is OC? D 0 2 0 5; so one-fifth this is one-tenth, then that next one is one-fifth. So, it should be somewhere there. I do it at 1 5. So, this distance is about 0.33, so 1 by 3 0.333. So, this goes somewhere there. So, this becomes d 030.

So, like that if I have a plane which is suppose that to be this 2 d p that is apparently extra 1 by d 20 it should be form that that. So, what will be that value? So, that cannot be dead, because that makes it that new big plane of that. So, all these reciprocal lattice points are going to form on these axis which are parallel. So, now, I am removing these parallel lines just like we keep.

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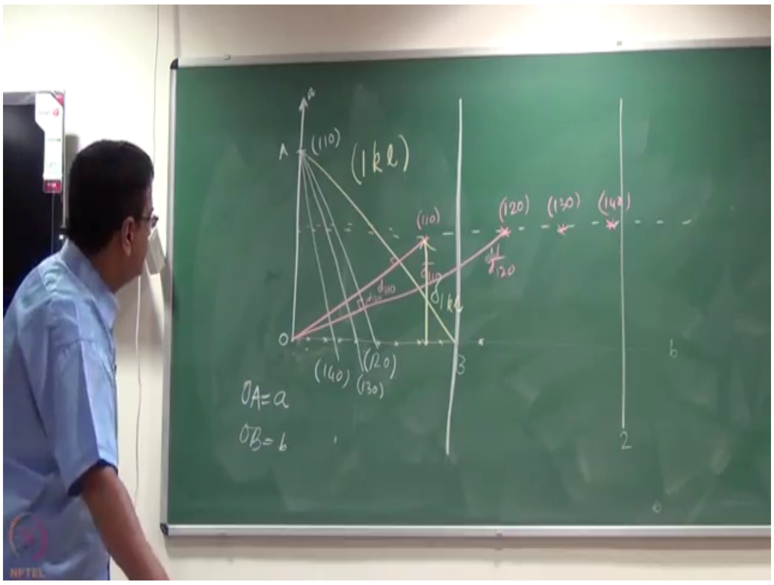

One and the reciprocal lattice points we would come out that line this reciprocal lattice point corresponding to all the planes which are cutting B at different distances.

Now, I do it from one I was still now talking about planes which are parallel to A. So, all the planes which are parallel to A are like this right at different distance from origin, but there all parallel to go in. Now, I am talking about set of planes which cut A at 1 and go like this, from here the plane goes like that, from here the plane can go like this from here the plane and go like that similarly you can go and cut there at 1. So, what is bigger indices what would be the bigger index for this?

Student: (Refer Time: 03:28).

One: so this becomes 110. If I do it like this, 120 like this 1 4 suppose. So, 140 15 would be somewhere there like that.

Student: (Refer Time: 04:22).

So, now the next thing that I am trying to do is to draw perpendicular from origin to all these four planes. What is this distance d 110 at that this point here that a distance 1 by d 110 and mark this point and 110 is equal to a lattice point. Now, I draw perpendicular from here to this what is that distance.

Student: (Refer Time: 05:22).

D 120 I cut it at a distance one point d 120 and falls here what this point has 120 and if we continue to do for all that these points will come somewhere there, and there it will correspond to 130 140 set of planes. Purposefully I have drawn them in such a way that as if they are falling on one line.

Now, I am only talking about the planes which are as used to be parallel to my z, but who said trustfully parallel to z this planes which we have talking here can be tilted suspect into transit z. So, the planes which I have drawn can have general miller indices as 1 k l in this direction k is changing elements fixed. If the plane is not like this, but slightly tilted the lines that can coming on the plane of the board will come slightly above the plane of the board in this row will have same value of l say 1, but it will be then 111 one; next one will be 112, 113, 114, 115 like that similarly here 120 121 122 123 like that it will go depending on how this plane is tilted.

So, in this direction this plane you have a set of reciprocal lattice points here we have a set of reciprocal lattice points suppose from here to there I say the distance is delta 1 k l. So now, for clarity and you have better understanding I am removing this in between things. Thus, those may be clear confusion. So, what I am doing is I am just removing the drawing which are not required.

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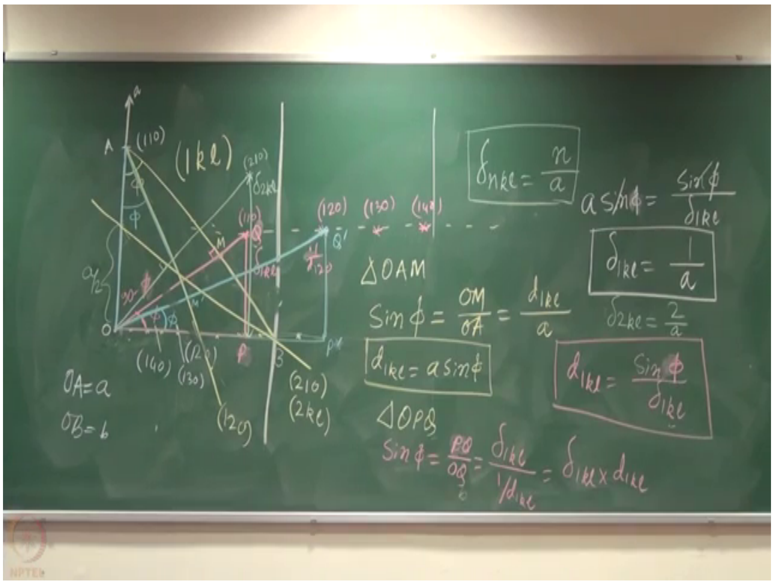

I have already B, right. So, suppose this is P and Q. What is this angle? Can be anything can be anything, I am saying it as phi instead of writing alpha beta gamma which make me confusing that it is the internal angle no, it can be anything. So, so, now that point is M. So, in this triangle in case of triangle OAM what is sin phi? What is sin phi?

Student: (Refer Time: 10:46).

OM by OA: what is OM? What is OM?

Student: (Refer Time: 11:00).

D d 1 k l right and what is OA? Is a. So, d 1 k l equal to a sin phi. Now, we consider the triangle OPQ what is this angle of? This is phi; this is 90, this is.?

Student: (Refer Time: 12:04).

90 minus phi, sorry see I am also writing the wrong way that is why phi is better 90 minus phi. So, this becomes phi. So now, what is sin phi here?

Student: (Refer Time: 12:23).

Sin phi is PQ by OQ. What is PQ?

Student: (Refer Time: 12:40).

Delta 1 k l what is OQ? 1 by?

Student: (Refer Time: 12:52).

D 1 k l which is equal to delta 1 k l into d 1 k l. So, that case from here what we get that d 1 k l is equal to sin phi by delta 1 k l, right. Now, we compare the two equations d 1 k l equal to a sin phi and that is equal to sin phi by 1 1 by delta a k delta 1 k l. So, we can equate one these two as a sin phi equal to sin phi by delta 1 k l sin phi is canceled on one either side. So, delta 1 k l is equal to 1 by a, right. Any doubt? Delta is equal to delta 1 k l equal to 1 by a.

Now, I will redraw those lines back to this is the 1 k l line I am drawing sorry this 110 line I am drawing 120 line I am dropping a perpendicular from here and extending it to that point. So, now if I assume this angle is my phi consider this blue triangle part. So, my M comes here as M prime Q goes there as Q prime Q could P comes here as P prime if this is phi that angle is also phi. If I do the same set of analytics using this triangle first and then using that triangle and equates we will end up getting delta 1 k l as 1 by a once again.

So, that means, all the reciprocal lattice points corresponding to those planes which cut a at one unit will fall on one line and that line is at a distance 1 by at a distance delta 1 k l from the line which is here. Now, somebody can tell me this then I do not need to deduct. What is this plane cutting at half?.

Student: 2 (Refer Time: 17:15).

That means 2 210. In general terms it is 2 k l k can be 1, 2, 3, 4 if k is 1, 2, 3, 4 that planes are like this like that like that and so on and when the l is not 0 here is 0 because it is parallel to z. When l is not zero; that means, it is the think z somewhere. So, exactly that way it was doing it is these are like that.

So, for this particular plane I am running out of colors I drop a perpendicular from here to that plane and cut it at a distance here which is 210 point. So, the distance from here to there is delta 2 k l what will be the value for delta 2?

Student: is equal to 2 by a.

2 by a; everybody understood why 2 by a because this has become now a by 2. So, whatever was here a is becoming a by 2. So, it becomes 2 by a, so in general delta n k l equal to n by a, right. So, now, this is only about a you do the same along b you do the same along c irrespective of the angle between a, b, c can be 90 degree can be not 90 degree. What it generates is a set of points set of imaginary points in space each and every point represents that plane in the triangle. And these points are called the reciprocal lattice points which called forms a reciprocal lattice and the called lattice constants are related to reciprocal lattice constants.

So, a, b, c and; a star b star c star have inverse relationship for cubic tetragonal orthorhombic it is just 1 by a, 1 by b, 1 by c, but monoclinic and triclinic the angle gets in coordinated. But, in all cases all the planes that one can consider with respect to one origin in itself it is now converted to a 3-dimensional grid the points. And those points are reciprocal lattice points which are required to understand it is diffraction phenomena.

So, in tomorrow's class we will then see how these reciprocal lattice points help us in understanding the diffraction phenomena. And, from there we will define two types of spheres sphere of reflection and Ewald's sphere and all. So, from there we will again continue how the then you can design the data collection strategy based on the size of Ewald's sphere.

So, we will stop here.