Crystals, Symmetry and Tensors
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Lecture 3c
Application of Weiss Zone Law

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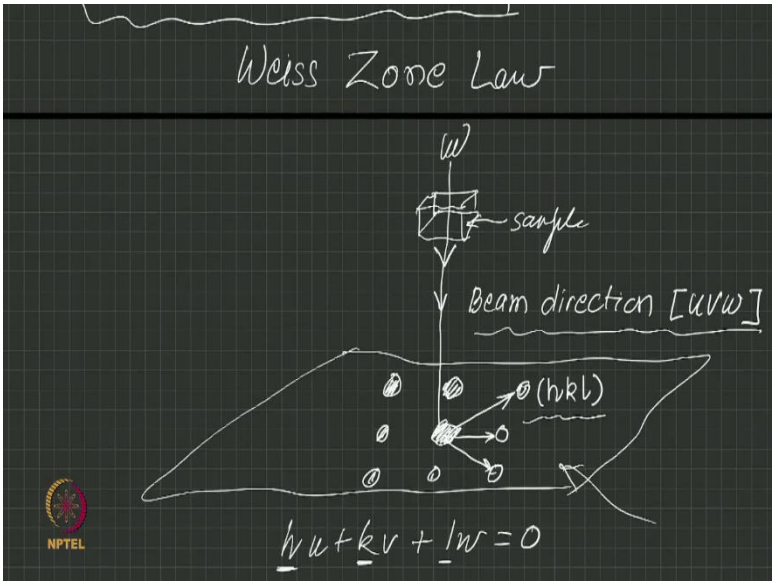

So, one application for example, one application is the electron diffraction pattern, means I am giving you an experimental idea, so electron diffraction pattern you will have a central spot, and then you will have several other spots. Let us say this is your electron diffraction pattern which you got. This was the film where you are recording the diffraction pattern, what is happening is the Electron Beam is coming from Top somewhere from the electron gun and your sample is somewhere here which is Crystal.

So, you can give the beam direction that in the crystal what direction the x-ray, the electrons were passing, so that beam direction in the crystal will be uvw. And each of the diffraction spot you know from Bragg's law is coming from a plane, so the indexing of the diffraction spot is in terms of the plane hkl, and here also you can show that Bragg's law will be satisfied only if the beam direction and the plane, the spot, satisfy the Weiss zone law.

So, you will always in electron diffraction pattern you will have hu plus kv plus lw is equal to 0, where now hkl is your diffraction spot and uvw is your beam direction. So, here we are not going into that sort of experimentation but let me just show you a quick example of what we did last time.

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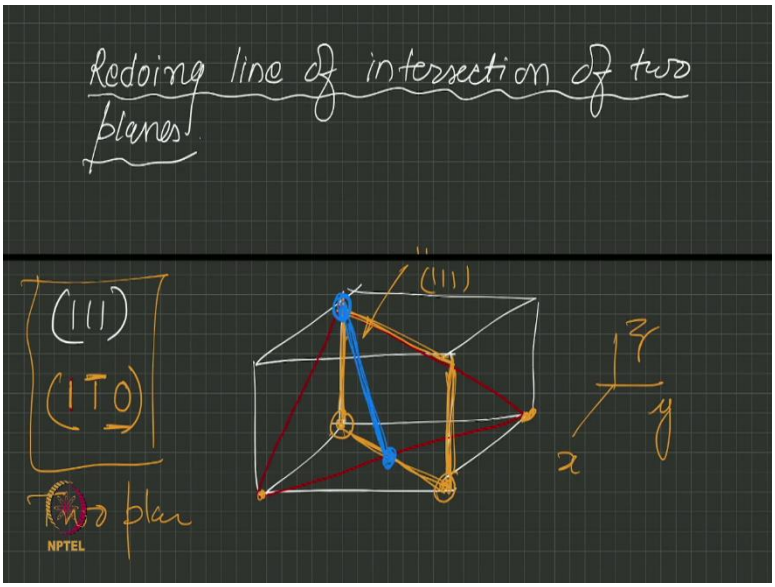

So, redoing line of intersection of two planes. Let us take up exactly the same problem, so this is one of the things another geometric application of Weiss zone law. Two applications of Weiss zone law, if two planes are given, you can find the common direction, if two directions are given you can find the plane passing through the direction.

So, remember that we had a we geometrically drew in within the unit cell, we were given two planes 111, so we drew the 111 plane and then we had 1, we had 1 bar 1 0 direction, 0 plane, so 2 planes, so for 1 bar one 0, we took the origin there 1 bar 1, 1 bar 1 our access system is x y and z. So, if I say choose the origin here one along x one along y and one along z, so I get the red plane 111.

If I choose the origin here, 1 along x is this, minus 1 along y is that, and 0 means in parallel to the z axis, so my plane is like this now, so these were the two planes. And there by our visualization we saw, by our drawing or construction that this is one common point, this is another common point, so this was the line of intersection.

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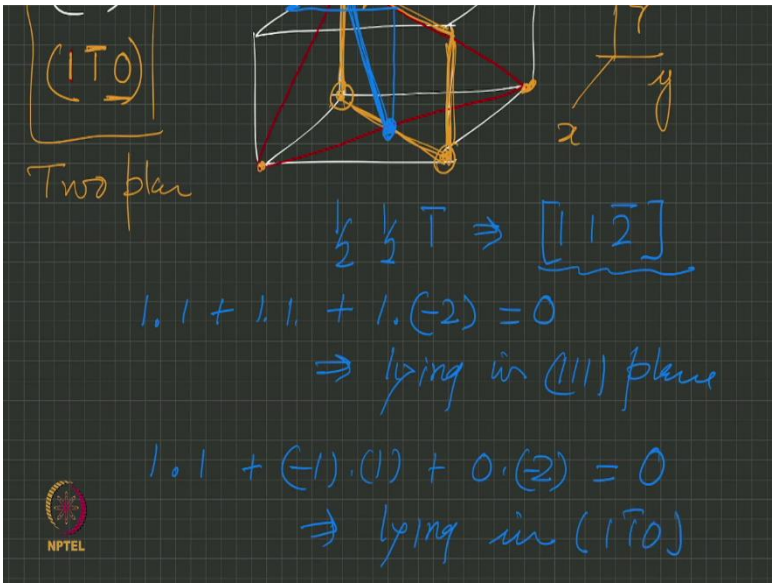

And then, we just indexed it by let us say choosing the origin here. So, we index it half along x, half along y, and minus 1 along z, half minus 1, which we said by multiplying by 2, the direction was 1 1 2 bar. You can use Weiss zone law to verify your result. If this direction is the line of intersection, it should be lying on both the planes.

So, it should lie on 111 as well as it should lie on 11 bar 0, and you can quickly see that is true because 1 into 1, plus 1 into 1 plus 1 into minus 2 is equal to 0, which shows that 1 1 2 is lying in 111 plane. And with the second one, 1 into 1 plus minus 1 into 1 plus 0 into minus 2 that also gives you 0. So, that is a check on my geometrical answer that we have not made any mistake, we are on the right track.

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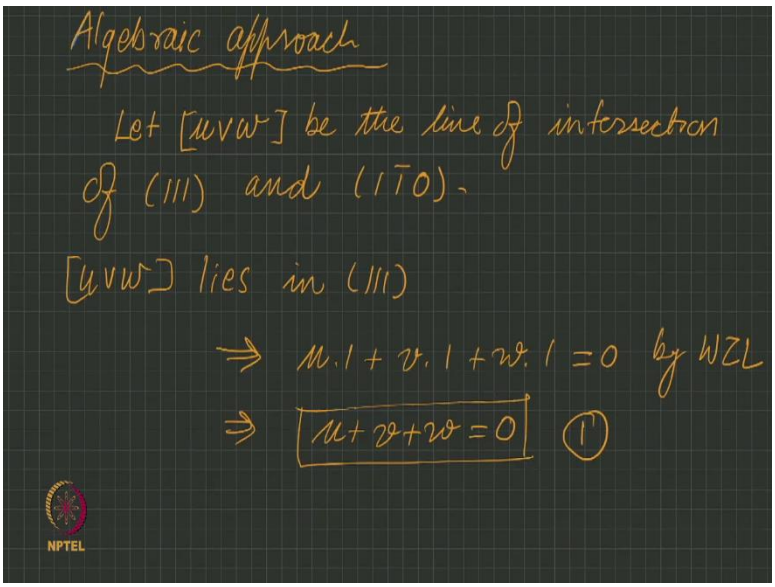

However, there was this drawing at all was not required, we could have taken a purely algebraic approach, so, there we will say let since we want to find the line of intersection, let uvw, we do not know, we want to solve that, let uvw with the line of intersection of 111 and 1 bar 1 0. So, line of intersection means the line should lie in both the planes, so I should be able to apply the Weiss zone law. So, uvw lies in 111 because it is a line of intersection, so this gives us u into 1, v into 1, w into 1 is equal to 0 by Weiss zone law, u plus v plus w is equal to 0.

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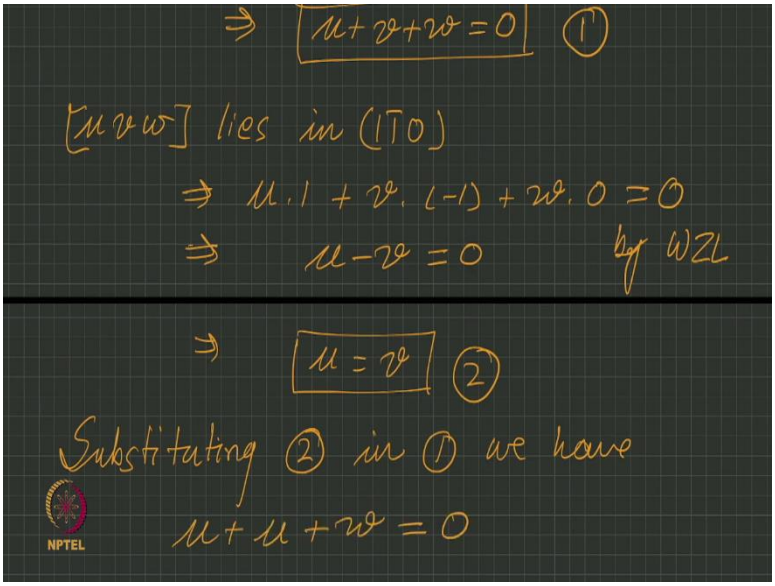

But since it is a line of intersection, it lies in the other plane also, u into 1 v into minus 1 w into 0 is 0. So, u minus v is equal to 0, this is also by again the second application of Weiss zone law. So, I can as well write this as u equal to v, I can substitute once I have found that u and v are equal, I can use that in 1. So, substituting 2 in 1, we have u plus u plus w is equal to 0, which gives w is equal to minus 2 u.

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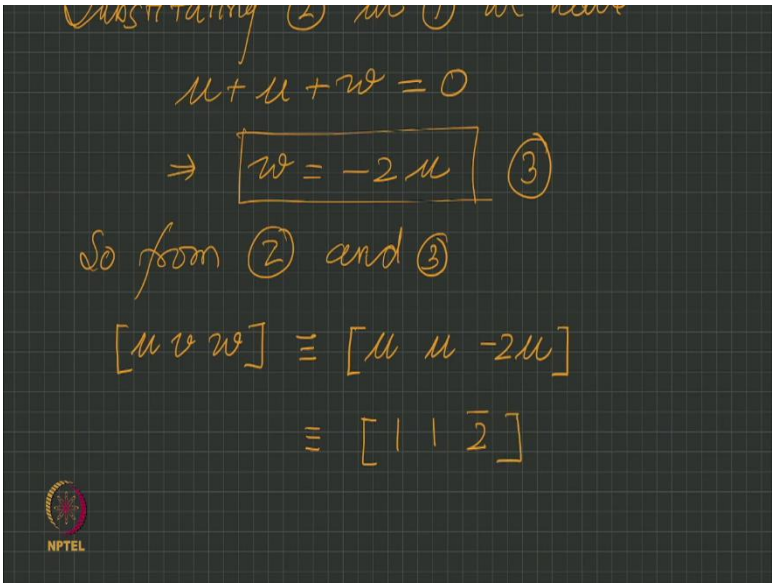

So, from 1, sorry from 2 and 3, what do I get? The line of intersection uvw, uvw was our line of intersection. 2 establishes that v is u, so for u I write u, 3 establishes that w is minus 2u, so I write u minus 2u, so I have got everything in terms of u, thanks to the God given rule that I can divide by any common factor, u is the common factor now, so the same direction can be written as 11 bar 2.

So, in this process, there was no need means I did not even picture, where is my 111 plane, where is my 111 bar 10 plane, and where is my line of intersection 112 is coming, just like a computational exercise I am getting, so I am getting the answer. So, it is a good way to get an answer, it means if you are writing a computer program to handle any such crystallographic exercise, you will write like this, because computer cannot do the geometrical visualization which you are doing to find the line of intersection.

But as beginning students of crystallography, I will recommend that actually whenever such exercise comes you try to do both ways. This algebraic method will always succeed, geometrical method will require little bit of more visualization drawing, but here you see with respect to the unit cell, I am able to actually see 111 plane, 1 bar 10 plane, the line of intersection coming this way inclined, so that develops your visualization skills and intuition, because three-dimensional visualization skill is very very important in crystallography.

If you want to do crystallography purely algebraically that is the hard way you can, but, and sometimes it may appear simpler also that why draw all this and why visualize, just compute numbers but you should try initially at least till you become quite familiar, you should try both ways.