Solid State Physics
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Lecture – 04
Structure of Solid (Contd.)

So, what we have seen so far that in Crystalline Solid.

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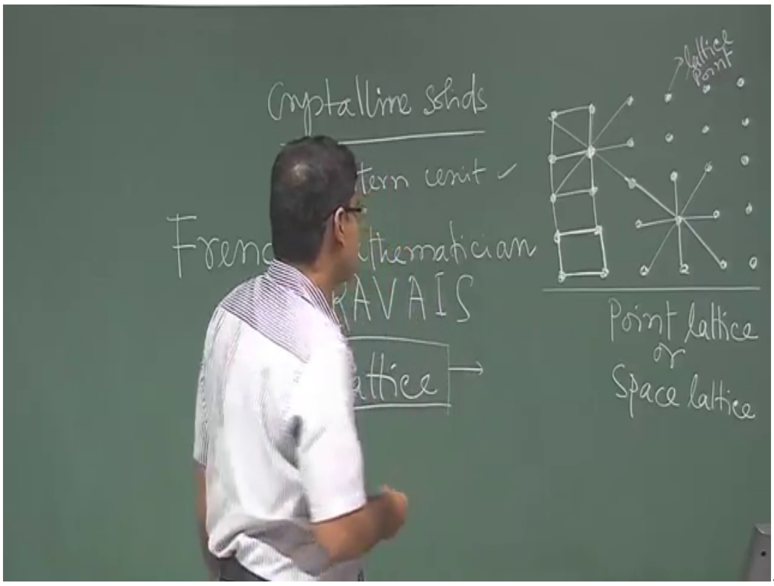

In Crystalline Solid there is a atoms are arranged orderly in the solid and it ahs a pattern unit a pattern unit and repetition, this pattern unit basically form the crystal structure. Now we want to we want to learn we want to find out that how many pattern unit are required to describe crystal structure of all materials right. So, in this regard and eminent French mathematician; French mathematician his name is Bravais, he introduced a if concept of lattice concept of lattice. So, this lattice is basically formation of lattice is basically mathematical concept. So, what is that?

So, basically if we imagine that that a infinite number of points infinite number of points are arranged in space. So, this diagram is similar to the earlier diagram, but there I told that these are atoms, but now it is not atoms it is basically the infinite number of points arranged in space in such a way that the surrounding of a given point will be same of the surrounding of any other points in space. So, if this criteria is fulfilled means if I take any points the points are arranged in space in such a way that if I consider any points and whatever the surrounding whatever the surrounding of this points.

So, there will be same surrounding there will be same surrounding of any other points same surrounding of any other points see if I take this point. So, all these points is arranged in a space in such a way that if I just look at a point and what are the surrounding of that point if I look at any other points it will have the same surrounding if. So, if arrangement is in space then this each point is called lattice point each point is called lattice point and this arrangement this arrangement in space.

Now, it is called point lattice or space lattice. So, this purely mathematical concept just take 100 1000 and 1000 points and arrange in space in such a way what about the arrangement it does not matter, but arrange in such a way that the surrounding of each point will be same then that arrangement in 3 dimension in space, it will be called space lattice or point lattice and each point are basically the it is lattice point.

So, from these arrangement; form these arrangement one can again find out the unit 1 unit and repetition and repetition of this unit is; so it is in 2 dimension. So, 3 dimension 1 can 1 can find out this unit. So, then this unit is basically is called unit cell this unit is called basically unit cell. So, whatever earlier we used to tell this pattern unit. Now we are telling; we are calling it as a unit cell; unit cell.

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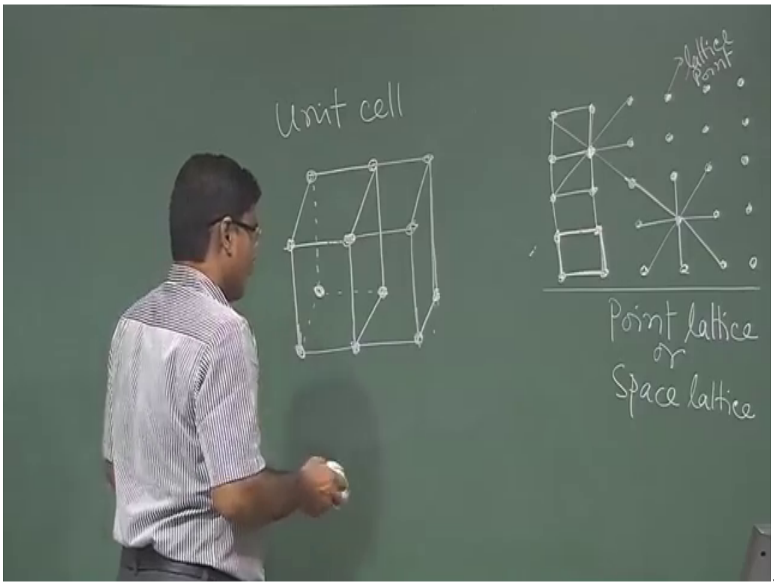

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So, pattern unit clearly; we told that is basically we talk in terms of in terms of atom, but here we are talking in terms of some points in space. So, here also these points are orderly arranged in space and one can find out the unit repetition of which one form this point lattice or space lattice. So, in 3 dimension this it is one can.

In 3 dimension one can one can get unit cell like this and repetition of this unit cell repetition of this unit cell basically written form the lattice space lattice. So, basically one has to draw I am not drawing basically it will continue is a and I should draw properly. So, just one can repeat in all directions in all directions and get the point lattice or space lattice.

So, how to arrange how to how to arrange the point in space? So, that there are different ways to do that. So, this one way is the following. So, if you divide the space taking 3 sets of planes each set of parallel planes each set of parallel planes, equally they are they are equally spaced their distance are same they are parallel. So, this is one sets of parallel planes divided the space and then another sets of parallel planes they are also equally spaced and parallel, but their distance may be this planar distance may be different than the earlier one here whatever planar distance in this other direction planar distance can be different, but in this set of parallel planes they are equally spaced and other sets of parallel planes other set of parallel planes.

So, they are also again equally spaced and parallel, but their planar spaces can be different from the other sets of parallel planes. So, if you divide the space taking 3 sets of parallel planes in each set of parallel planes the planes are parallel and equally spaced. So, then what we will get we will get basically this type of this type of structure.

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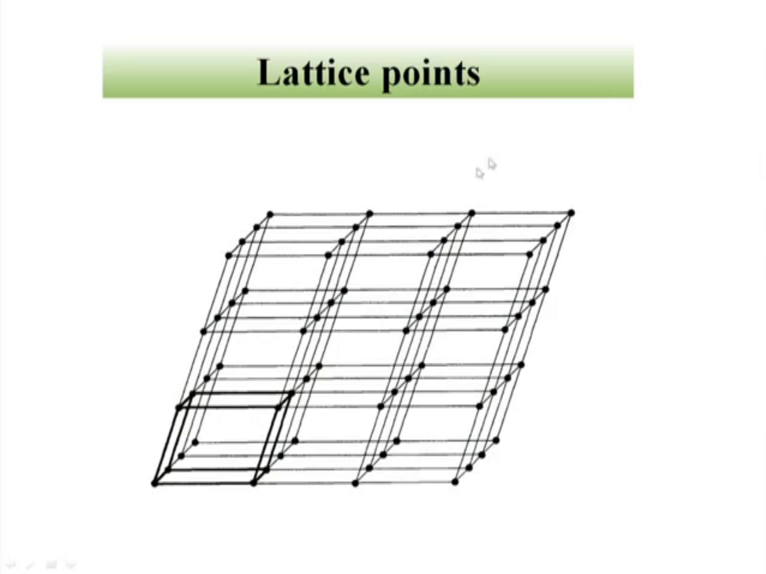

So, here so these are one set of parallel planes they are equally spaced, this another set of parallel planes they are equally spaced and these are other set of parallel planes so this way.

So, they are parallel and equally spaced. So, then what we are getting we are getting basically cells; we are getting basically this whole space is now divided into many cells and these cells are all cells are equivalent identical their size shape are identical.

So, now, corner point of each intersection of 3 planes. So, this is this is one sets of parallel, planes this is another set of parallel planes. So, intersection of these 2 planes and this is another set of another set of parallel planes. So, these 3 planes these plane, this plane and this plane they intersect at this point right and now just consider the parallel of these planes. So, you will intersect of these 3 planes at each corner of this unit cell.

So, these are the intersecting points intersecting points here whatever this we have shown they are basically intersecting points. So, this intersecting points is basically is lattice point intersecting points are basically now lattice point and these all points together all corner points of cells basically forms the point lattice or the space lattice. Just from this figure if you just remove the those lines just leave these points, then you can see the arrangement of the points in space arrangement of the points in space. So, that whole arrangement in space is basically called the lattice is space lattice or point lattice we just call a lattice.

So, this way one can form without we are not discussing anything about atoms and nothing you know just this the concept of Bravais that in space how we can arrange points, where the points each points will satisfy some condition where what is that condition the each point will have the same surrounding, what about the point will consider it will have the same surrounding of this like other points. So, this is one way to form the; this is one way to form the lattice point in space and we can get the unit cell from this arrangement of the lattice point.

So, now this arrangement of the lattice point it can be different depending on the spacing of the parallel planes in each set. So, 3 sets of planes in each set of planes there are many parallel planes. So, their spacing their spacing whatever the spacing another set of parallel planes their spacing may be different. So, spacing of this 3 sets of parallel planes can be same can be different etcetera; 2 are same one are different and also this parallel planes a set of parallel planes how they what is the angle with the another set of parallel planes, whether these angle are 90 degree this is one sets of parallel planes another sets of parallel plane is this. So, if it can be 90 degree it can be other than 90 degree.

Basically here important is the spacing of the spacing of the parallel planes for 3 sets of planes and angle between the planes among the 3 sets of planes. So, that can be that can vary. So, depending on this angle and the spacing of 3 sets of planes one can have one can have different arrangement of points in space so; that means, it will form different point lattice or space lattice so to describe this one to describe this different kind of point lattice or space lattice.

So, we have to consider the this spacing of the planes as well as the as well as the angle among the planes.

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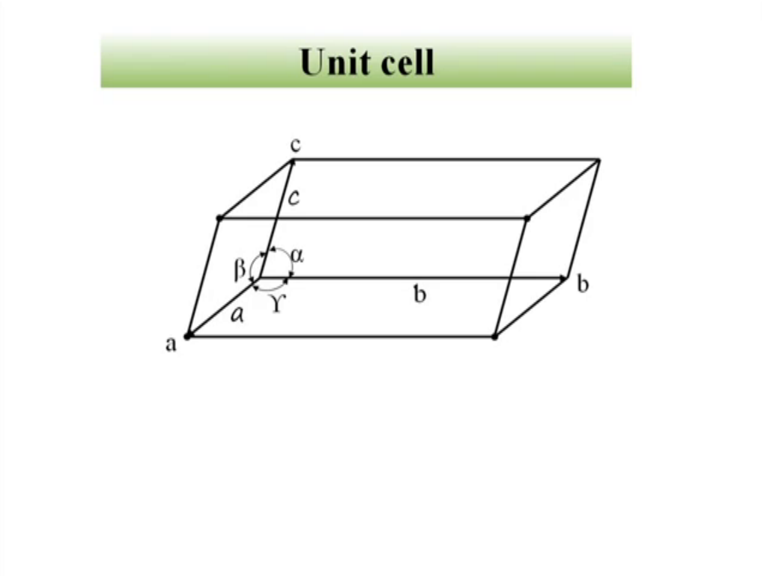

So, this is defined the spacing; so this spacing of one set of parallel planes spacing another sets of parallel planes.

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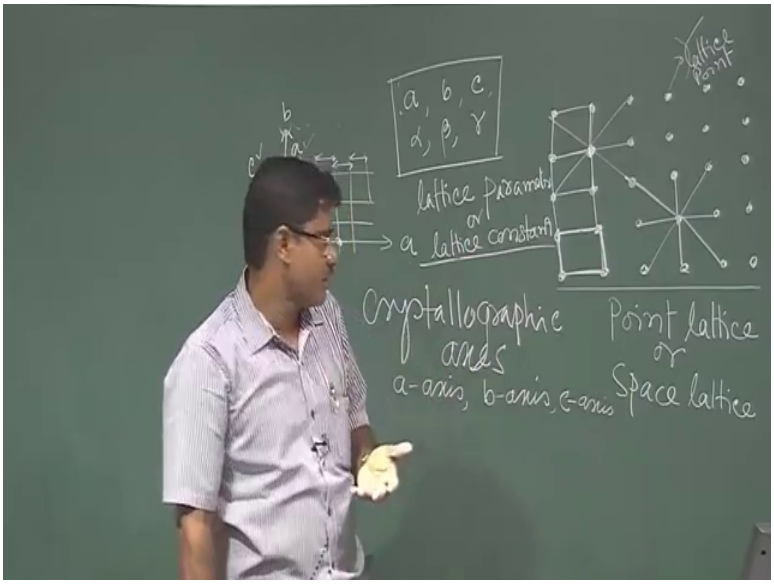

So, this is the spacing; basically as I told this in one set of parallel planes the spacing are constant this is another set of parallel planes. So, these are the spacing. So, these are again these are constant. So, these in other direction in other direction this will be the spacing at this say these are the sets of parallel planes. So, this another spacing this if we consider this a say this b and these other direction is if it is c, then in figure whatever we are seeing this a, b, c that is that is basically this spacing of parallel planes as well as angle we have we can define so this is a, so this basically b, this is basically b, and then your other direction in other direction. So, this; the same other direction say it is perpendicular basically on this space c. Now this angle is between b and c between b and c it is defined as alpha, between c and a, it is defined as a beta, and between b and a it is defined a, this angle as a gamma.

So, imagine that taking 3 sets of parallel planes we can divide the whole space right depending on the spacing of this spacing of each spacing of planes in each set. So, for 3 sets this spacing are a b c and the angle between the 2 planes angle between the 2 planes. So, that we have defined for 3 planes this angle we have defined alpha beta gamma. So, whatever the whole space is divided whatever the whole space is divided and gives us a smallest unit that we are saying that see unit cell. So, that unit cell have, these are in figure these are the unit cell.

So, unit cell can be defined as a 3 axis a axis, b axis, c axis, and 3 angles alpha beta gamma alpha beta gamma. So, these 3 axis are called basically crystallographic axis crystal axis crystallographic axis crystallographic axis, a axis, b axis, and c axis right and the angle and the angle alpha beta gamma and the angle alpha beta gamma this among the among the 3 axis alpha beta gamma.

So, along the x axis along the a axis whatever the minimum distance between the 2 points; minimum distance between the 2 points. So, lattice point right minimum distance of these 2 points is basically this length this between these 2 points is we take as a a similarly along b direction the minimum distance between 2 points are b and in c axis along the c axis it is c. So, a, b, c and this angle between angle between b c it is alpha other is beta and this gamma.

So, these 3 parameters length parameters a, b, c and this 3 angle parameter alpha beta gamma, these putting the value of these 6 parameters define the unit cell varying these parameters we can get different unit cells. So, these are called these 6 parameters these are called lattice parameters; this is called lattice parameters lattice parameter and basically it is called lattice constant. So, for each lattice for each lattice these parameters are whatever the parameter and that will vary and we will get different unit cell for different space lattice. So, we will continue this discussion in next class.

Thank you thank you for