Condensed Matter Physics
Prof. G. Rangarajan
Department of Physics
Indian Institute of Technology, Madras

Lecture - 39
Dislocation in Solids – Worked Examples

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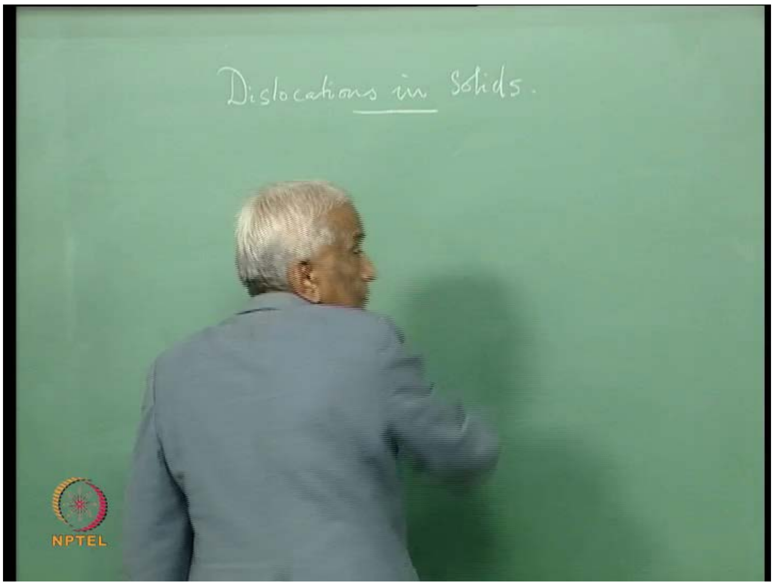

Today, we will work out some examples on dislocations in solids.

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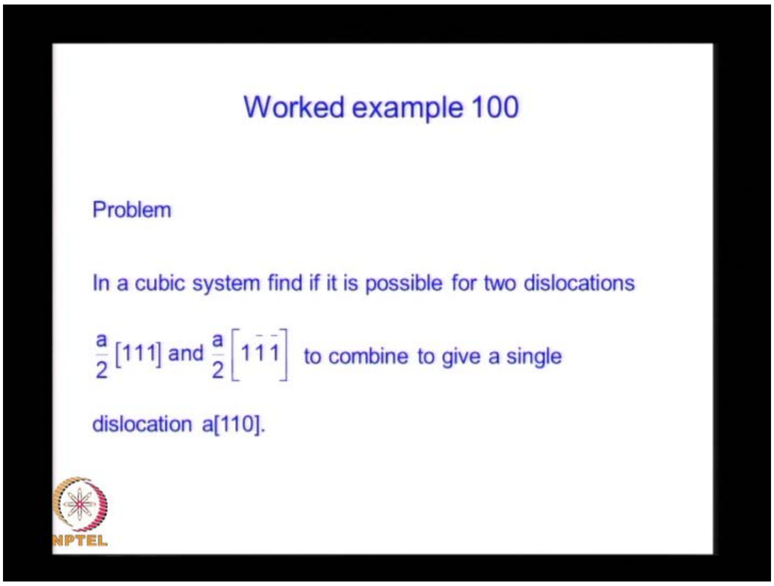

The first example tells us that we have a cubic crystal and we are asked to check if it is possible for two dislocations represented by a by 2 111 each whether it is possible for these two dislocations to combine to form a single dislocation at 110 that is the question, a 110.

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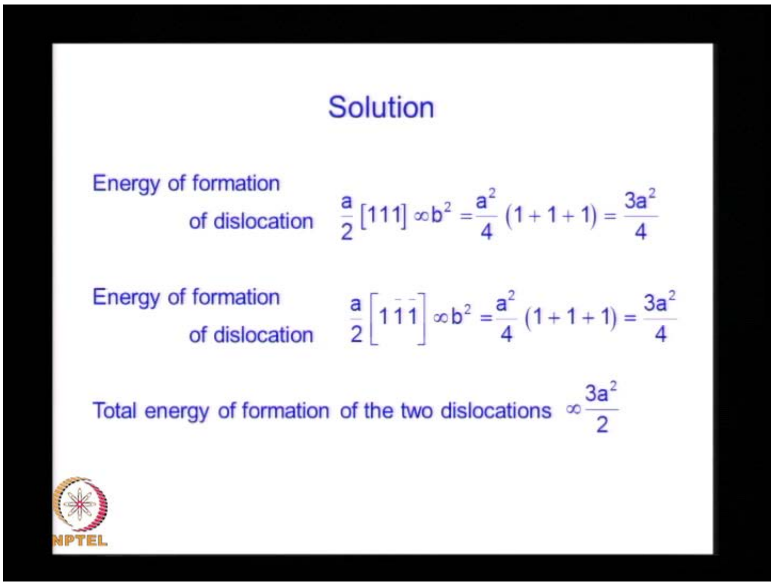

In order to find this is basically a question of energy of the formation of dislocation a by 2 111, this is equal to a square plus k square 1 square plus 1 square plus 1 square by 2 a square which is 3 by 2 a square, so that is the energy of the single dislocation. So, energy of two dislocations is 3 half's a square, whereas the energy of a dislocation 1 110 is 1 square 1 plus square into a square which is 2 a square. So, since this energy, so this is e 1 this is e 2, it is clear that e 1 is less than e 2. So, the combination, the two dislocations combining to form a single dislocation is not energetically possible that is the answer.

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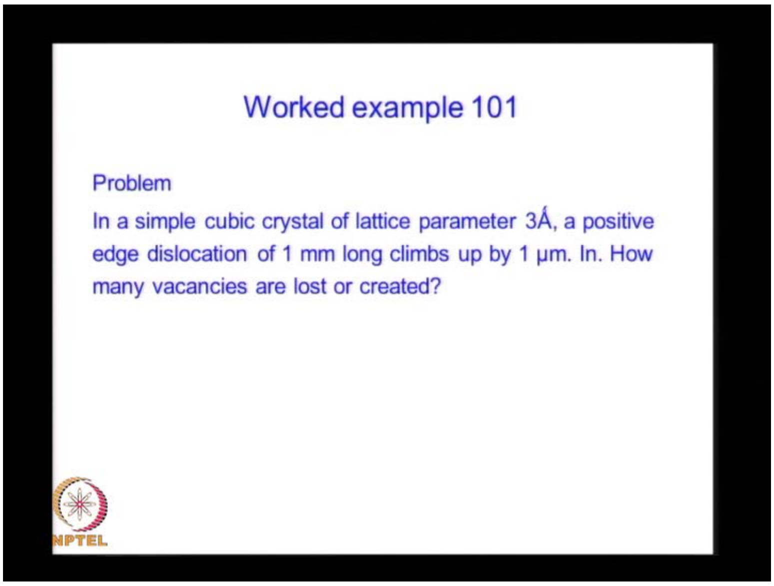

Next we are again told that we have a simple cubic crystal whose lattice parameter is a 3 angstrom. So, a positive edge dislocation whose length is one millimetre, we are told that it climbs up by 1 micro meter. We are asked find how many vacancies are lost or created that is the question.

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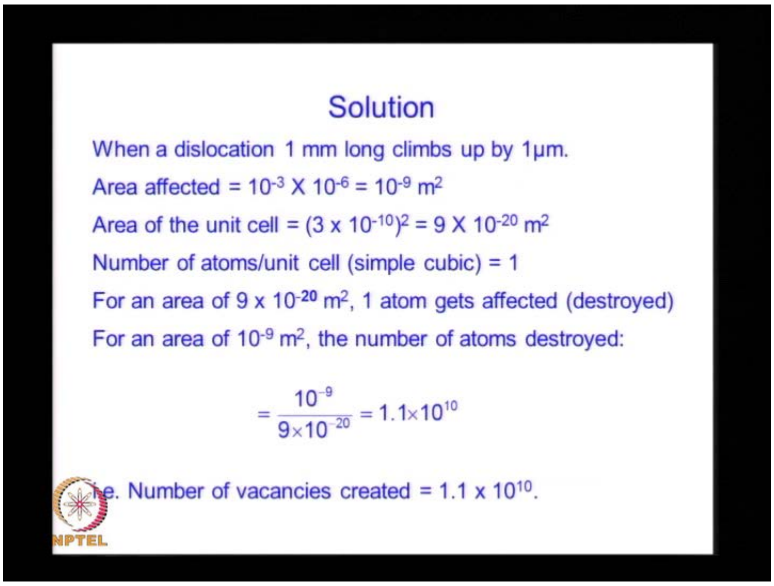

So, we are told that you have an the area is 1 millimetre 10 to the power minus 3 meters into one micron metre, which is 10 to the power minus 6 which is 10 to power minus 9 meters that is the area affected. It is 3 into 10 to the power minus 10 square which is 9 into 10 to the power minus 20 meter square. So, in this area how many unit cells are there for an area of 10 to the power minus 9. We have 10 to the power minus 9 by 9 into 10 to the power minus 20, which is 1 by 9 into 10 to the power 11 which is 1.1 into 10 to the power 10. This is the number of vacancies created.

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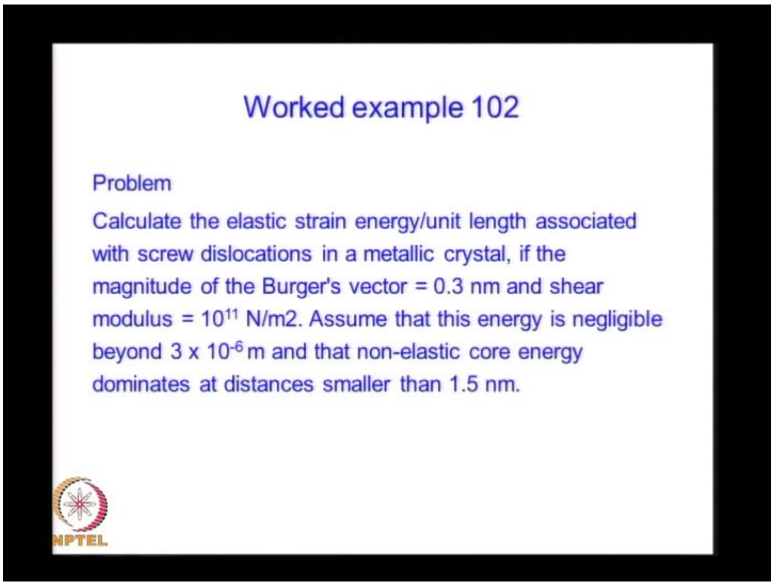

The next problem concerns the elastic strain, we are asked to calculate the elastic strain per unit length associated with screw dislocations in a metallic crystal. We are told that the burgers vector is 0.3 nanometres. The shear modulus is 10 to the power 11 newton per metre square. You are also given as to assume that this strain energy is negligible beyond 3 into 10 to the minus 6 meters, and the non elastic core energy, dominates at a distance less than 1.5 nano meters.

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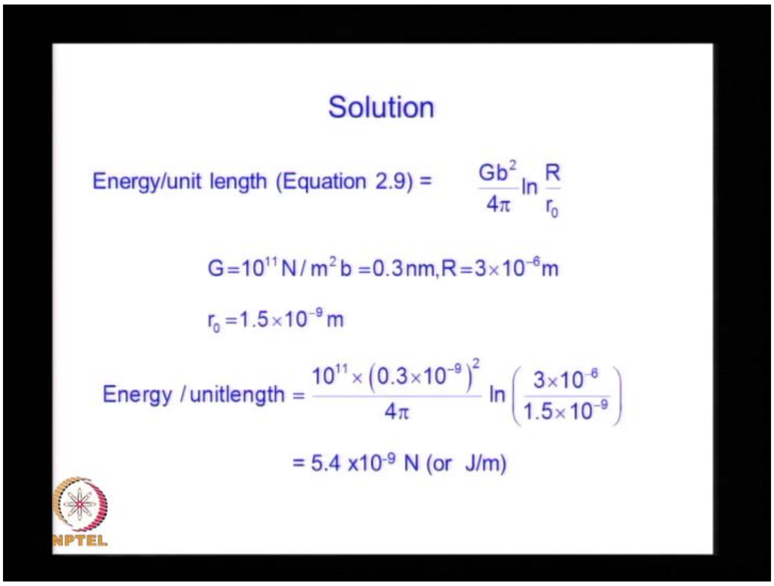

This is the substitutional problem in which we know the expression for the strain energy which was discussed in the lecture it is strain elastic strain per unit length is G b square by 4 pi log R by r zero. So, in this, this is b, this is G this is r zero and this is R. So, substituting these values 10 to the power 11 into 0.3 into 10 to the minus 9 square by ln R is 3 into 10 to the power minus 6 by r zero is 1.5 into 10 to the power minus 9. So, calculation gives per metre.

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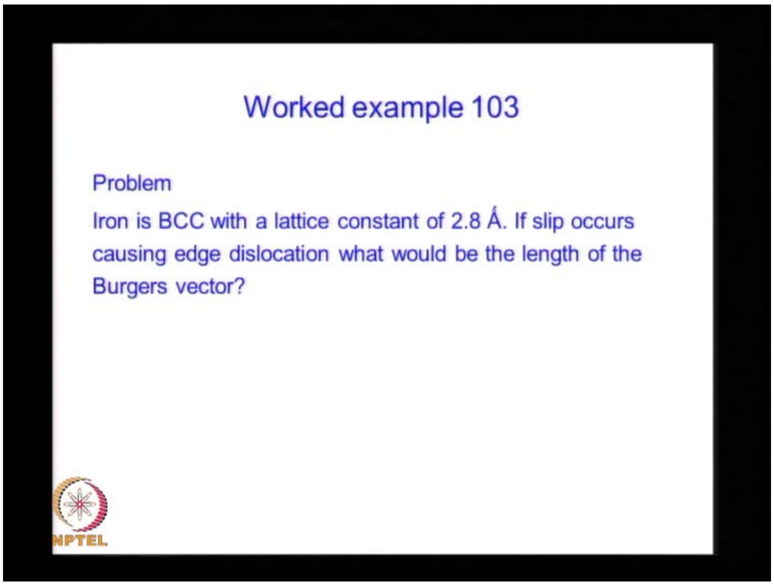

In the last question, we are told that iron has a body cantered cubic structure with a lattice constant. If slip occurs causing edge dislocation what would be the length of the Burgers vector? You know that the slip direction in a bcc structure is 111. And it is a by 2 111. So, this will be in the case of 111, since lattice constant is 2.8 angstroms, this 2.8 into root of 1 square plus 1 square plus 1 square by 2. So, this will be which is…