Line defects

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THAPAR INSTITUTE
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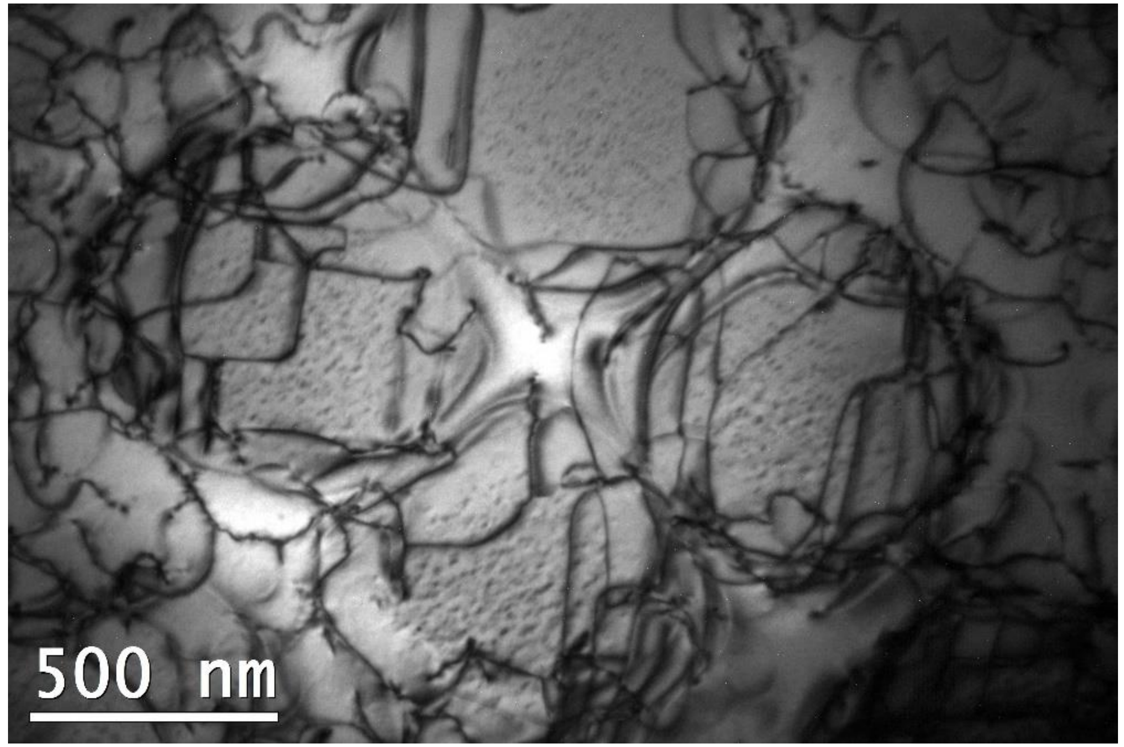
One dimensional defects

One dimensional or line defects are often called as dislocations.



TEM Bright-Field image showing the dislocation loops around γ′ precipitates in Ni-base superalloys

Types

Edge Dislocation

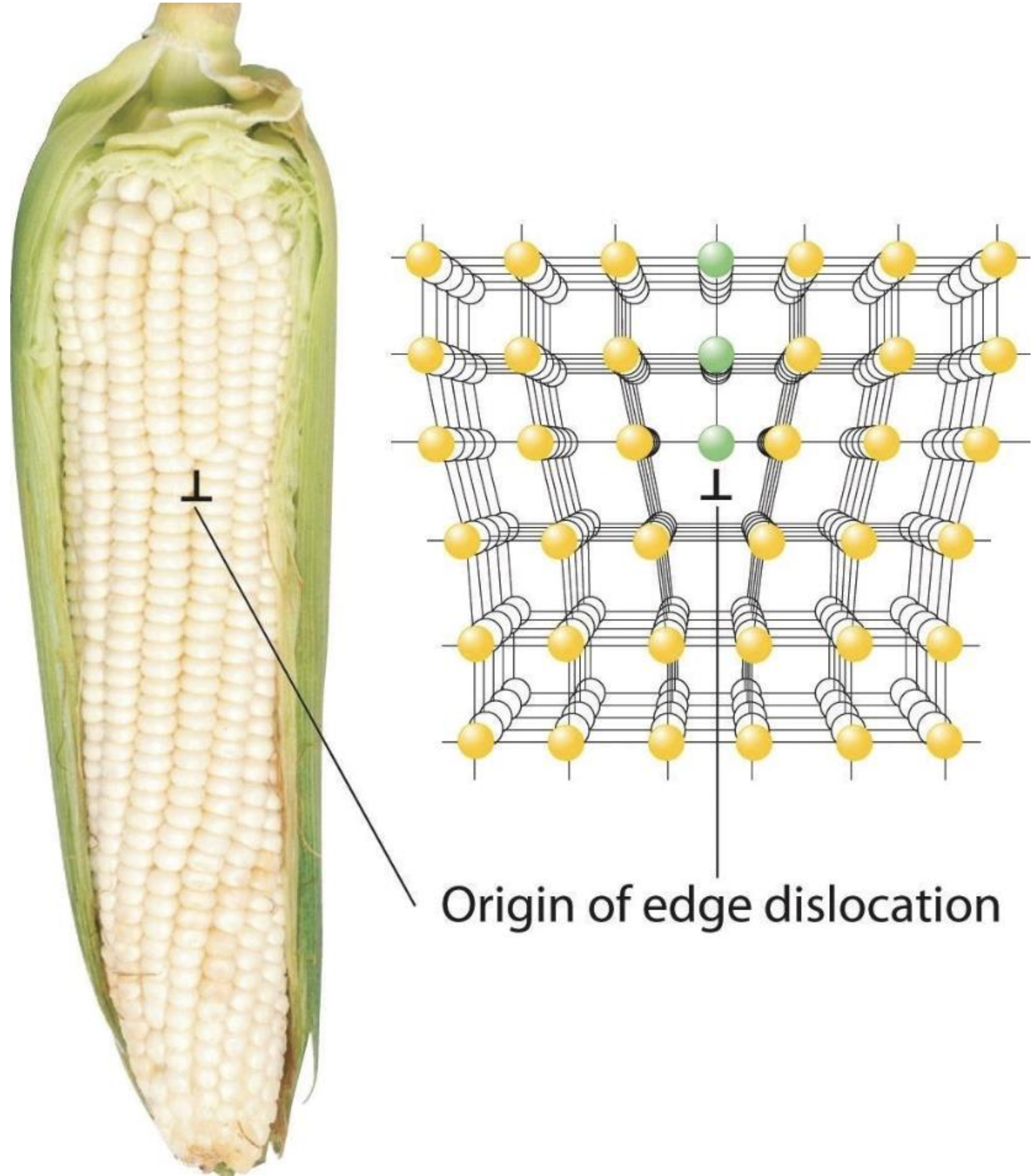
Mixed Dislocation

Screw Dislocation

$\perp$

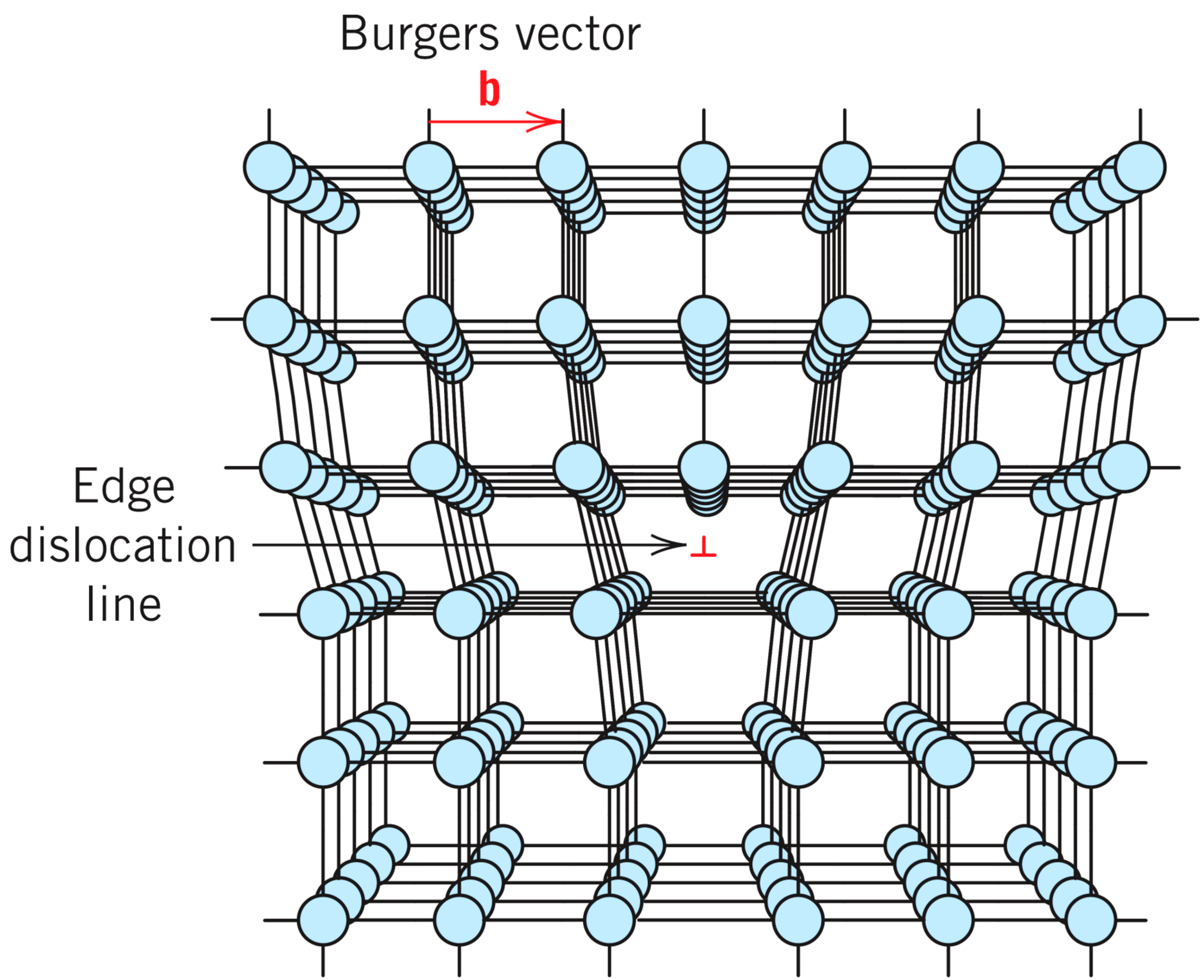
TEM image produced by Dr. Sanjay Kashyap, TIET, Patiala

Edge Dislocation

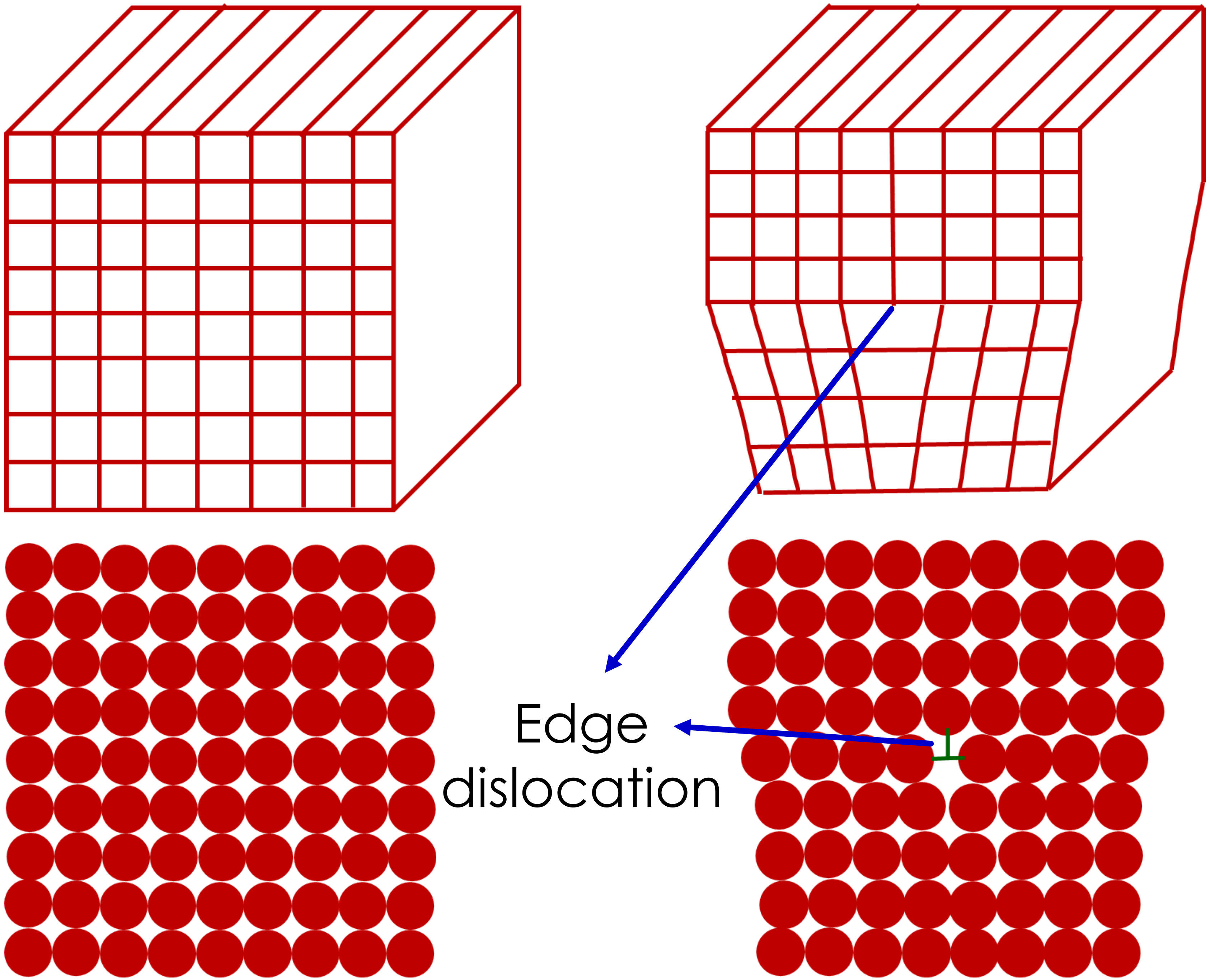


1. Within in a perfect crystal, if an extra half plane or extra portion of plane of atoms, terminates with in the crystal.
2. This will create an edge dislocation.
3. It centres around the end of line made by the extra half-plane of atoms.

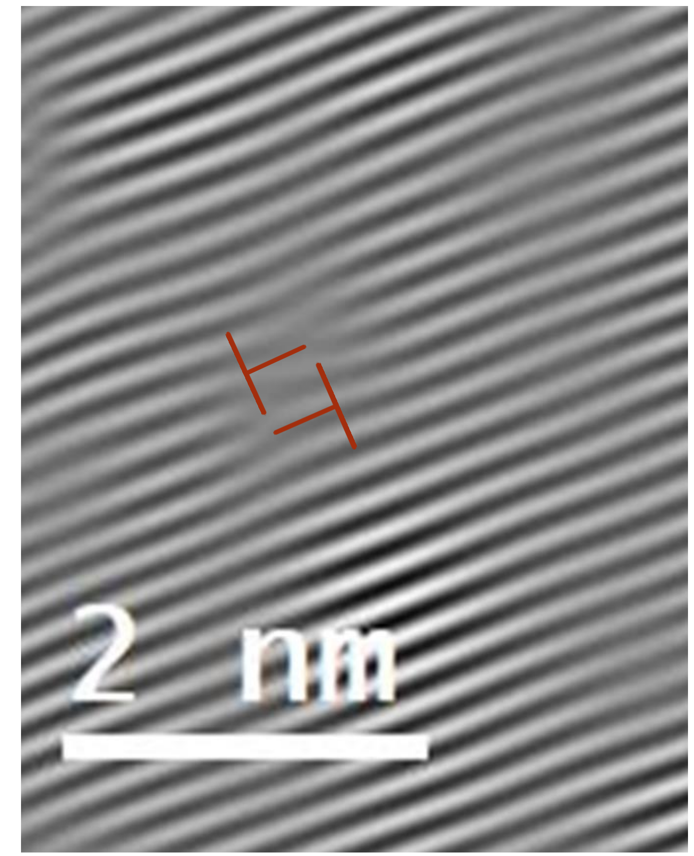
Edge Dislocation



Edge dislocation



Perfect Crystal

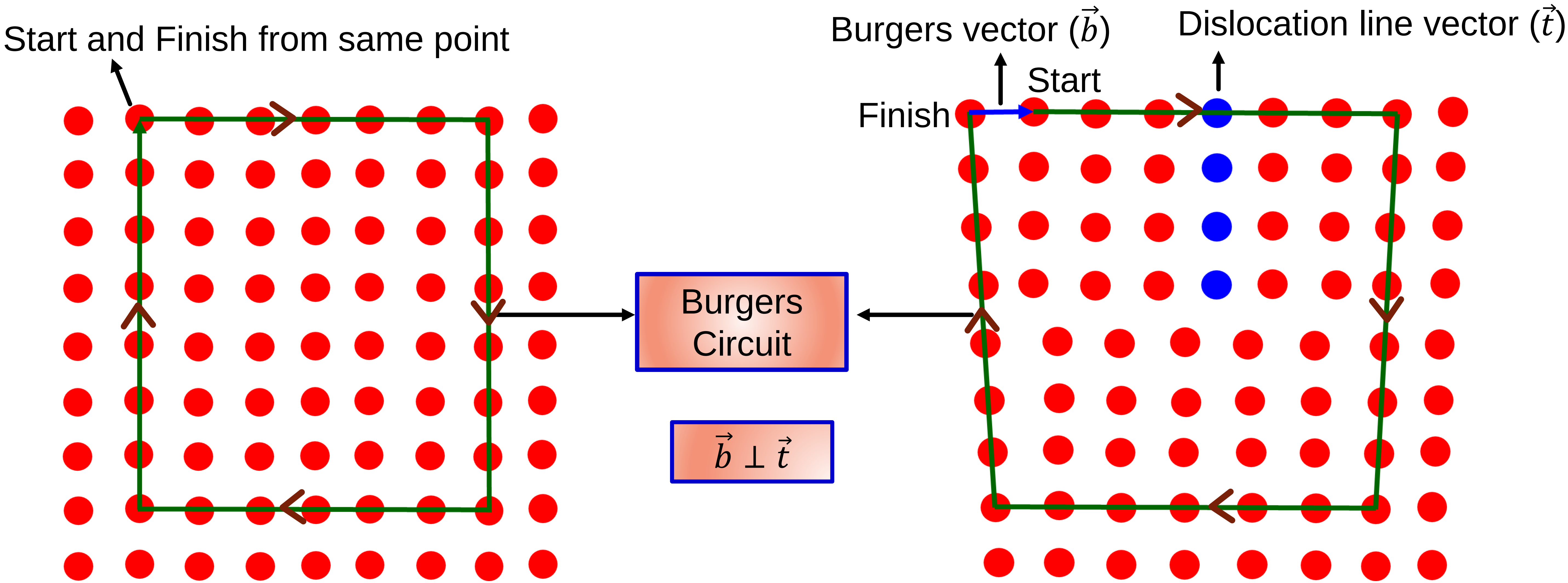


edge
dislocation

TEM image produced by Dr. Sanjay Kashyap, TIET, Patiala

Edge dislocation

Burgers vector: dislocation are defined by its Burgers vector.

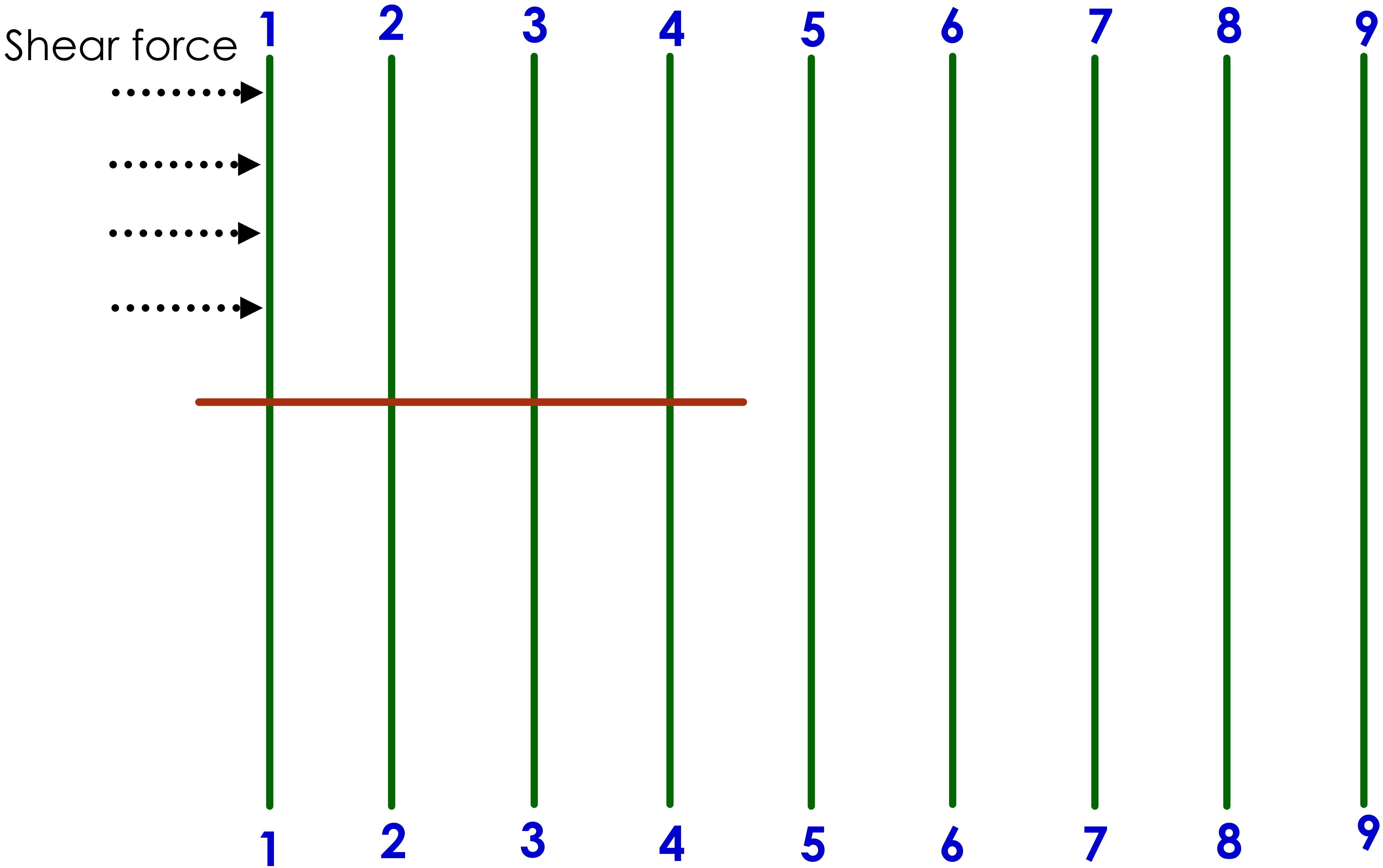


Perfect Crystal

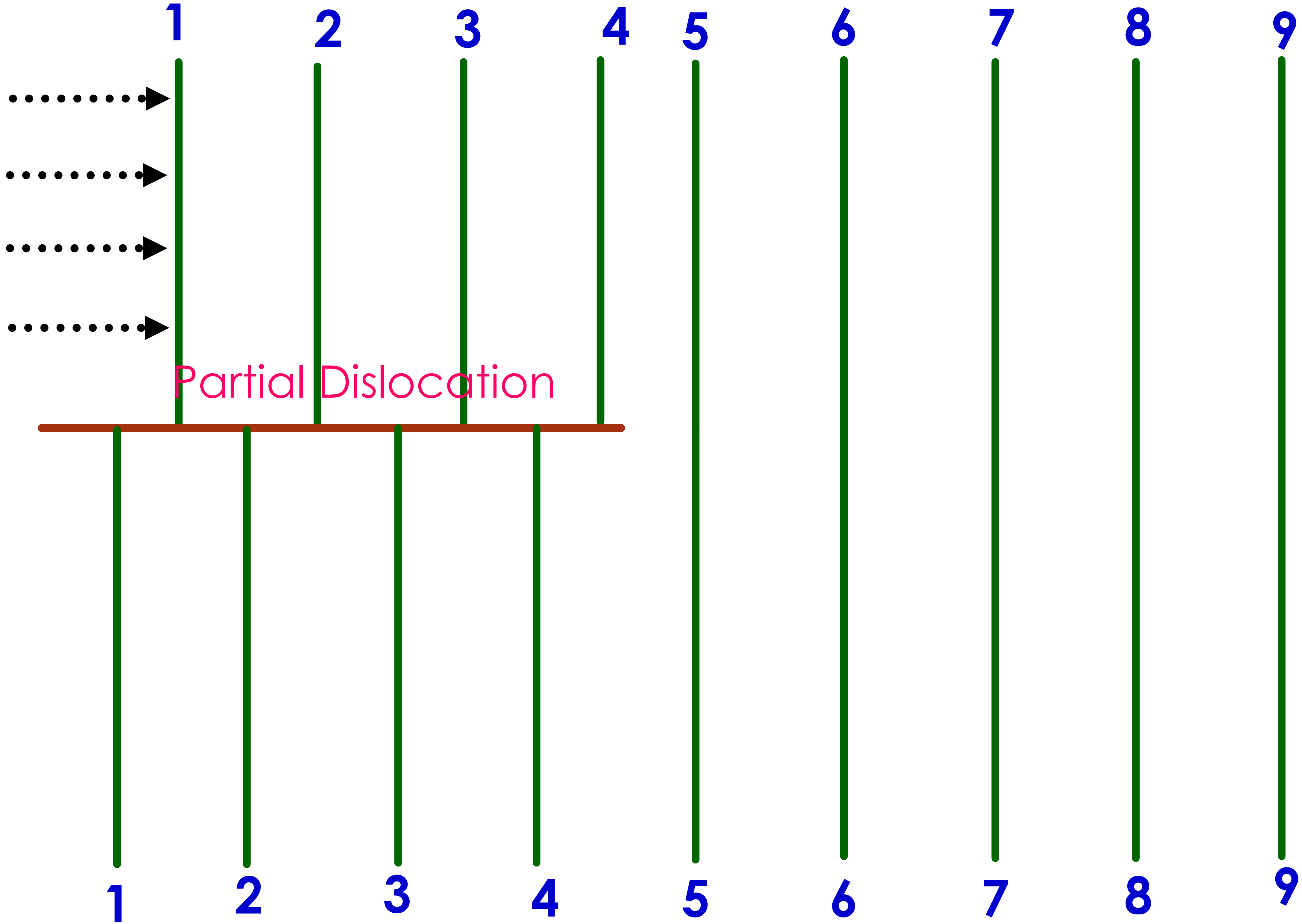
Imperfect Crystal with an edge dislocation

The magnitude and direction of lattice distortion (displacement) with dislocation is defined by a vector called the Burgers Vector ($\vec{b}$). It is determined by using the Right Hand Finish to Start (RHFS) rule.

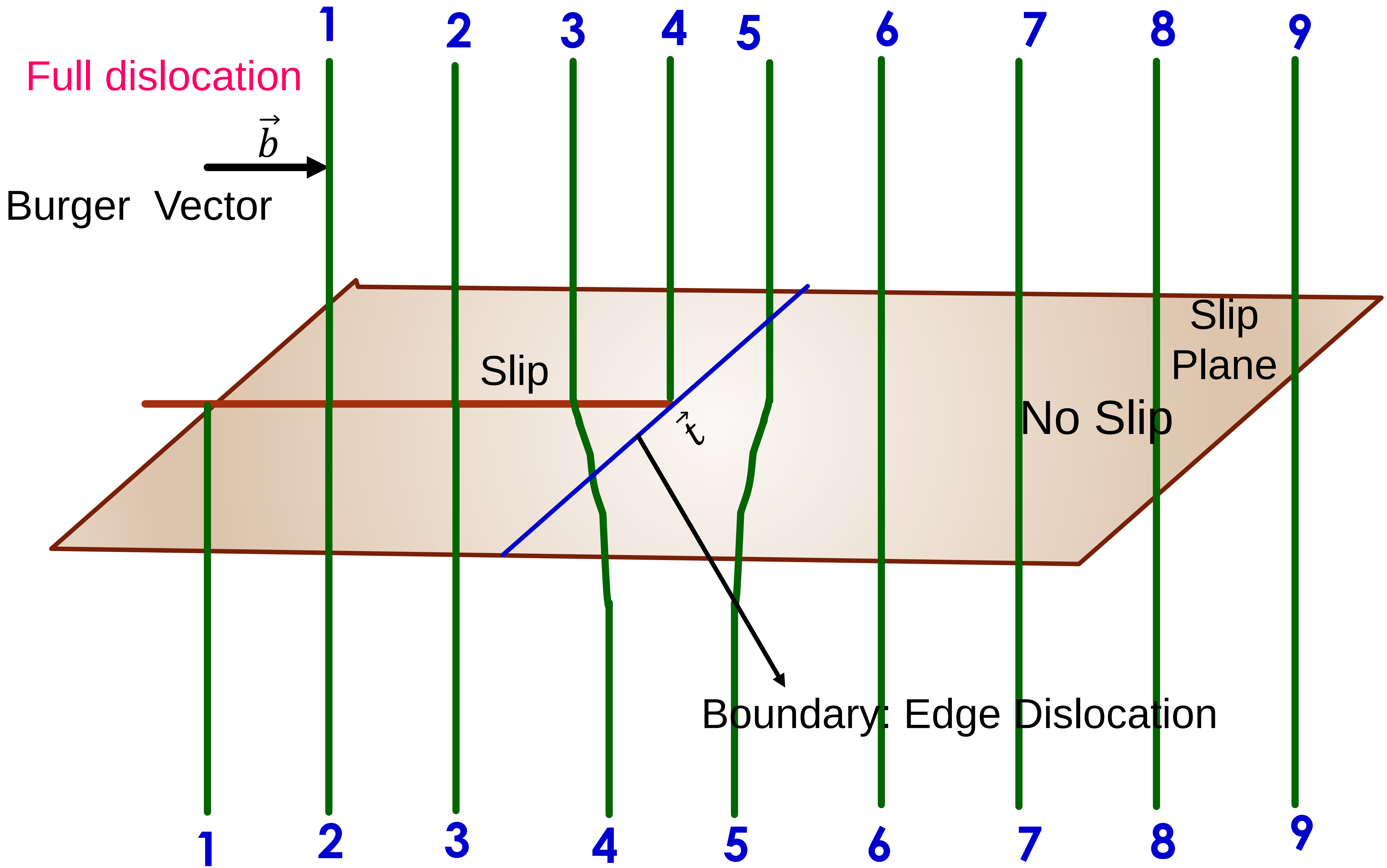
Edge dislocation formation



Edge dislocation formation



Edge dislocation formation

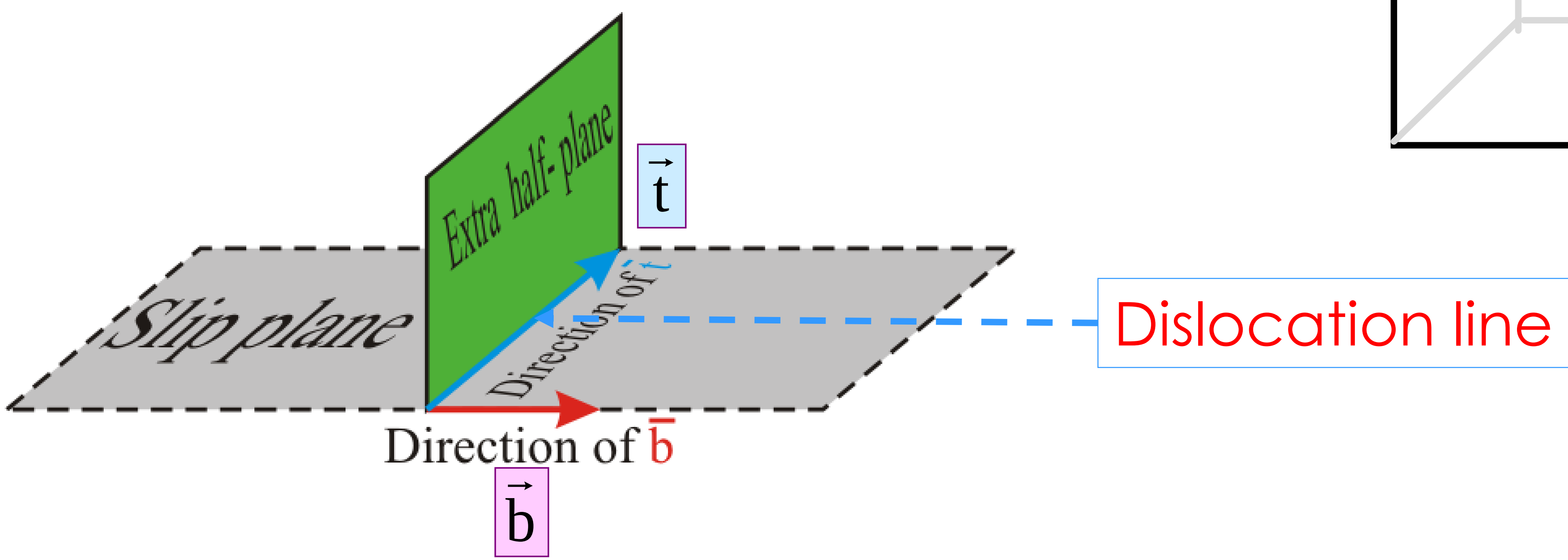


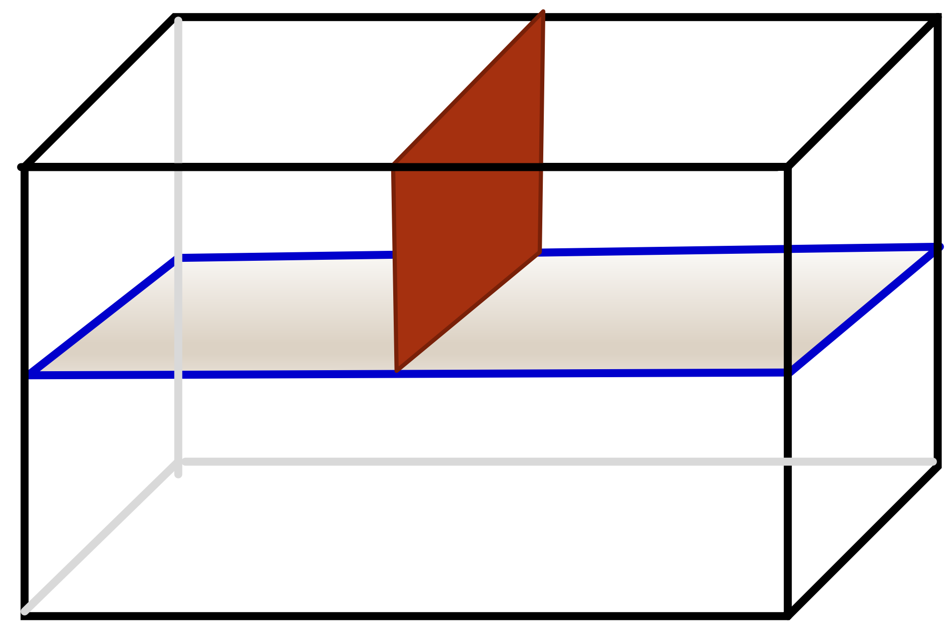
Edge dislocation

The intersection of the extra half-plane and slip plane can be visualized as the dislocation line

b is ⊥ to the edge dislocation line

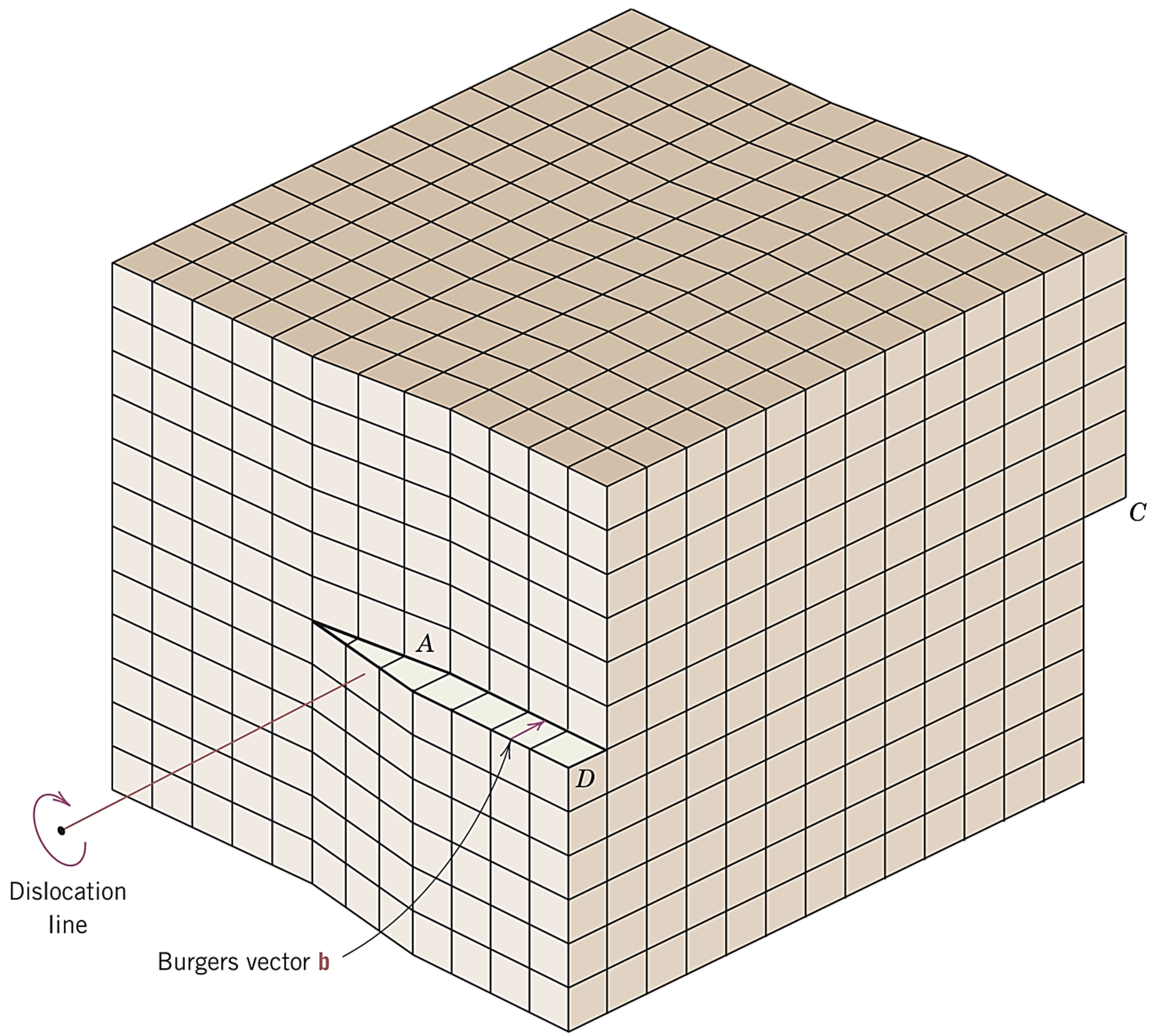
Slip direction is always | | to b

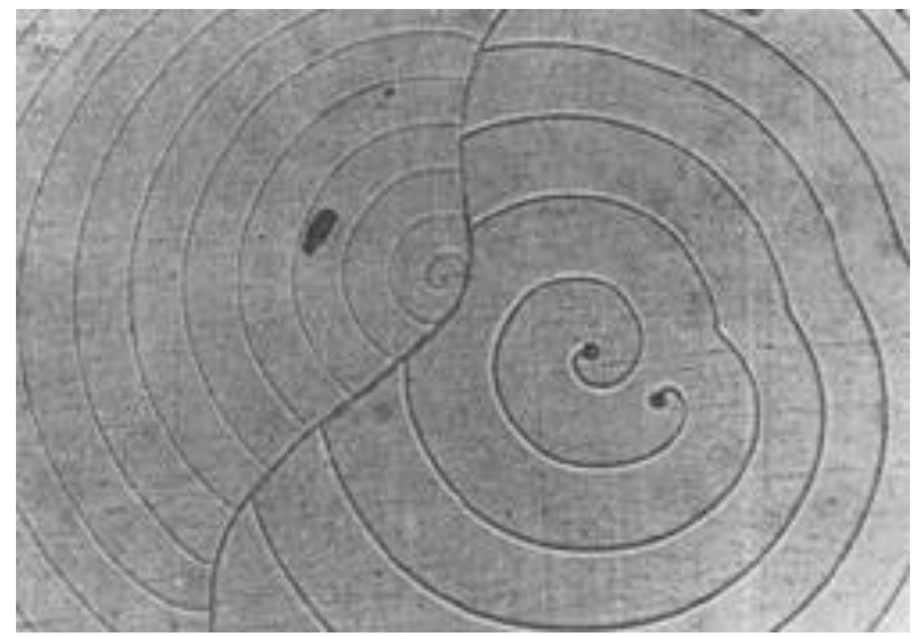




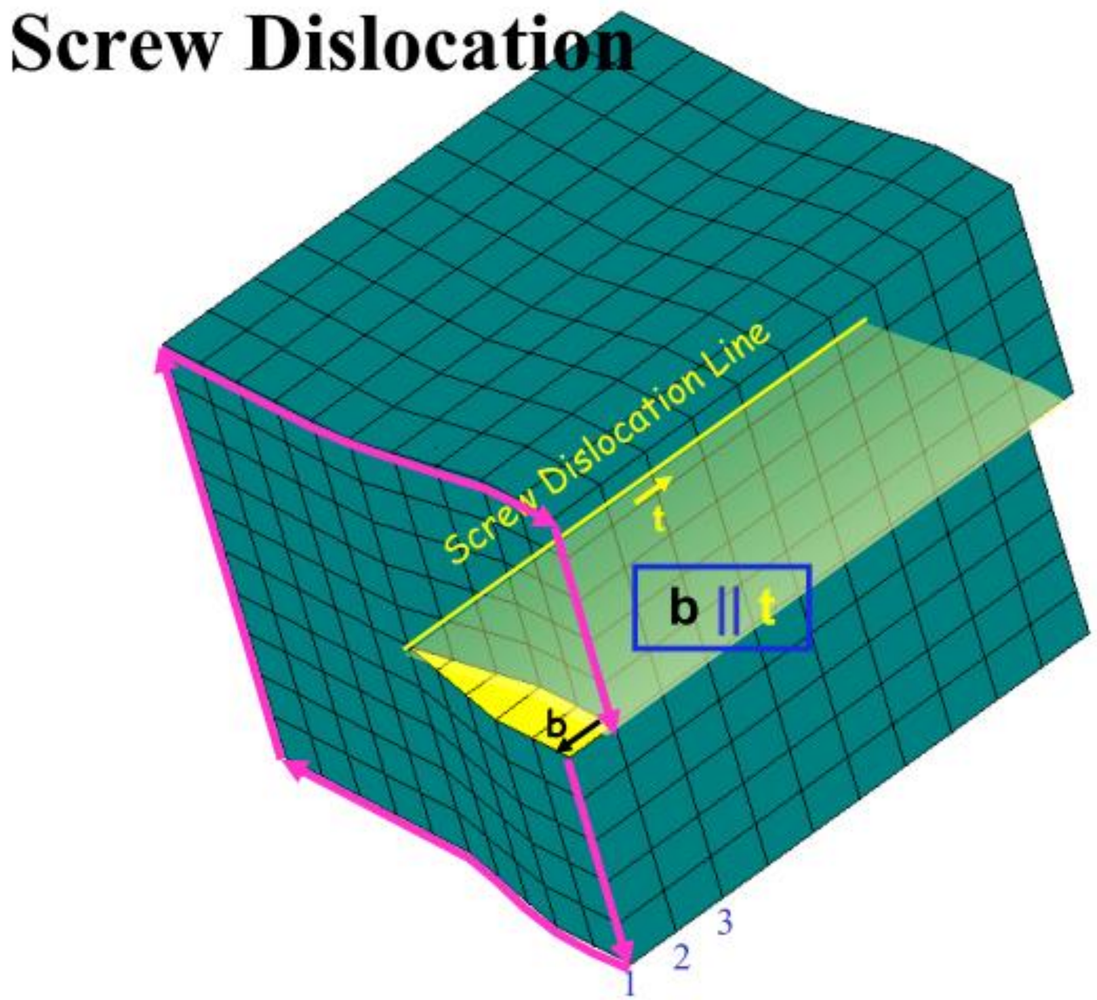
Screw dislocation

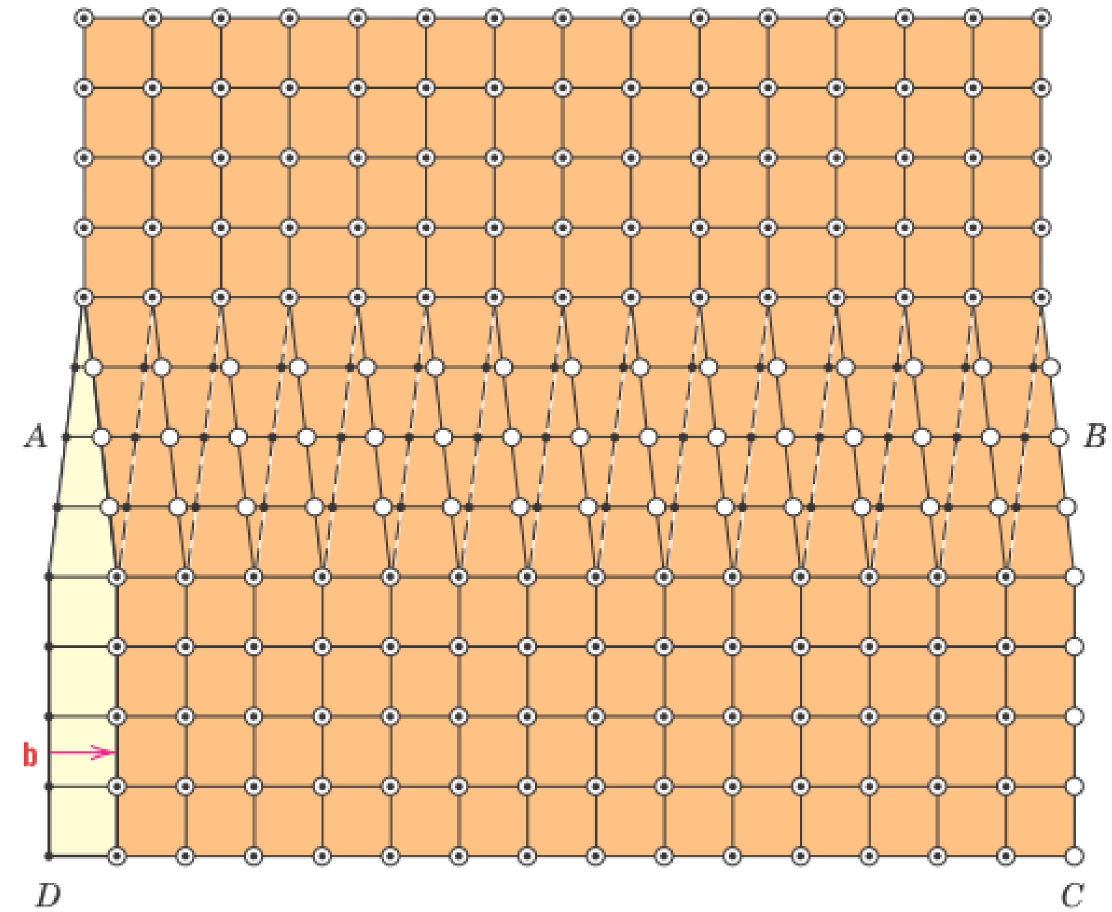
The motion of a screw dislocation is a result of shear stress which produce the distortion in crystal , where the upper front region of the crystal is shifted one atomic distance to the right or left (depends on the direction of shear stress) relative to the bottom portion. It is also called as Burger's dislocation.





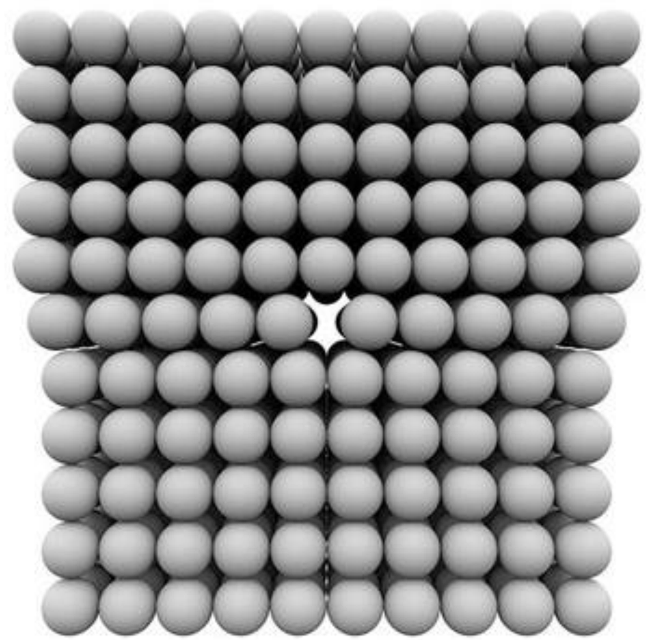
Screw dislocation

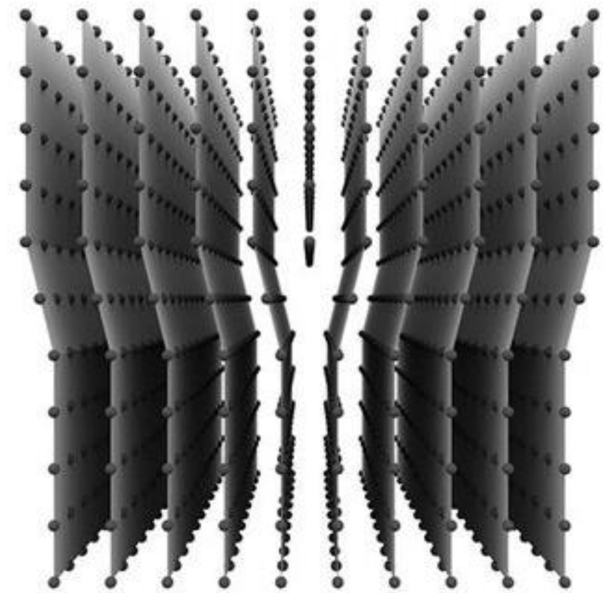


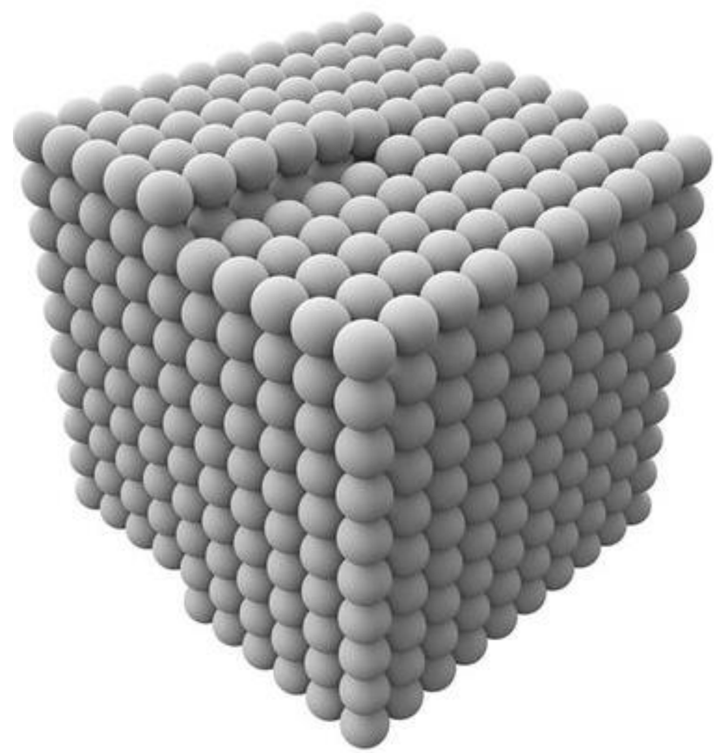


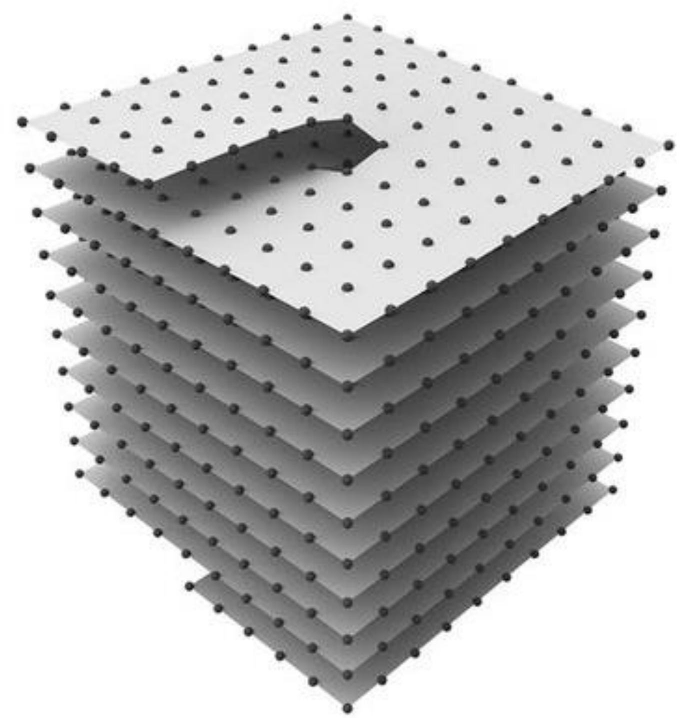
If $\vec{b} \parallel \vec{t}$, then parallel planes perpendicular to the dislocation line lose their distinct identity and become one continuous spiral ramp. Hence the name Screw dislocation

Edge and Screw dislocation



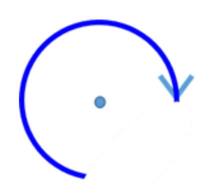






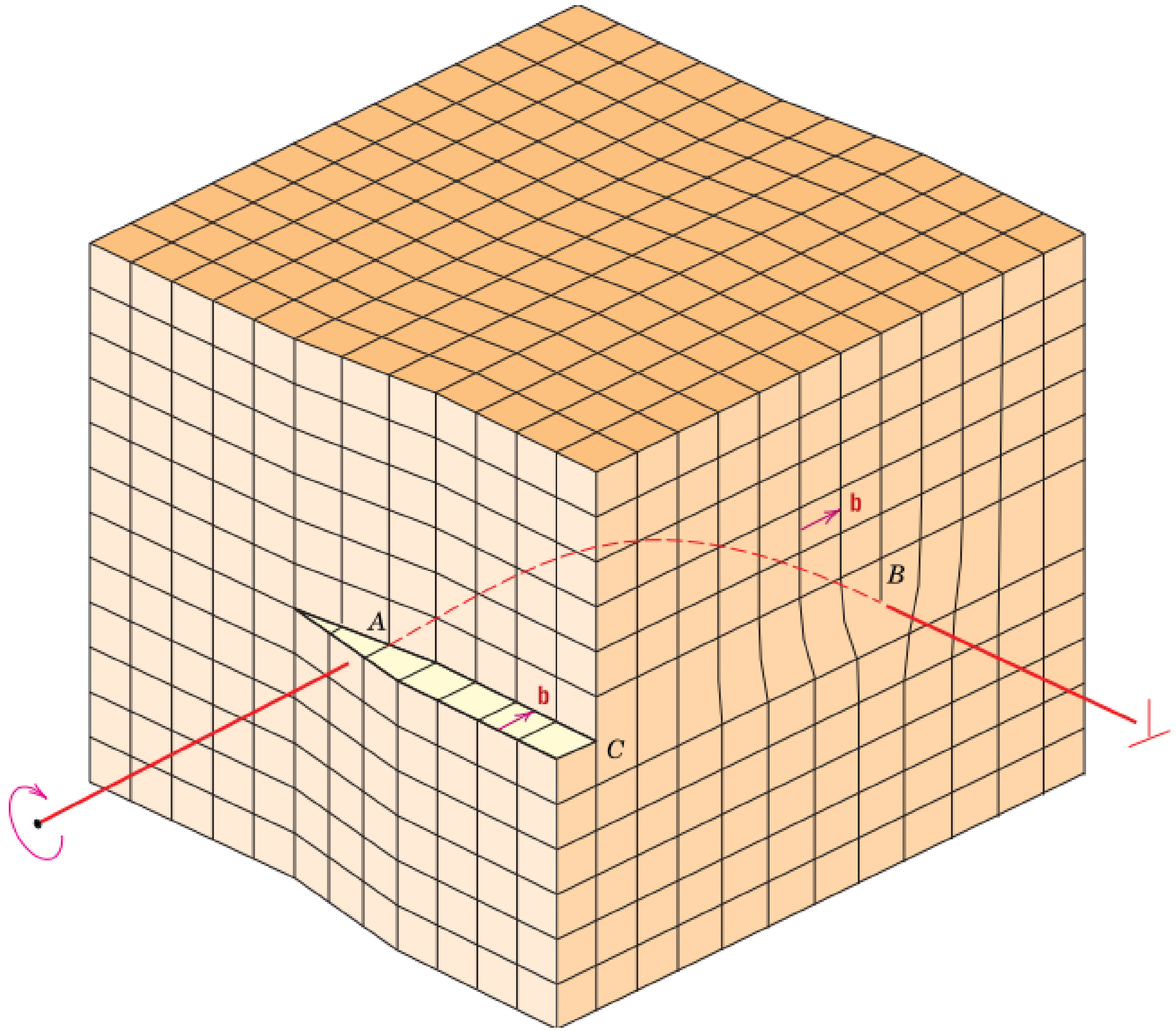
One dimensional defects

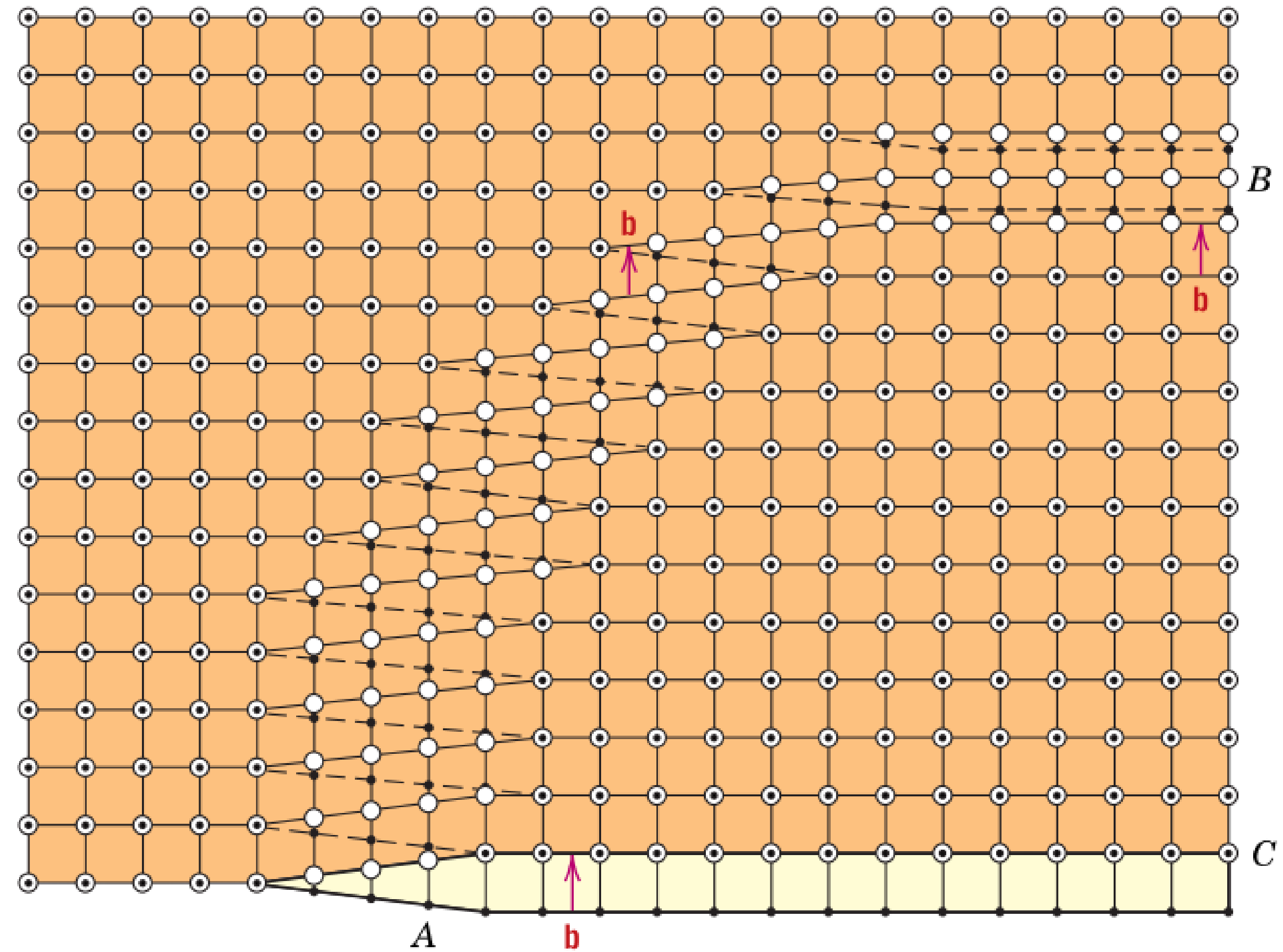
Remember

Type of dislocations	Positive	Negative
Edge Dislocation	If extra half plane is above the slip plane Extra half plane $\perp$ Slip plane	If extra half plane is below the slip plane $\top$ Slip plane Extra half plane
Screw Dislocation	Left-handed spiral ramp $\vec{b}$ *parallel* to $\vec{t}$ 	Right-handed spiral ramp $\vec{b}$ *antiparallel* to $\vec{t}$ 

Mixed dislocation

Dislocations with mixed edge and screw character





The Burger vector $(\overrightarrow{b})$ is invariant, i.e. it has same direction and magnitude all along a dislocation line irrespective of the dislocation (screw or edge or mixed)

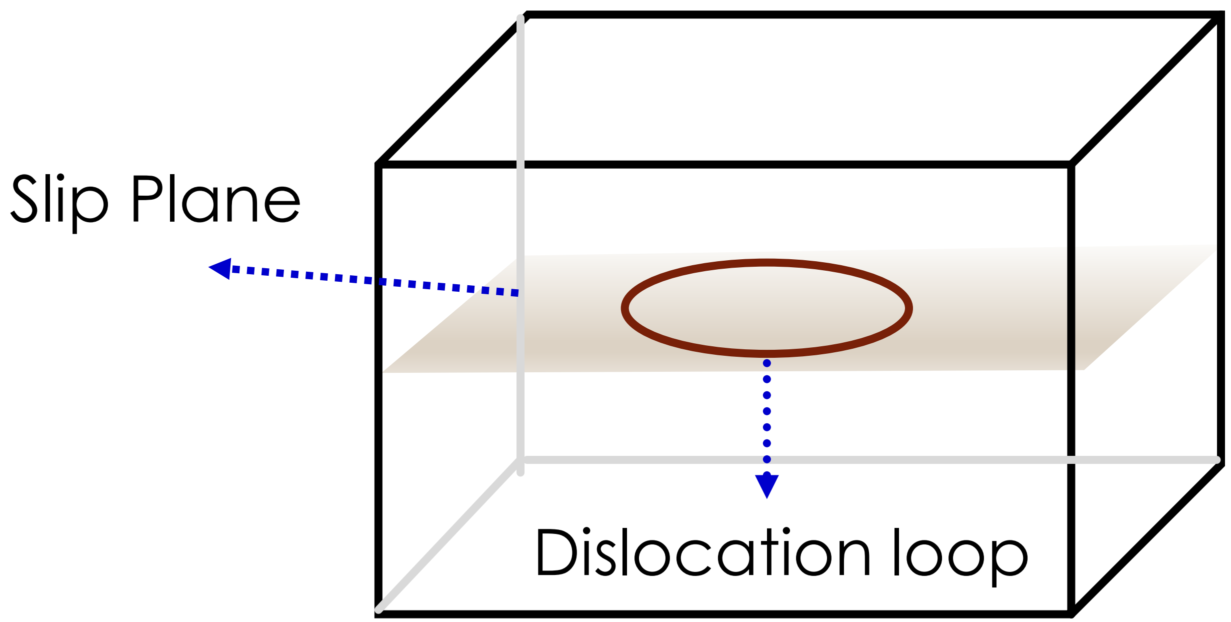
Mixed Dislocations

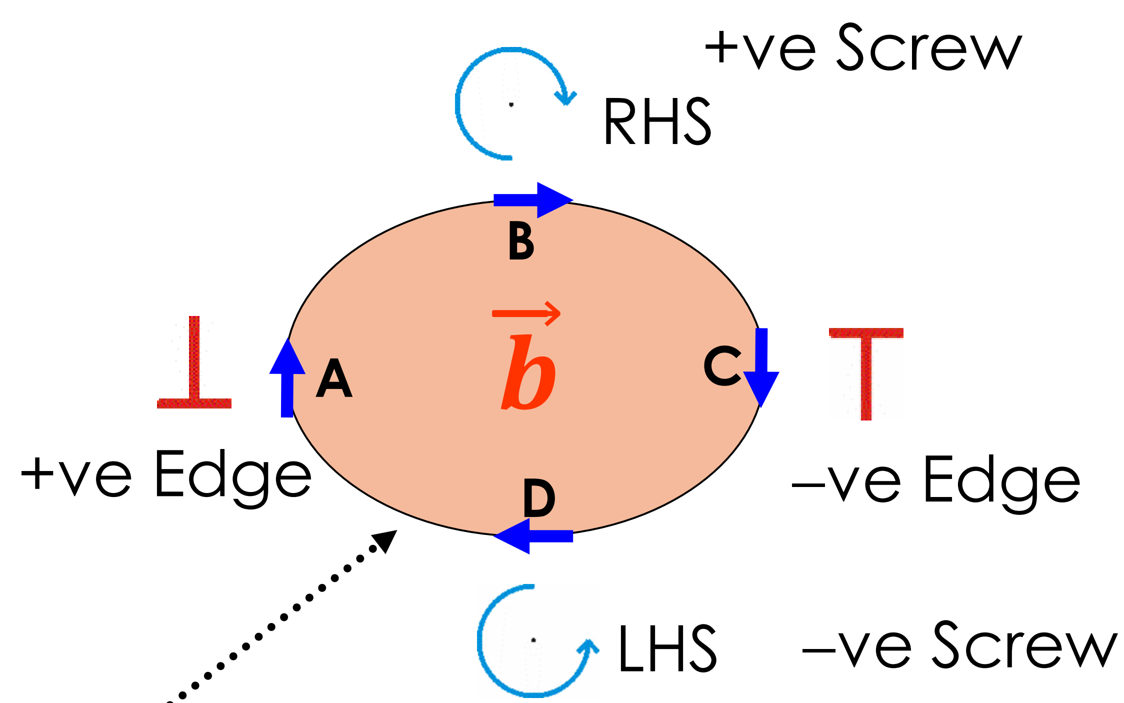
- In a curved dislocation the edge and screw character change from point to point.
- Typically in a dislocation loop only 'points' have pure edge or pure screw character

  Edge: $\vec{b} \perp \vec{t}$ → two points A,C   Screw: $\vec{b} \parallel \vec{t}$ → two points B,D.

- The region enclosed by the loop can be considered as the 'slipped region'.

Vectors defining a dislocation $\boxed{\vec{b}}$ $\boxed{\vec{t}}$





The $\vec{t}$ vector changes from point to point on the loop, but the $\vec{b}$ vector is constant.

Summary

1. Both edge and screw dislocating formed by the shear force.
2. The extra plane inside a crystal leads to edge dislocation.
3. The Burger vector gives the magnitude and direction of the dislocation.
4. In edge dislocation the Burgers vector is perpendicular to the dislocation line.
5. In screw dislocation the Burgers vector is parallel to the dislocation line.
6. A crystal often have mixed dislocation characteristics.

Assignment

1. Does the burger vector change with the size of the burger circuit? Explain.
2. Distinguish between the direction of the dislocation line, the burgers vector and the direction of motion for both the edge and screw dislocations. Differentiating between positive and negative types.