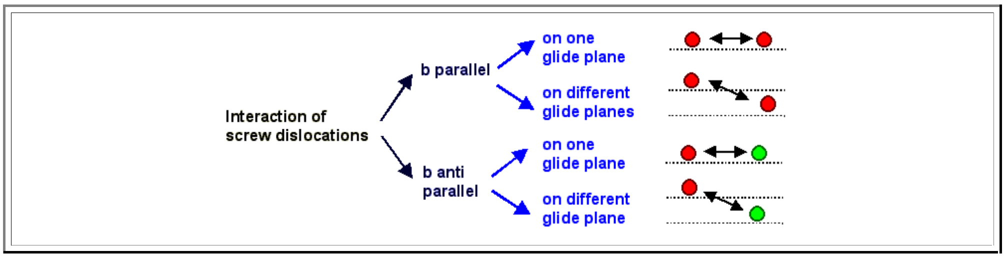
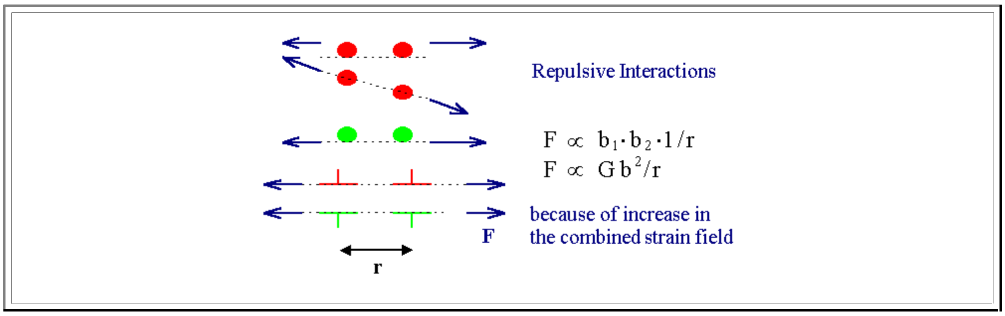
5.2.5 Interactions Between Dislocations

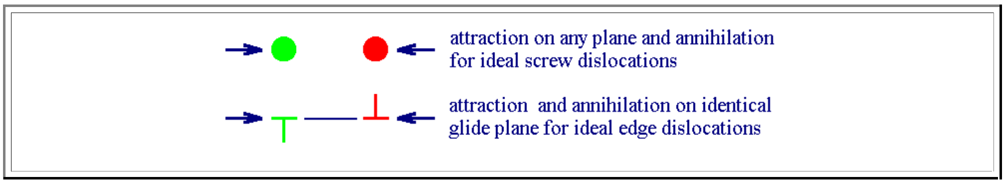
- We will first investigate the interaction between two *straight* and *parallel* dislocations of the same kind.
  - If we start with screw dislocations, we have to distinguish the following cases:



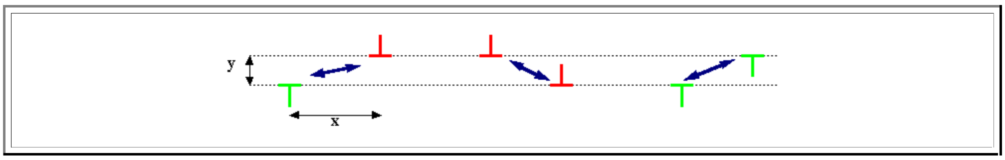
- In analogy, we next must consider the interaction of edge dislocations, of edge and screw dislocations and finally of mixed dislocations.
  - The case of mixed dislocations - the general case - will again be obtained by considering the interaction of the screw- and edge parts separately and then adding the results.
- With the formulas for the stress and strain fields of edge and screw dislocations one can calculate the resolved shear stress caused by *one* dislocation on the glide plane of the *other one* and get everything from there.
- But for just obtaining some basic rules, we can do better than that. We can classify some *basic cases* without calculating anything by just exploiting one obvious rule:
  - The superposition of the stress (or strain) fields of two dislocations that are moved toward each other can result in two basic cases:
  - **1.** The combined stress field is now *larger* than those of a single dislocation. The energy of the configuration than increases and the dislocations will *repulse* each other. That will happen if regions of compressive (or tensile) stress from one dislocation overlaps with regions of compressive (or tensile) stress from the other dislocation.
  - **2.** If the combined stress field is *lower* than that of the single dislocation, they will *attract* each other. That will happen if regions of compressive stress from one dislocation overlaps with regions of tensile stress from the other dislocation
- This leads to some simple cases (look at the stress / strain pictures if you don't see it directly)
  - **1.** Arbitrarily curved dislocations with *identical* ***b*** on the *same* glide plane will *always* repel each other.



  - **2.** Arbitrary dislocations with *opposite* ***b*** vectors on the *same* glide plane will *attract and annihilate* each other



  - *Edge dislocations* with *identical* or *opposite* Burgers vector ***b*** on *neighboring* glide planes may *attract* or *repulse* each other, depending on the precise geometry. The blue double arrows in the picture below thus may signify repulsion or attraction.

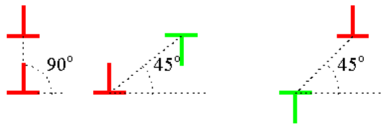


- The general formula for the forces between edge dislocations in the geometry shown above is

$$F_x = \frac{Gb^2}{2\pi(1-\nu)} \cdot \frac{x \cdot (x^2 - y^2)}{(x^2 + y^2)^2}$$

$$F_y = \frac{Gb^2}{2\pi(1-\nu)} \cdot \frac{y \cdot (3x^2 + y^2)}{(x^2 + y^2)^2}$$

- For $y = 0$, i.e. the same glide plane, we have a **1/*x*** or, more generally a **1/*r*** dependence of the force on the distance ***r*** between the dislocations.
- For ***y* < 0 or y > 0** we find zones of repulsion and attraction. At some specific positions the force is zero - this would be the equilibrium configurations; it is shown below.
- The formula for F_y is just given for the sake of completeness. Since the dislocations can not move in ***y***-direction, it is of little relevance so far.



Possible equilibrium configurations

The illustration in the link gives a quantitative picture of the forces acting on one dislocation on its glide plane as a function of the distance to another dislocation.