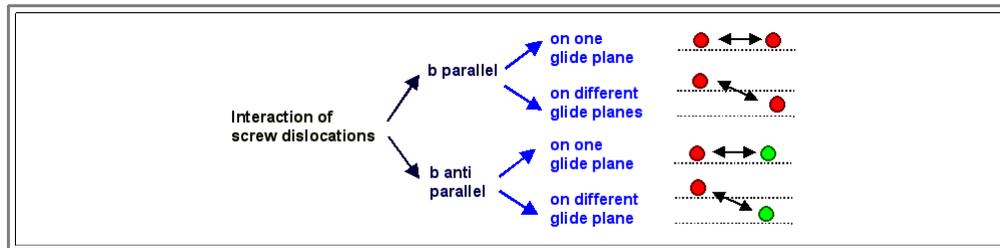## 5.2.5 Interactions Between Dislocations

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 $\underline{b}$* on the *same* glide plane will *always* repel each other.
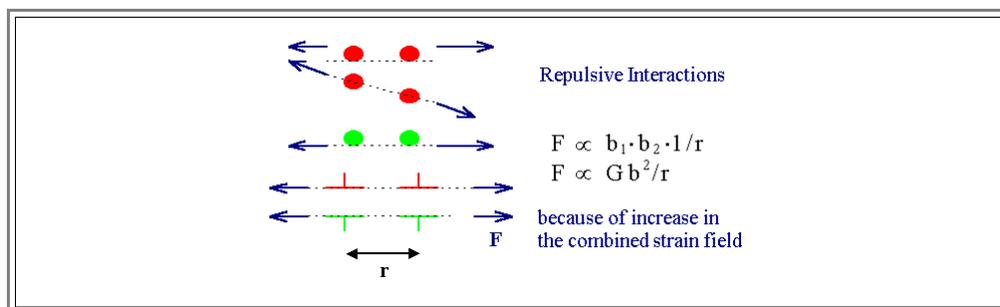
- **2.** Arbitrary dislocations with *opposite $\underline{b}$* vectors on the *same* glide plane will *attract and annihilate* each other
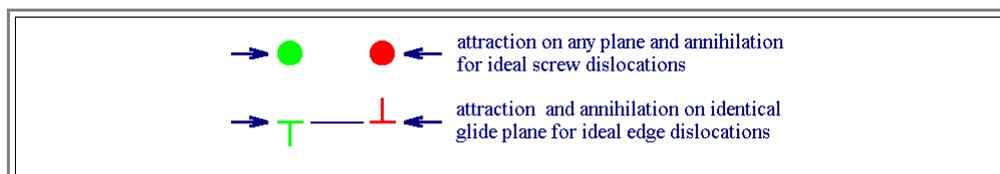
- *Edge dislocations* with *identical* or *opposite* Burgers vector *$\underline{b}$* on *neighboring* glide planes may *attract* or *repulse* each other, depending on the precise geometry. The blue double arrows in the picture below thus may signify repulsion or attraction.
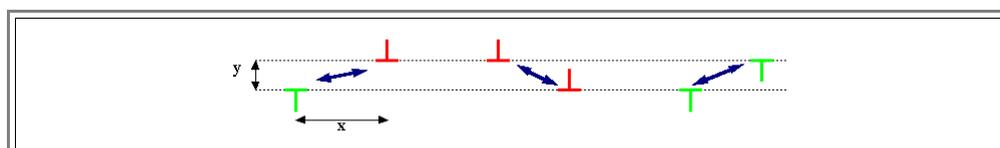

The general formula for the forces between edge dislocations in the geometry shown above is

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

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

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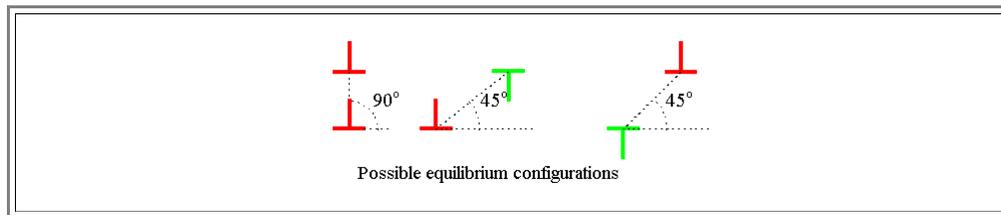
The illustration in the link gives a quantitative picture of the [forces acting on one dislocation](#) on its glide plane as a function of the distance to another dislocation.