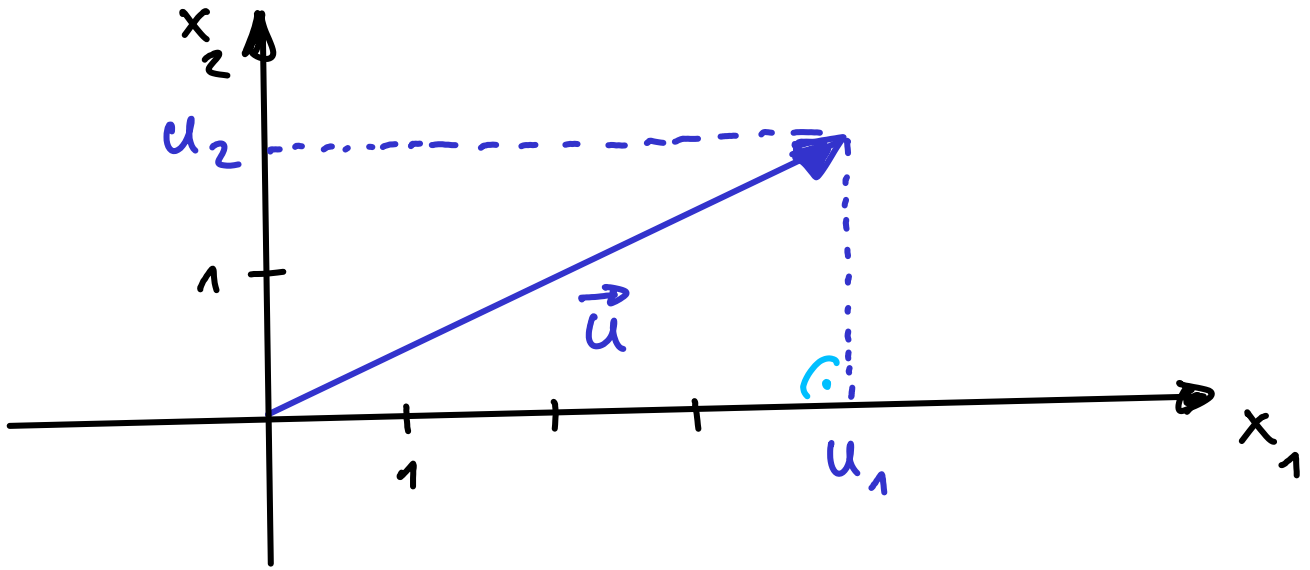
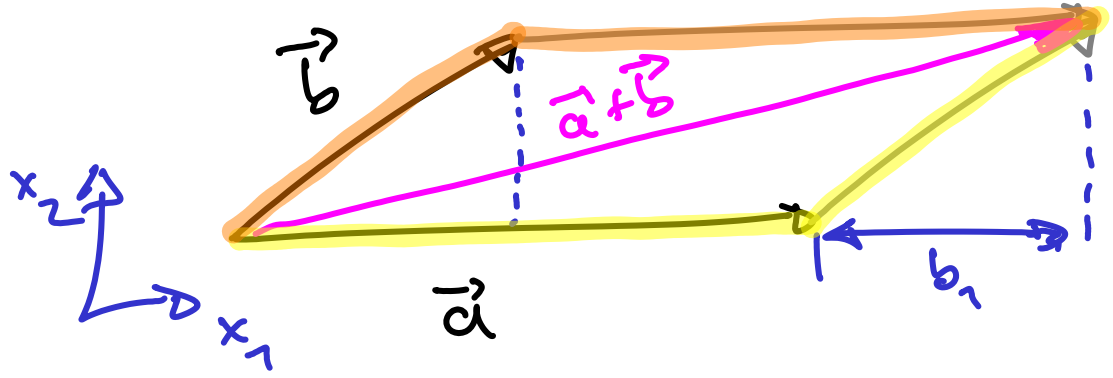


$$\vec{u} = \begin{pmatrix} u_1 \\ u_2 \end{pmatrix} = \begin{pmatrix} 4 \\ 2 \end{pmatrix}$$

$$|\vec{u}| = \sqrt{4^2 + 2^2} = \sqrt{20} = 2\sqrt{5}$$

Betrag des Vektors
Länge des Pfeils



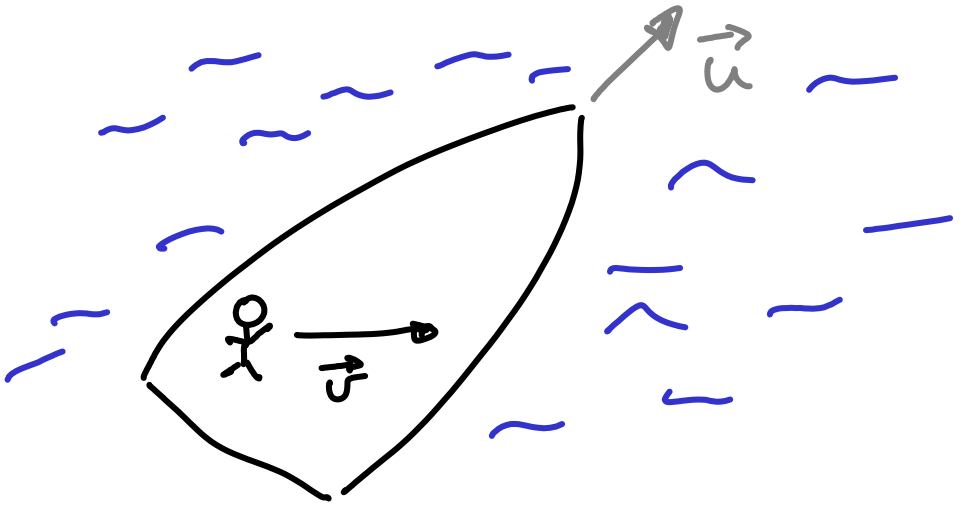
$$\vec{a} = \begin{pmatrix} a_1 \\ a_2 \end{pmatrix}$$

$$\vec{b} = \begin{pmatrix} b_1 \\ b_2 \end{pmatrix}$$

$$\vec{a} + \vec{b} = \vec{b} + \vec{a}$$

$$\vec{a} = \begin{pmatrix} 4 \\ 0 \end{pmatrix}, \quad \vec{b} = \begin{pmatrix} 2 \\ 2 \end{pmatrix}$$

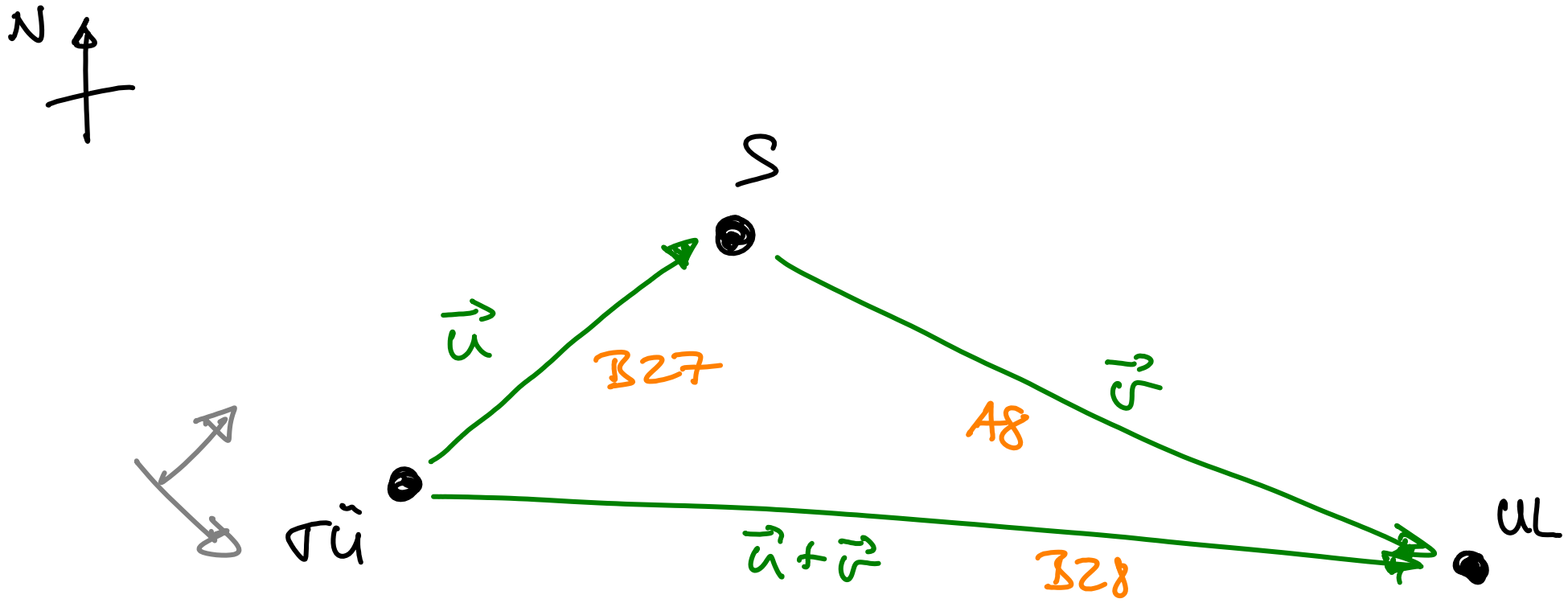
$$\vec{a} + \vec{b} = \begin{pmatrix} 4+2 \\ 0+2 \end{pmatrix} = \begin{pmatrix} 6 \\ 2 \end{pmatrix}$$



$\vec{v}$: Geschw. der Person auf dem Schiff

$\vec{u}$: Geschw. des Schiffs bzgl. Wasser

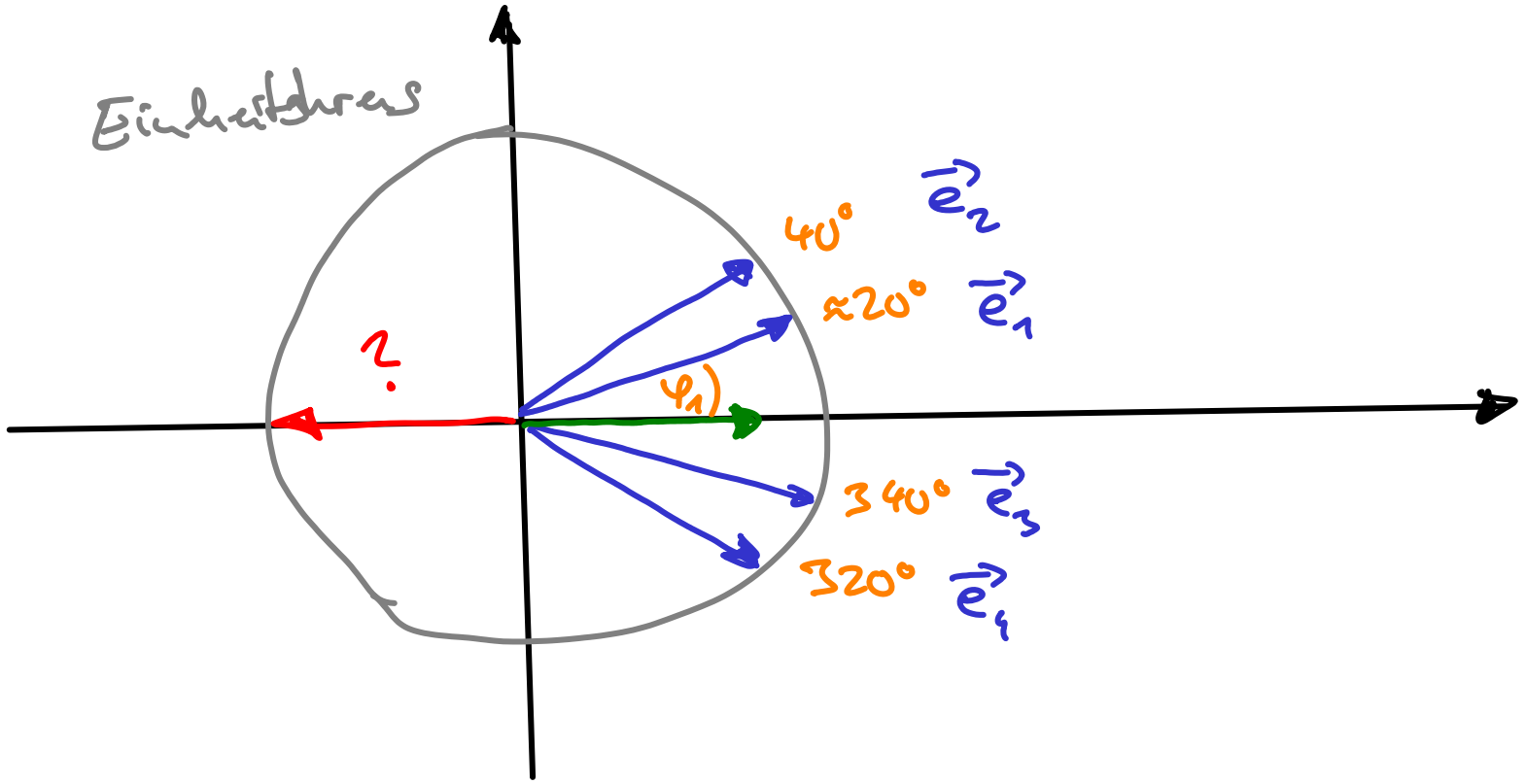
: Geschw. Person gegenüber Wasser



$$\vec{u} = \begin{pmatrix} 0 \\ 50 \end{pmatrix} \text{km}, \quad \vec{v} = \begin{pmatrix} 100\,\text{km} \\ 0 \end{pmatrix}$$

$$|\vec{u}+\vec{v}| = \left|\begin{pmatrix} 100 \\ 50 \end{pmatrix}\right| \text{km} = \sqrt{10\,000\,\text{km}^2 + 2500\,\text{km}^2}$$

$$\approx 110\,\text{km}$$



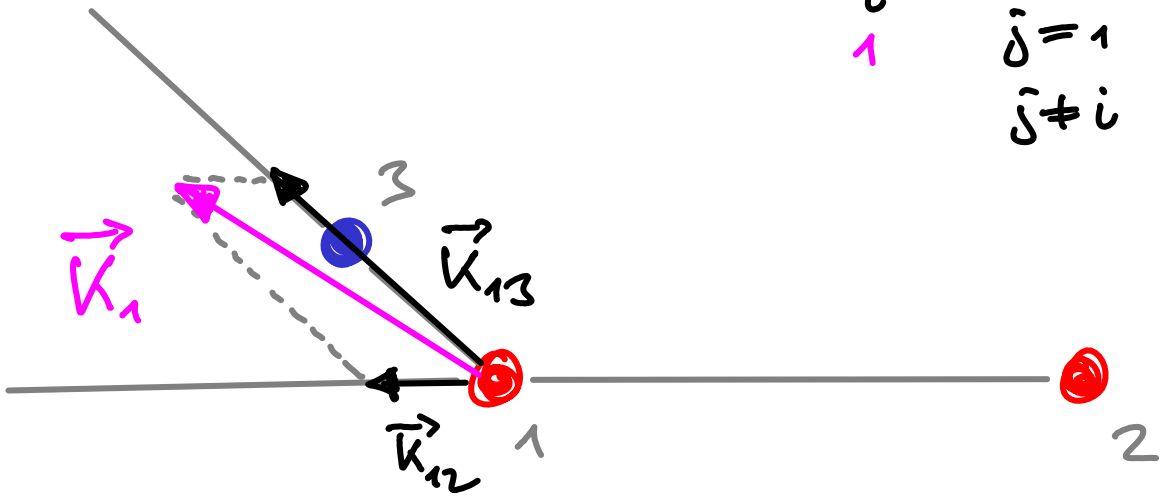
$$\overline{\varphi} = \frac{\varphi_1 + \varphi_2 + \varphi_3 + \varphi_4}{4} = \underline{180°}$$

$$\overrightarrow{\overline{e}} = \frac{\vec{e}_1 + \vec{e}_2 + \vec{e}_3 + \vec{e}_4}{4}$$

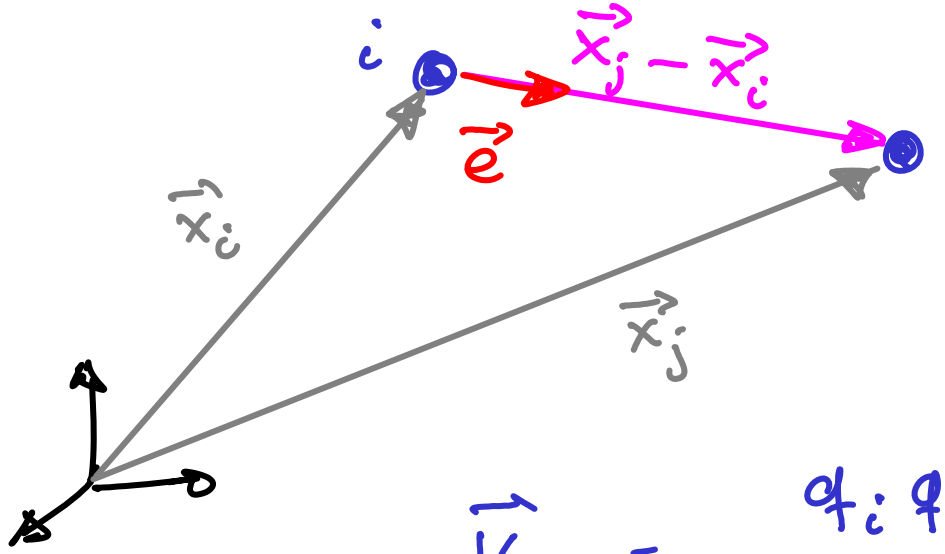
besser!

Pfeile addieren, geht ohne Koordinatensystem ohne Referenzrichtung

$$\vec{K}_i = \sum_{\substack{j=1 \\ j \neq i}}^{N} \vec{K}_{ij} = \sum_{j=2}^{N} \vec{K}_{1j}$$



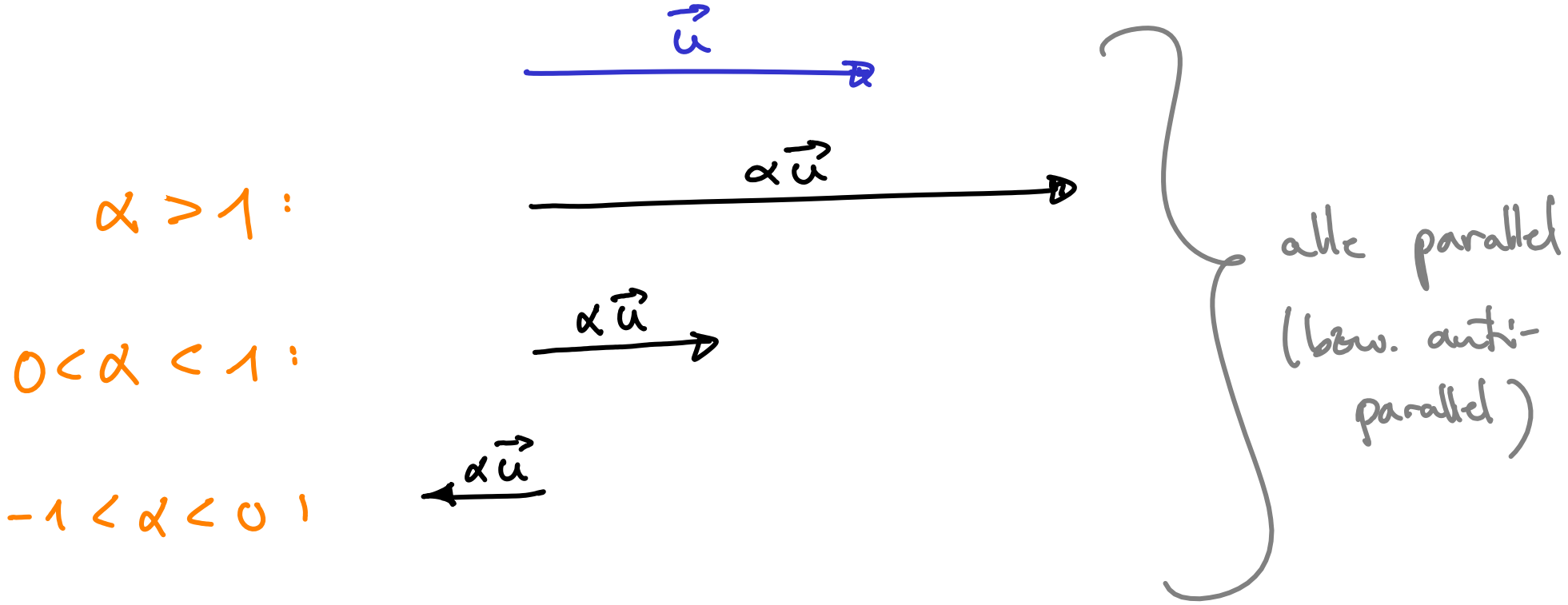
Gesamtkraft auf Teilchen 1: $i = 1$, $N = 3$



$|\vec{e}| = 1$

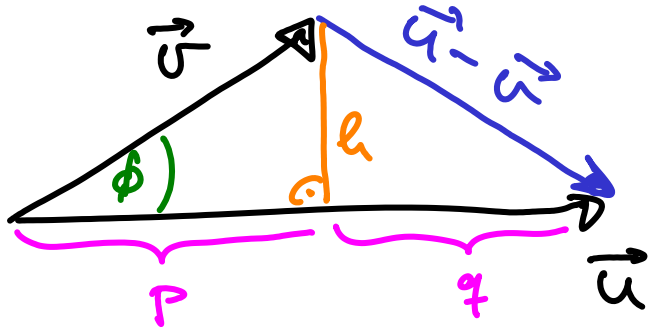
$$\vec{K}_{ij} = \frac{q_i q_j}{|\vec{x}_i - \vec{x}_j|^2} \vec{e}$$

$$\vec{e} = \frac{\vec{x}_j - \vec{x}_i}{|\vec{x}_j - \vec{x}_i|} \quad \text{damit} \quad \vec{K}_{ij} = q_i q_j \frac{\vec{x}_j - \vec{x}_i}{|\vec{x}_j - \vec{x}_i|^3}$$


$\vec{u}$
$\alpha > 1$:
$\alpha\vec{u}$
$0 < \alpha < 1$:
$\alpha\vec{u}$
$-1 < \alpha < 0$:
$\alpha\vec{u}$
alle parallel
(bzw. anti-
parallel)

$$\vec{u} = \begin{pmatrix} 1 \\ 2 \\ 3 \end{pmatrix}, \quad \vec{v} = \begin{pmatrix} 0 \\ 1 \\ -1 \end{pmatrix}$$

$$\vec{u} \cdot \vec{v} = 1 \cdot 0 + 2 \cdot 1 + 3 \cdot (-1) = -1$$



$$\cos\phi = \frac{p}{|\vec{v}|}$$

Pythagoras: $p^2 + h^2 = |\vec{v}|^2$, $q^2 + h^2 = |\vec{u}-\vec{v}|^2$

$$\Rightarrow \quad |\vec{v}|^2 - p^2 = |\vec{u}-\vec{v}|^2 - q^2 \qquad , \; q = |\vec{u}| - p$$

$$q^2 = |\vec{u}|^2 + p^2 - 2|\vec{u}|p$$

$$\Leftrightarrow \quad |\vec{v}|^2 - p^2 = (\vec{u}-\vec{v})\cdot(\vec{u}-\vec{v}) - |\vec{u}|^2 - p^2 + 2|\vec{u}|p$$

$$\Leftrightarrow \quad |\vec{v}|^2 = |\vec{u}|^2 + |\vec{v}|^2 - 2\,\vec{u}\cdot\vec{v} - |\vec{u}|^2 + 2|\vec{u}|p$$

$$\Leftrightarrow \quad \vec{u}\cdot\vec{v} = |\vec{u}|\cdot p = |\vec{u}||\vec{v}|\cos\phi$$

$p = |\vec{v}|\cos\phi$