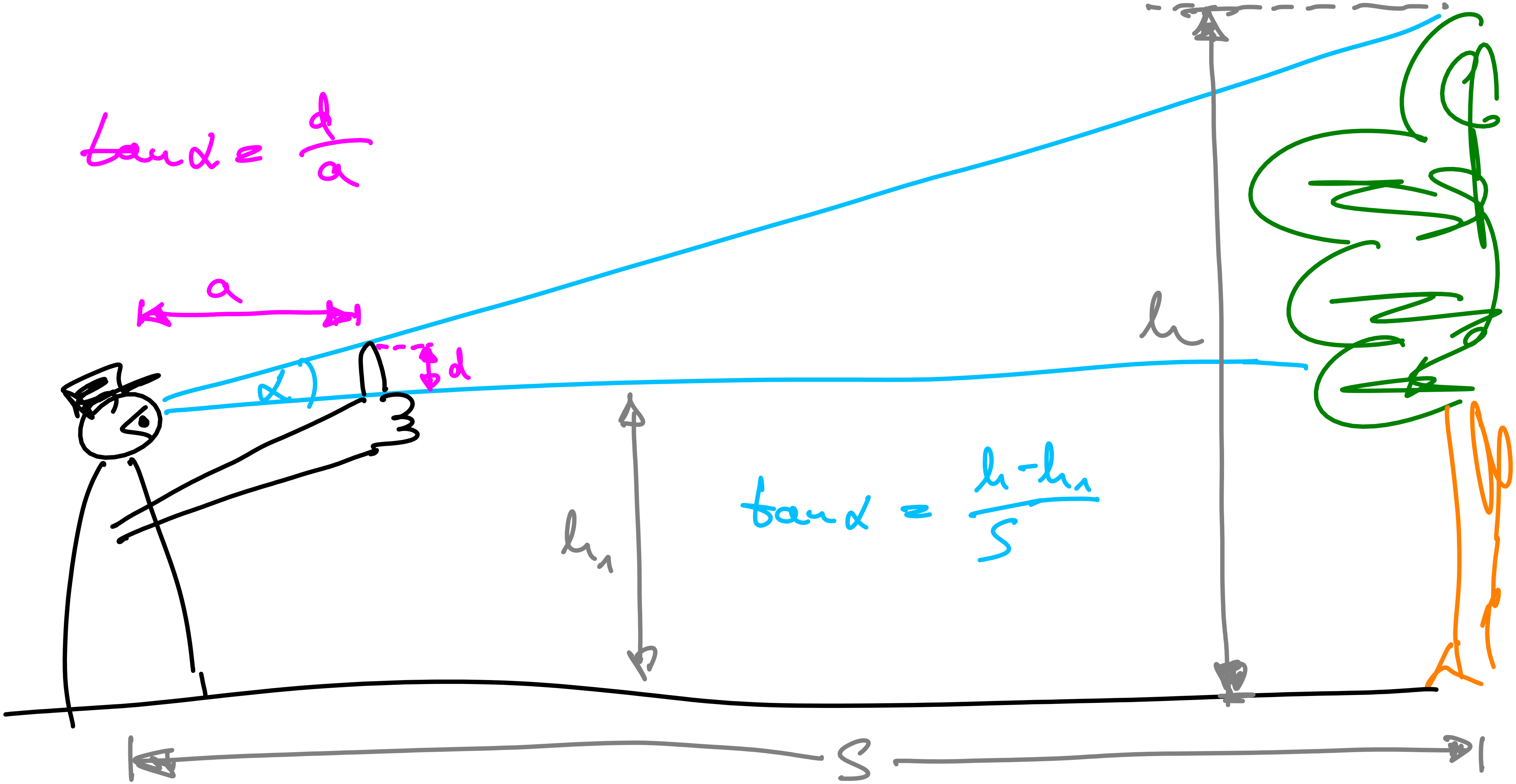
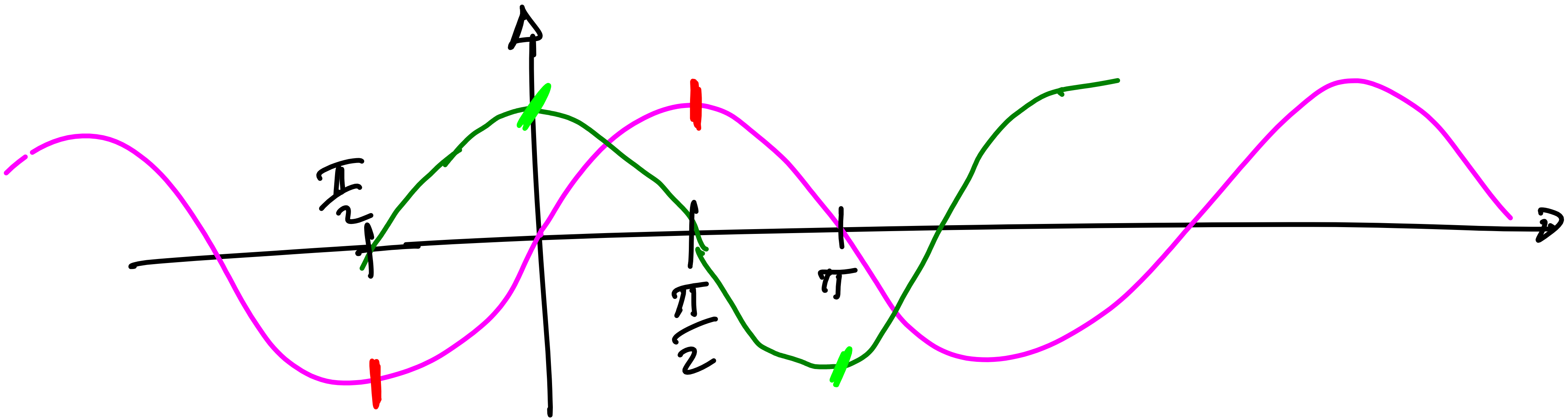


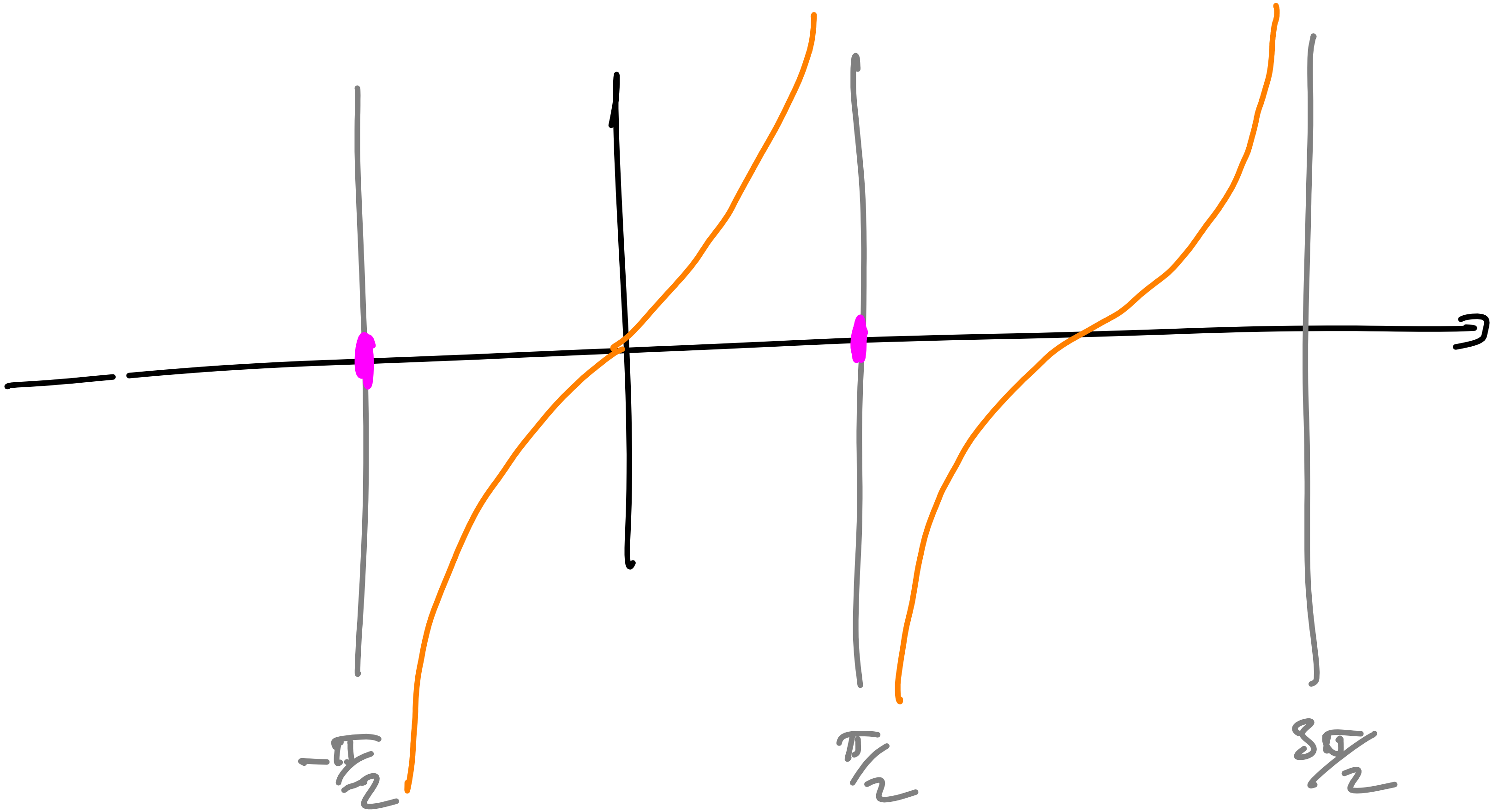
$$h = h_1 + s\tan\alpha = h_1 + s\cdot\frac{d}{a}$$

@ Add-Theorem.

vgl. e-Fkt.: $e^{x+y} = e^x \cdot e^y$

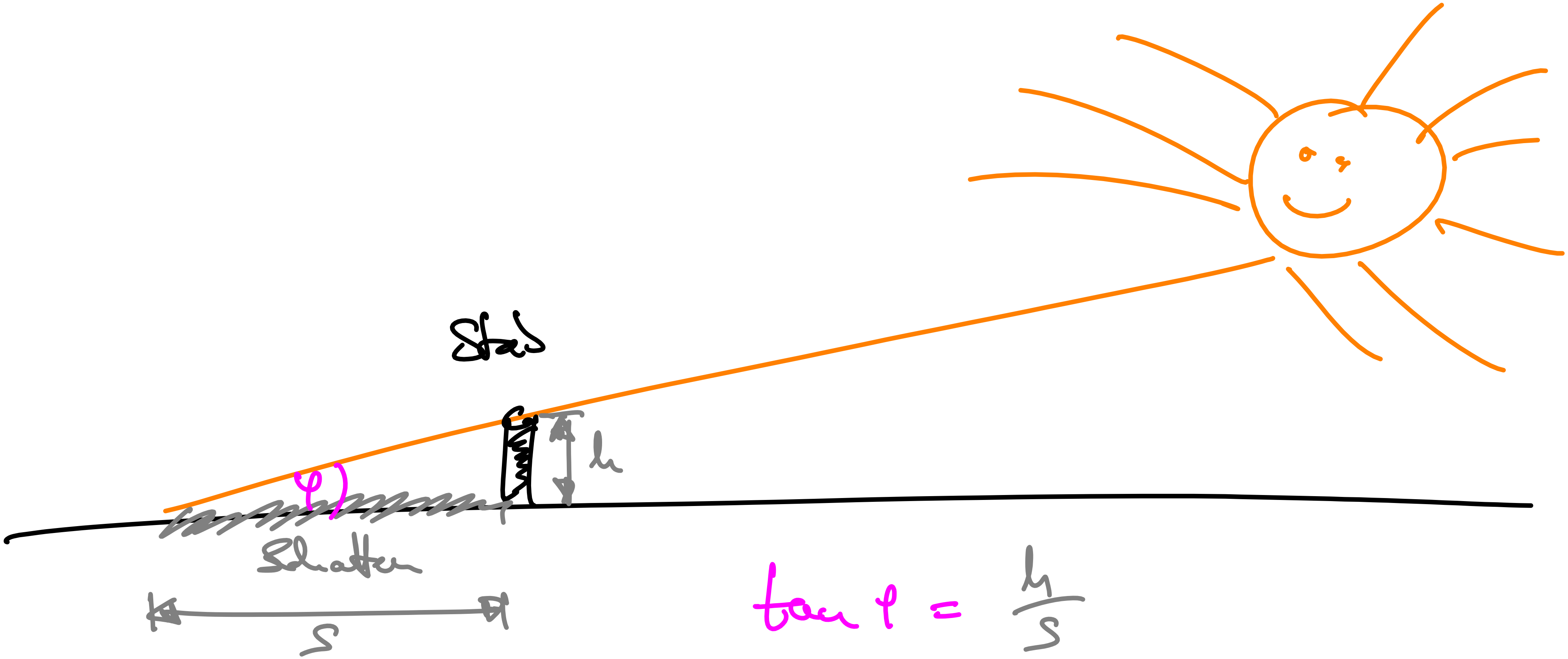
für sin & cos ähnlich, aber zwei Terme





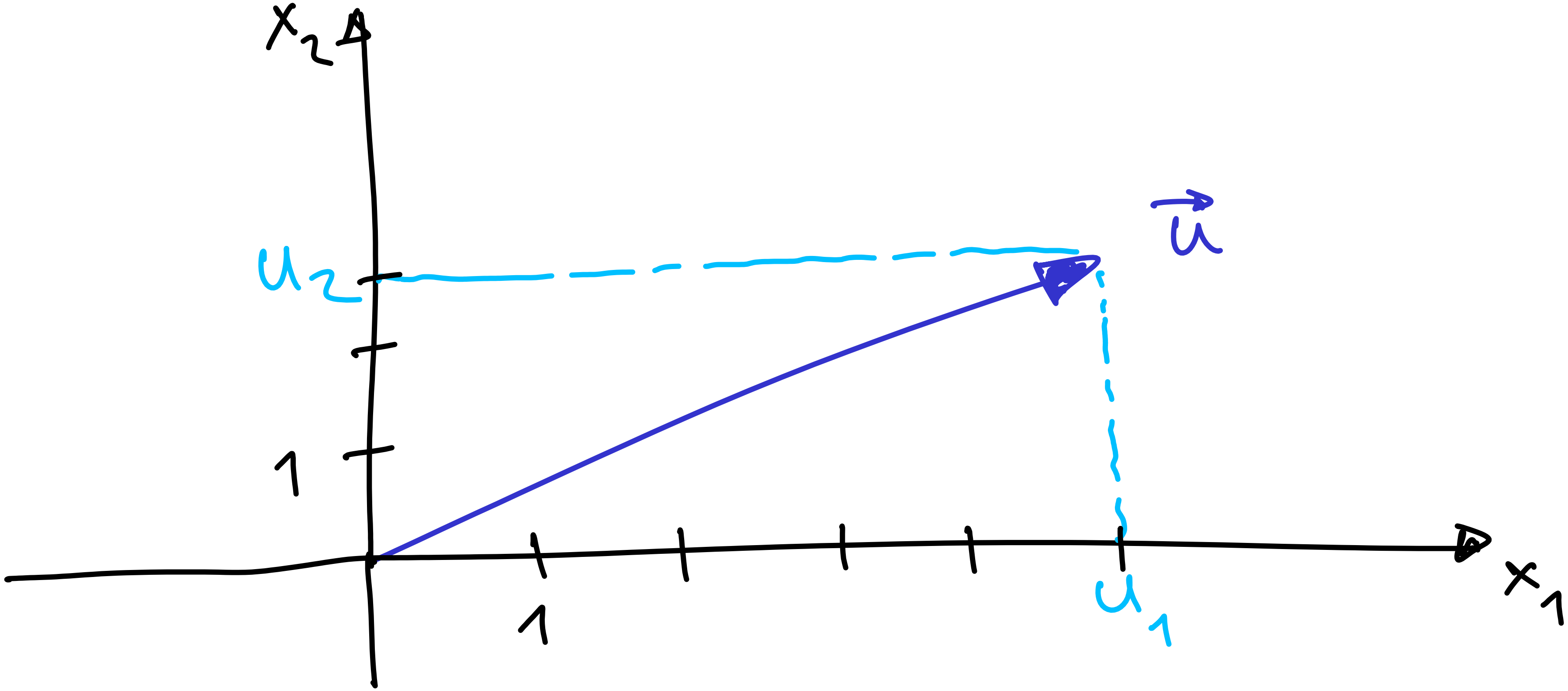
$\tan : \left(-\frac{\pi}{2}, \frac{\pi}{2}\right) \longrightarrow \mathbb{R}$

$\arctan : \mathbb{R} \to \left(-\frac{\pi}{2}, \frac{\pi}{2}\right)$



$$\tan\varphi = \frac{h}{s}$$

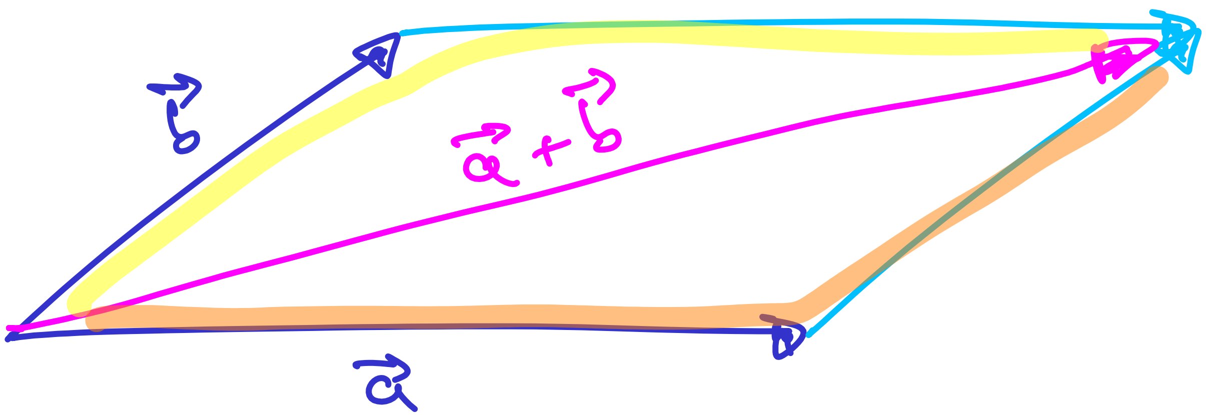
$$\Rightarrow \varphi = \arctan\left(\frac{h}{s}\right)$$



$$\vec{u} = \begin{pmatrix} 5 \\ 3 \end{pmatrix} = \begin{pmatrix} u_1 \\ u_2 \end{pmatrix}$$

$$|\vec{u}| = \sqrt{u_1^2 + u_2^2} = \sqrt{25+9} = \sqrt{34}$$

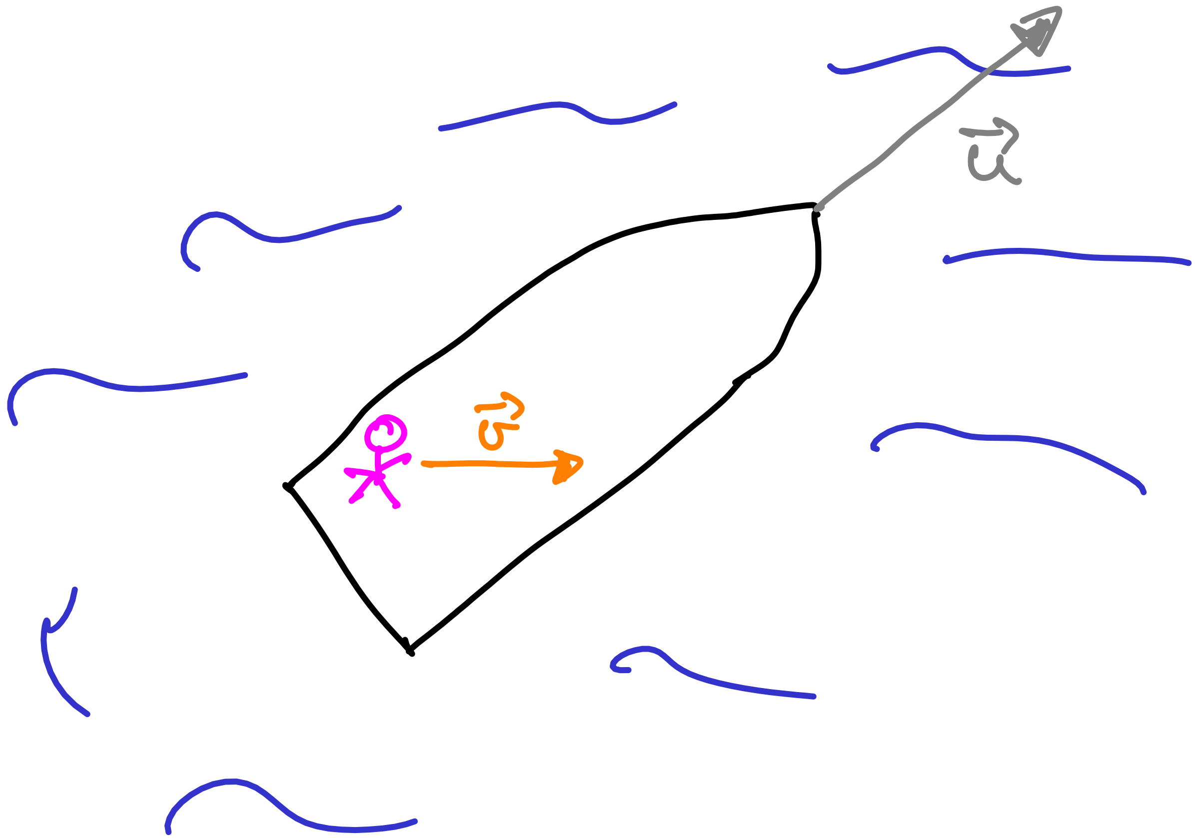
Länge des Pfeils



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

z.B.

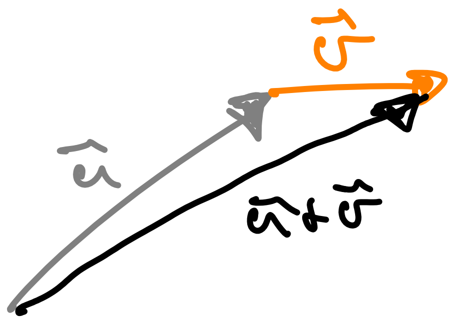
$$\vec{a} = \begin{pmatrix} 5 \\ 0 \end{pmatrix}, \quad \vec{b} = \begin{pmatrix} 2 \\ 2 \end{pmatrix} \Rightarrow \vec{a}+\vec{b} = \begin{pmatrix} 7 \\ 2 \end{pmatrix}$$

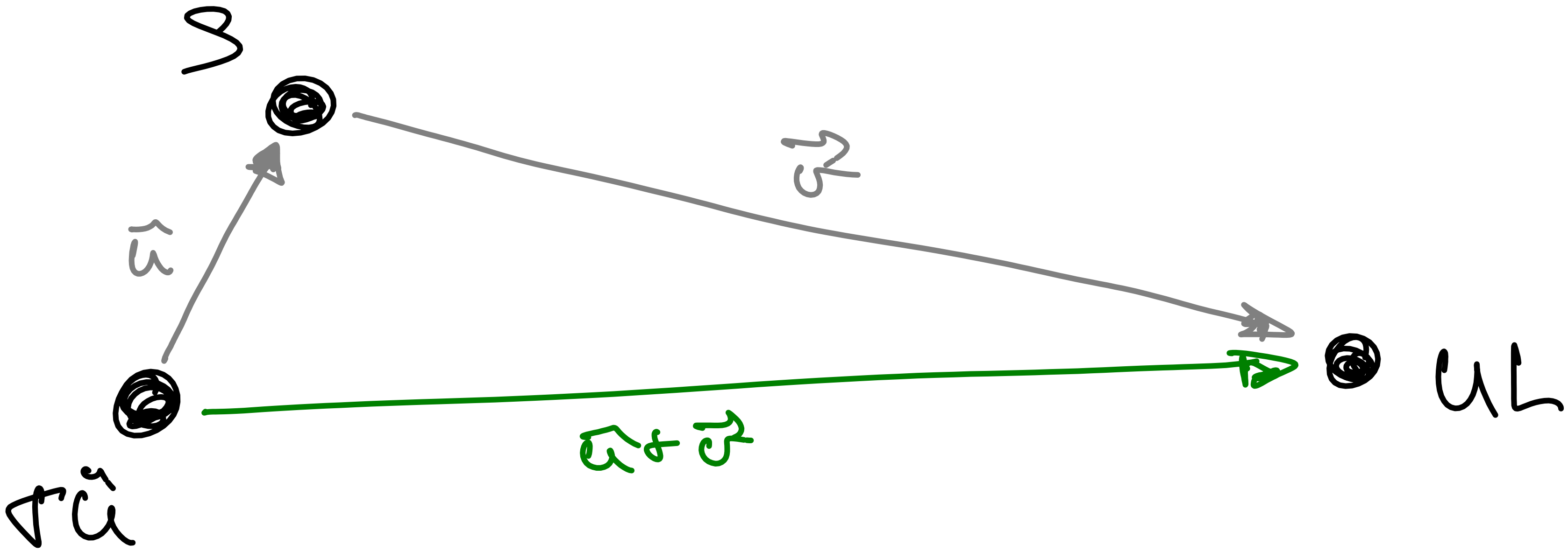


$\vec{u}$: Geschw. des Schiffs (gegen Wasser)

$\vec{v}$: Geschw. Person (gegen Schiff)

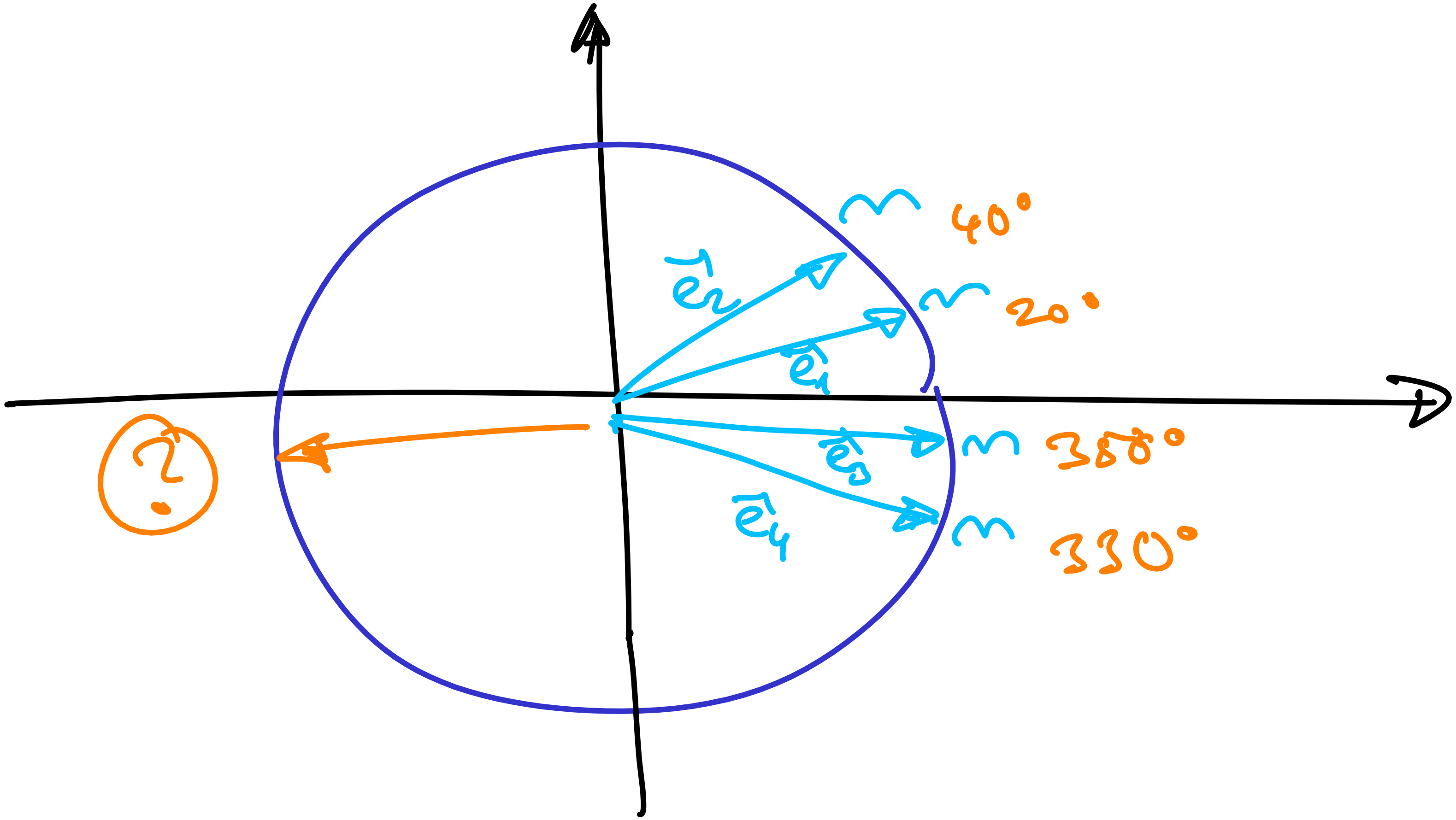
$\vec{u}+\vec{v}$: Geschw. Person (gegenüber Wasser)





$$\hat{u} = \frac{50\,\text{km}}{\sqrt{10}} \begin{pmatrix} 1 \\ 3 \end{pmatrix} \qquad \hat{v} = \frac{100\,\text{km}}{\sqrt{17}} \begin{pmatrix} 4 \\ 1 \end{pmatrix}$$

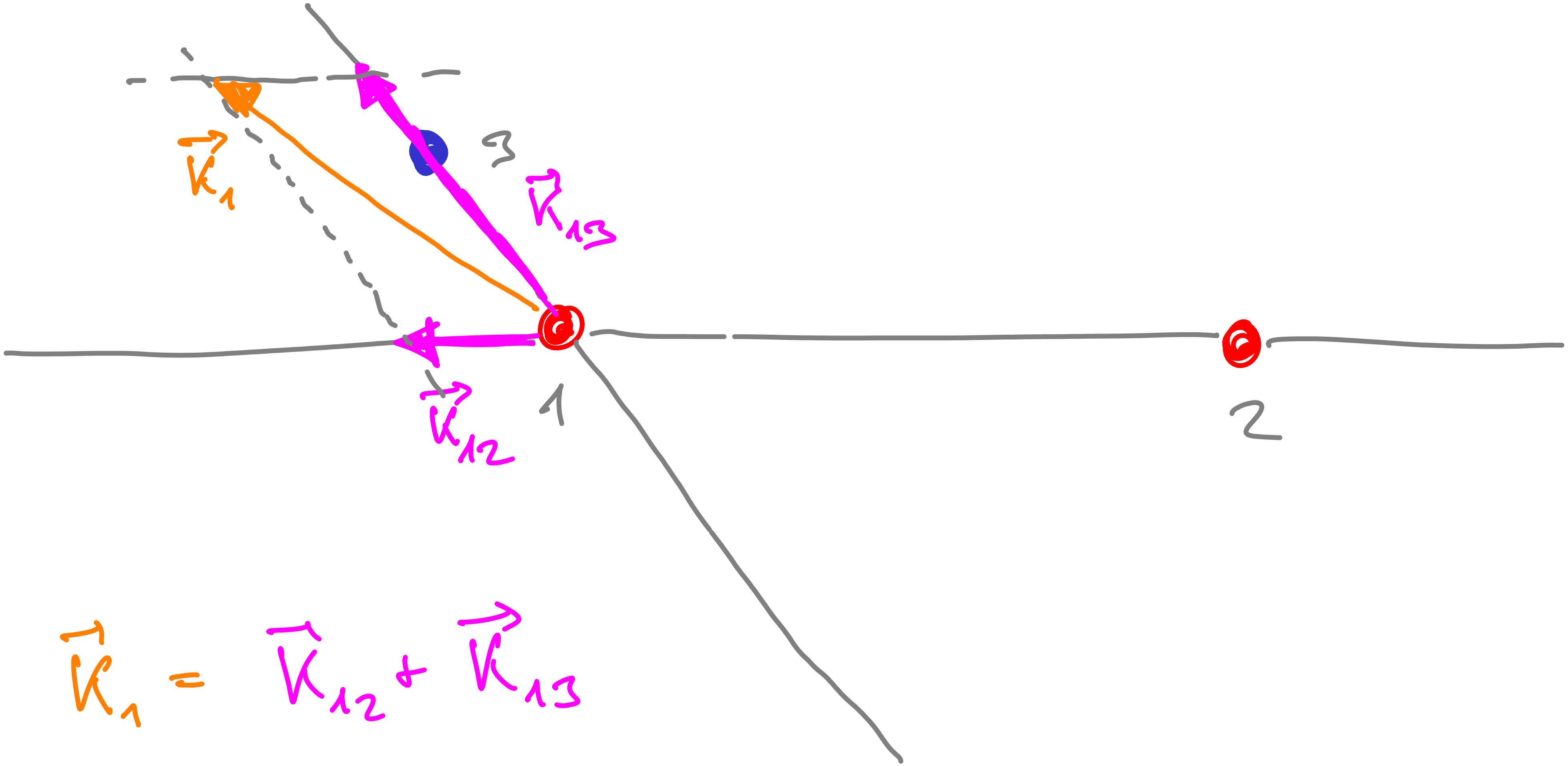
$$|\hat{u} + \hat{v}| = \left| \frac{50\,\text{km}}{\sqrt{10}} \begin{pmatrix} 1 \\ 3 \end{pmatrix} + \frac{100\,\text{km}}{\sqrt{17}} \begin{pmatrix} 4 \\ 1 \end{pmatrix} \right| = \ldots$$



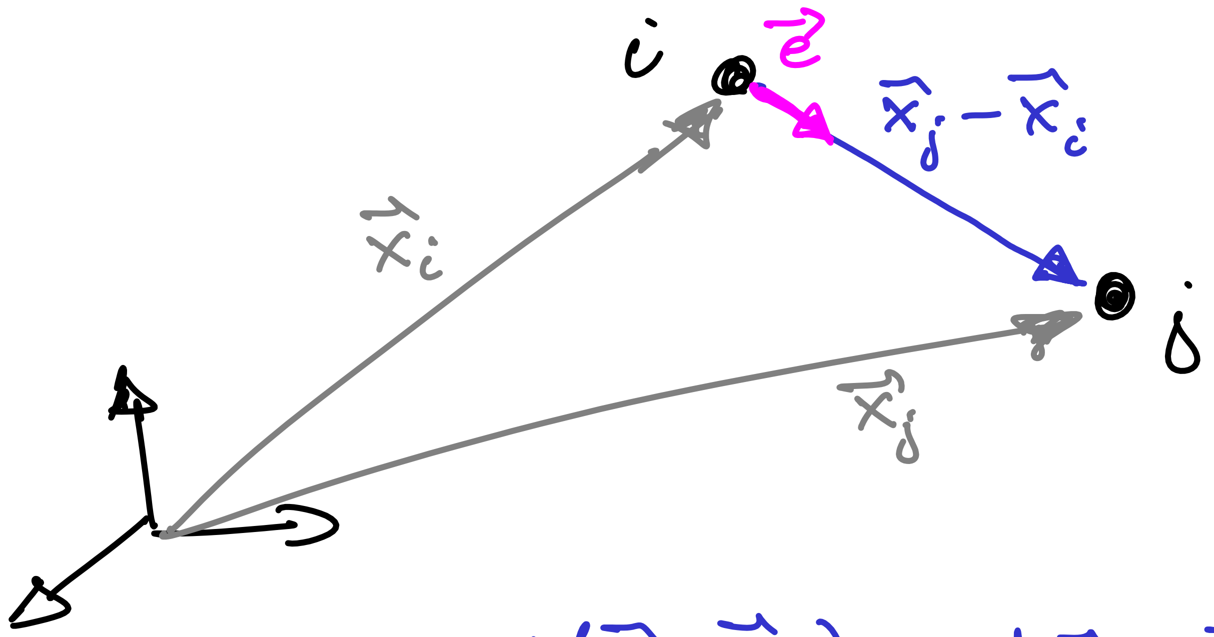
$$\bar{\varphi} = \frac{20° + 40° + 350° + 330°}{4} = 185° \quad ?$$

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

Zick-Zack aber auch rechts



$$\vec{K}_1 = \vec{K}_{12} + \vec{K}_{13}$$

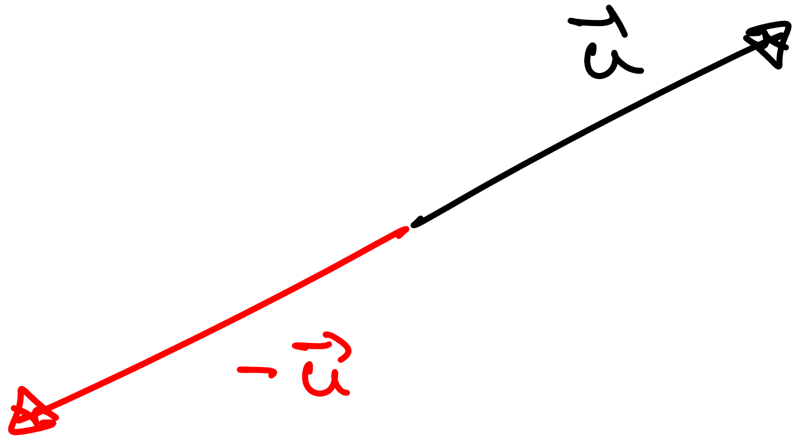


$$|\vec{e}| = 1$$

$$d(\vec{x}_i, \vec{x}_j) = |\vec{x}_i - \vec{x}_j| = |\vec{x}_j - \vec{x}_i|$$

$$\vec{e} = \frac{\vec{x}_j - \vec{x}_j}{|\vec{x}_j - \vec{x}_j|}$$

$$\vec{K}_{ij} = -\frac{q_i \cdot q_j}{|\vec{x}_j - \vec{x}_i|^2} \frac{\vec{x}_j - \vec{x}_j}{|\vec{x}_j - \vec{x}_j|} = -\frac{q_i q_j}{|\vec{x}_j - \vec{x}_j|^3} (\vec{x}_j - \vec{x}_i)$$



z.B.

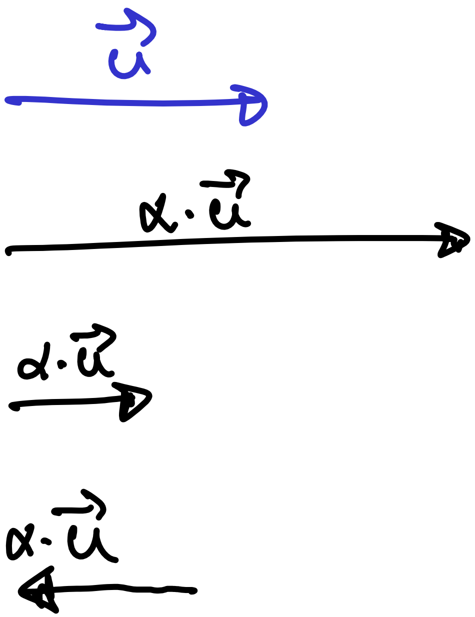
$$\vec{u} = \begin{pmatrix} 3 \\ 2 \end{pmatrix}$$

$$-\vec{u} = \begin{pmatrix} -3 \\ -2 \end{pmatrix}$$

$\alpha > 1$:

$0 < \alpha < 1$:

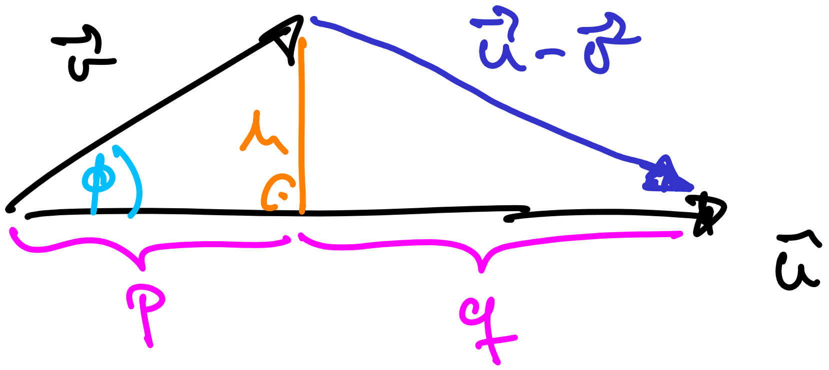
$-1 < \alpha < 0$:



alle parallel (bzw. antiparallel)

$$\vec{u} = \begin{pmatrix} 1 \\ 2 \\ 0 \end{pmatrix}, \quad \vec{v} = \begin{pmatrix} -2 \\ 3 \\ 4 \end{pmatrix}$$

$$\vec{u} \cdot \vec{v} = 1 \cdot (-2) + 2 \cdot 3 + 0 \cdot 4 = 4$$



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

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

$$q = |\vec{u}| - p$$

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

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

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

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

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