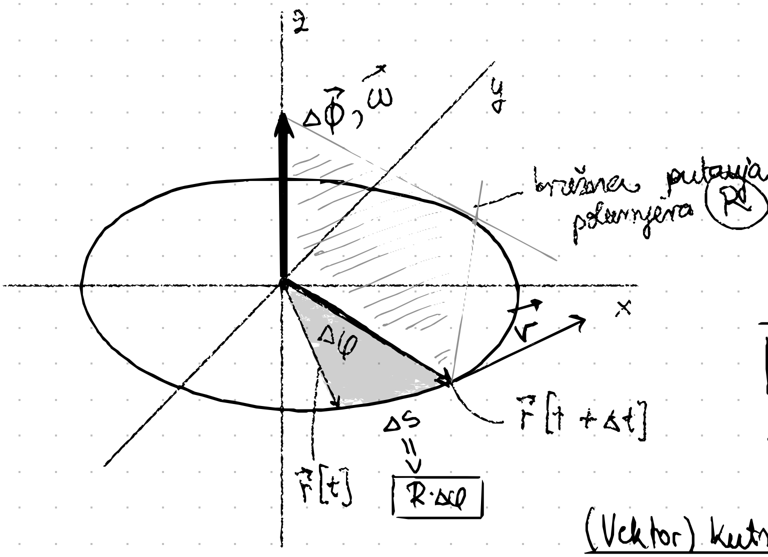
KRUŽNO GIBANJE

radijani!



Vektor zakreta

$$|\Delta\vec{\phi}| = \Delta\varphi$$

smjer = pravilo desne ruke

(Vektor) kutne brzine

$$\vec{\omega} = \lim_{\Delta t\to 0} \frac{\Delta\vec{\phi}}{\Delta t} = \frac{d\vec{\phi}}{dt}$$

Brzina: $\vec{v} = \vec{\omega} \times \vec{r}$

$$v = |\vec{v}| = |\vec{\omega}\times\vec{r}| = |\vec{\omega}|\,|\vec{r}|\cdot \underline{\sin\gamma} \longrightarrow 1 \text{ jer je } \gamma = \frac{\pi}{2}$$

$$= \frac{\Delta\varphi}{\Delta t} R = \underline{\frac{\Delta s}{\Delta t}}$$

Akceleracija: $\vec{a} = \frac{d\vec{v}}{dt} = \frac{d}{dt}(\vec{\omega}\times\vec{r}) = \boxed{\frac{d\vec{\omega}}{dt}\vec{r}} + \vec{\omega}\,\frac{d\vec{r}}{dt}$

$\hookrightarrow \vec{a}_{tang}$

$$\vec{\omega}\times\vec{v} = \vec{\omega}\times(\vec{\omega}\times\vec{r})$$

(okomiti su pa nula 0)

$$= (\vec{\omega}\cdot\vec{r})\vec{\omega} - (\vec{\omega}\cdot\vec{\omega})\vec{r}$$

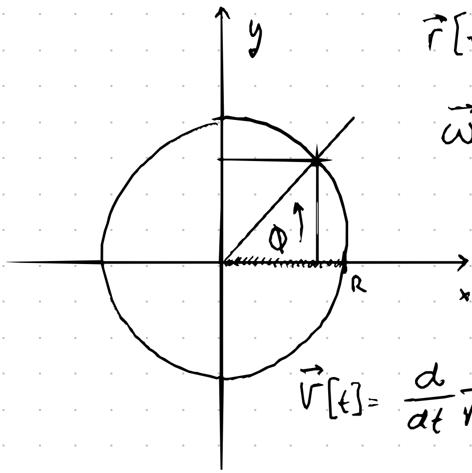
$$= \underline{-\vec{\omega}^2\,\vec{r} = \vec{a}_{cp}}$$

Kutna akceleracija:

$$\vec{\alpha} = \frac{d\vec{\omega}}{dt}$$

opći identitet: $\vec{a}\times(\vec{b}\times\vec{c}) = (\vec{a}\cdot\vec{c})\vec{b} - (\vec{a}\cdot\vec{b})\vec{c}$

Kružno gibanje u PKS (pravokut. koord. sust)



$$\vec r[t] = R\left(\cos\varphi(t)\,\hat{\vec x} + \sin\varphi[t]\,\hat{\vec y}\right)$$

$$\vec\omega[t] = \frac{d}{dt}\varphi[t]\,\hat{\vec z} = \dot\varphi[t]\,\hat{\vec z}$$

$$\vec v[t] = \frac{d}{dt}\vec r[t] = R\left(-\sin\varphi[t]\,\dot\varphi[t]\,\hat{\vec x} + \cos\varphi[t]\,\dot\varphi[t]\,\hat{\vec y}\right)$$

$$= \underbrace{R\dot\varphi[t]}_{\text{iznos brzine}}\underbrace{\left(-\sin\varphi[t]\,\hat{\vec x} + \cos[t]\,\hat{\vec y}\right)}_{\text{okomit u odnosu na smjer } \vec r[t]}$$

$$\vec v[t] = \vec\omega(t) \times \vec r[t] =$$

$$= \dot\varphi[t]\,\hat{\vec z} \times R\left(\cos\varphi[t]\,\hat{\vec x} + \sin\varphi[t]\,\hat{\vec y}\right)$$

$$= \begin{vmatrix} \hat{\vec x} & \hat{\vec y} & \hat{\vec z} \\ 0 & 0 & \dot\varphi[t] \\ R\cos\varphi & R\sin\varphi & 0 \end{vmatrix} = \hat{\vec x}\left(-\dot\varphi[t]\cdot R\sin\varphi\right) - \hat{\vec y}\left(-\dot\varphi[t]\,R\cos\varphi\right) + \hat{\vec z}\cdot 0$$

$$= -R\sin\varphi\cdot\dot\varphi[t]\,\hat{\vec x} + R\cos\varphi\cdot\dot\varphi[t]\,\hat{\vec y}$$

$$= R\dot\varphi[t]\left(-\sin\varphi\cdot\hat{\vec x} + \cos\varphi\cdot\hat{\vec y}\right)$$

Galilejeve transformacije:

↳ relacije koje povezuju vektore položaja, brzine i akceleracije čestice u dva referentna okvira koji se međusobno gibaju stalnom brzinom

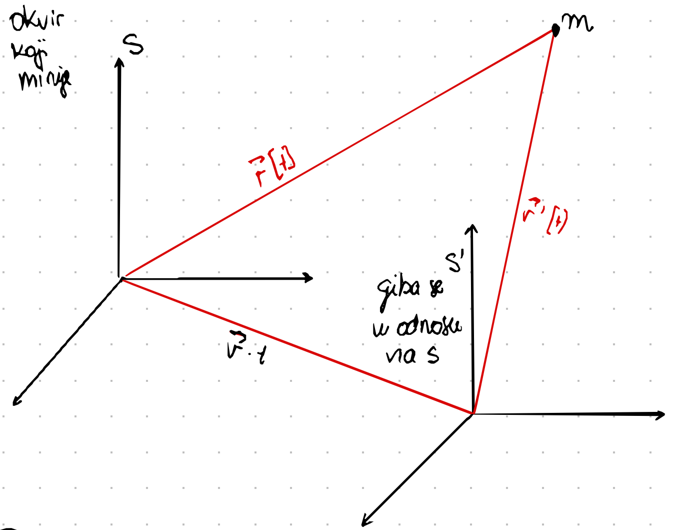
nije deriv. nego određena putanja

$$\vec{r}(t) = \vec{v}\cdot t + \vec{r}\,'(t) \quad \Big/ \frac{d}{dt}$$

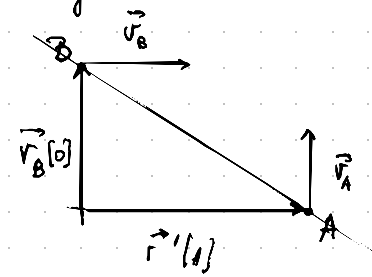
$$\vec{v}(t) = \vec{v} + \vec{v}\,'(t) \quad \Big/ \frac{d}{dt}$$

nije deriv nego v u S'

$$\vec{a}(t) = \vec{a}\,'(t)$$



Primjer:



Kako pilot iz A gleda u gibanje aviona B?

Sustav vezan za avion A:

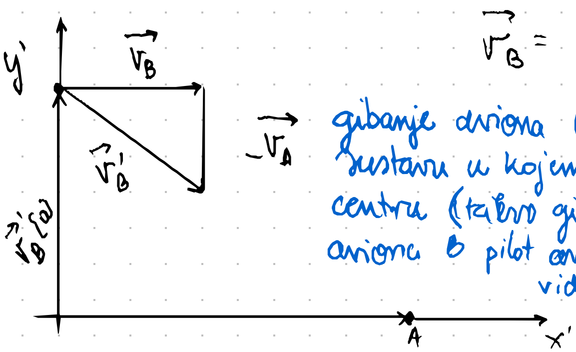
$\vec{v} = \vec{v}_A$ (jer A na taj način u sust. miruje)

$* \quad \vec{v}(t) = \vec{v} + \vec{v}\,'(t)$

$\vec{v}_B = \vec{v} + \vec{v}_B\,'$

$\vec{v}_B = \vec{v}_A + \vec{v}_B\,' \quad \rightarrow \quad \vec{v}_B\,' = \vec{v}_B - \vec{v}_A$

$\downarrow$



gibanje aviona B u refer. sustavu u kojem je A u centru (takvo gibanje aviona B pilot aviona A vidi na radaru)

$$\vec{r}_B\,' = \vec{r}_B - \vec{v}_A\cdot t$$

$$\vec{r}_B\,' = (\vec{r}_B(0) + \vec{v}_B t) - \vec{v}_A\cdot t$$

$$\vec{r}_B\,' = \vec{r}_B(0) + (\vec{v}_B - \vec{v}_A)t$$