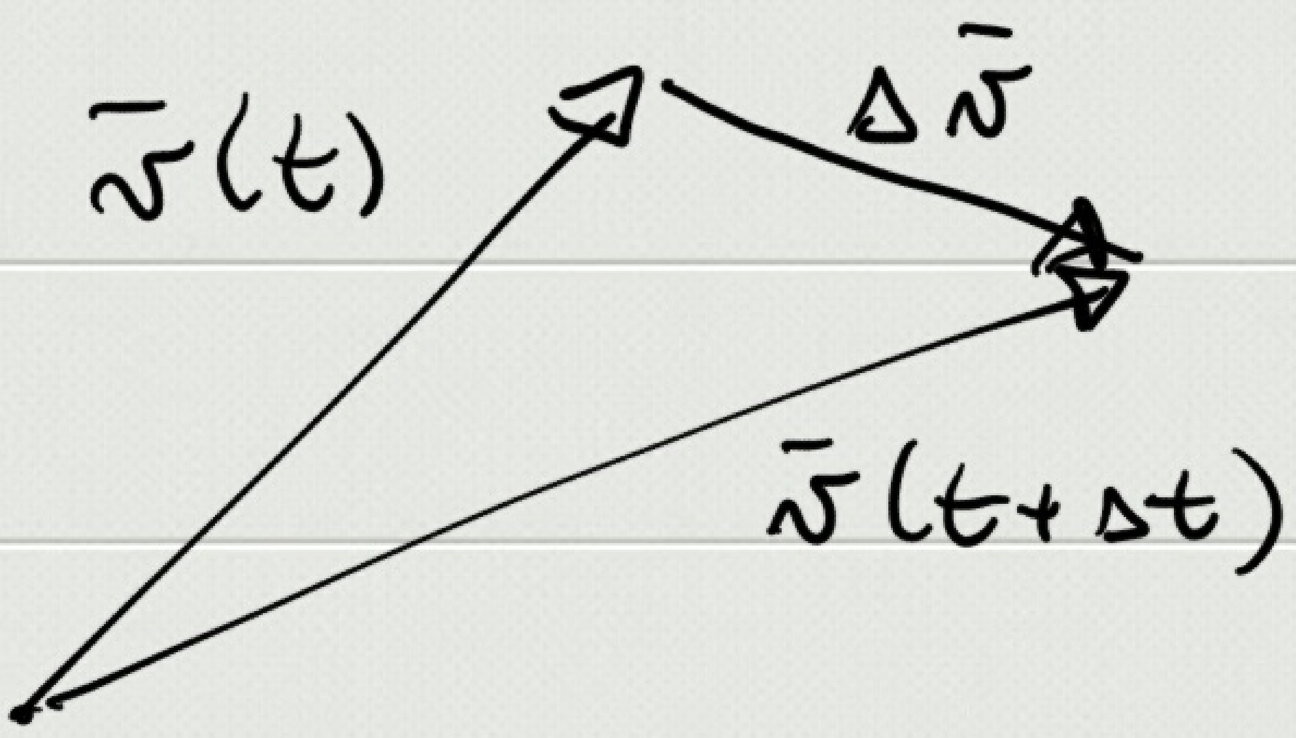
$$\bar{v} = \bar{v}(t)$$



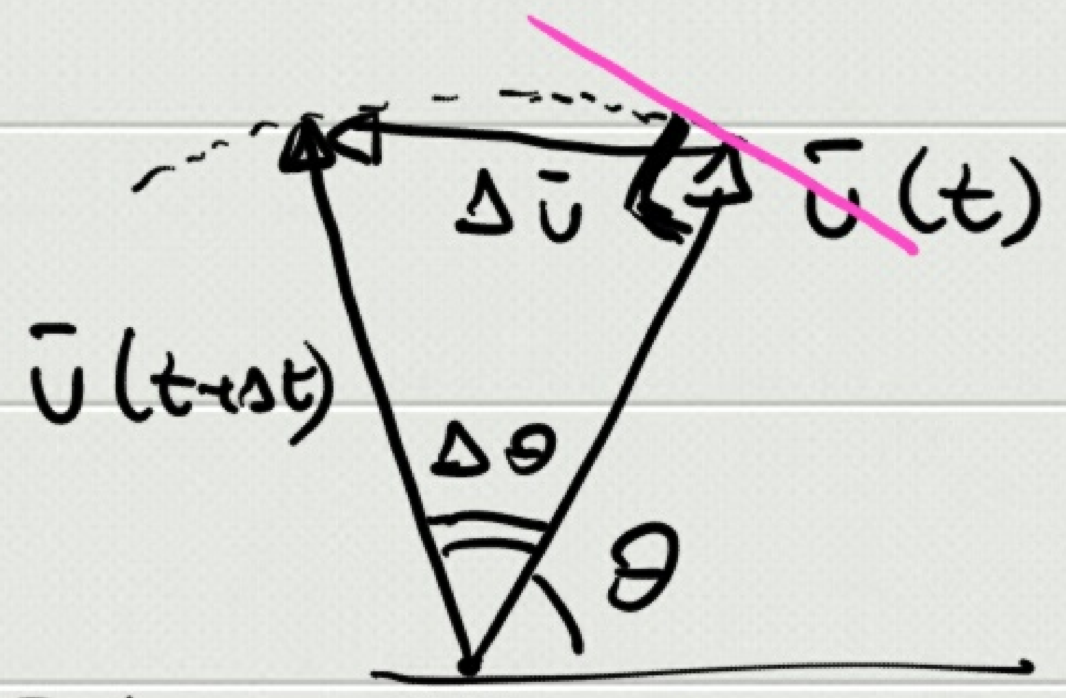
$$\frac{d\bar{v}}{dt} = \lim_{\Delta t \to 0} \frac{\bar{v}(t+\Delta t) - \bar{v}(t)}{\Delta t} = \lim_{\Delta t \to 0} \frac{\Delta \bar{v}}{\Delta t}$$

$$\frac{d\bar{v}}{dt} \nparallel \bar{v}$$

- $\frac{d}{dt}(\bar{a} + \bar{b}) = \frac{d\bar{a}}{dt} + \frac{d\bar{b}}{dt}$
- $k = \text{cos}^t \Rightarrow \frac{d}{dt}(k\bar{v}) = k\frac{d\bar{v}}{dt}$
- $\frac{d}{dt}\left[f(t)\,\bar{v}(t)\right] = \frac{df}{dt}\bar{v}(t) + f(t)\frac{d\bar{v}}{dt}$
- $\frac{d}{dt}\left[\bar{a}(t)\cdot\bar{b}(t)\right] = \frac{d\bar{a}}{dt}\cdot\bar{b} + \bar{a}\cdot\frac{d\bar{b}}{dt}$
- $\frac{d}{dt}\left[\bar{a}(t)\times\bar{b}(t)\right] = \frac{d\bar{a}}{dt}\times\bar{b} + \bar{a}\times\frac{d\bar{b}}{dt}$
- $\bar{v}(t) = v_x(t)\,\bar{u}_x + v_y(t)\,\bar{u}_y + v_z(t)\,\bar{u}_z$

$$\frac{d\bar{v}}{dt} = \frac{dv_x}{dt}\bar{u}_x + \frac{dv_y}{dt}\bar{u}_y + \frac{dv_z}{dt}\bar{u}_z$$

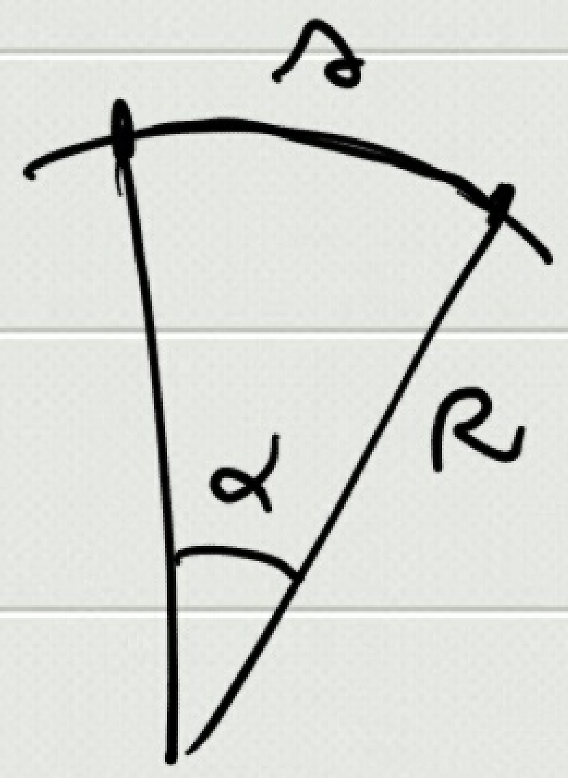
Derivata di un versore : $\bar{u} = \bar{u}(t)$ $\quad |\bar{u}| = 1$

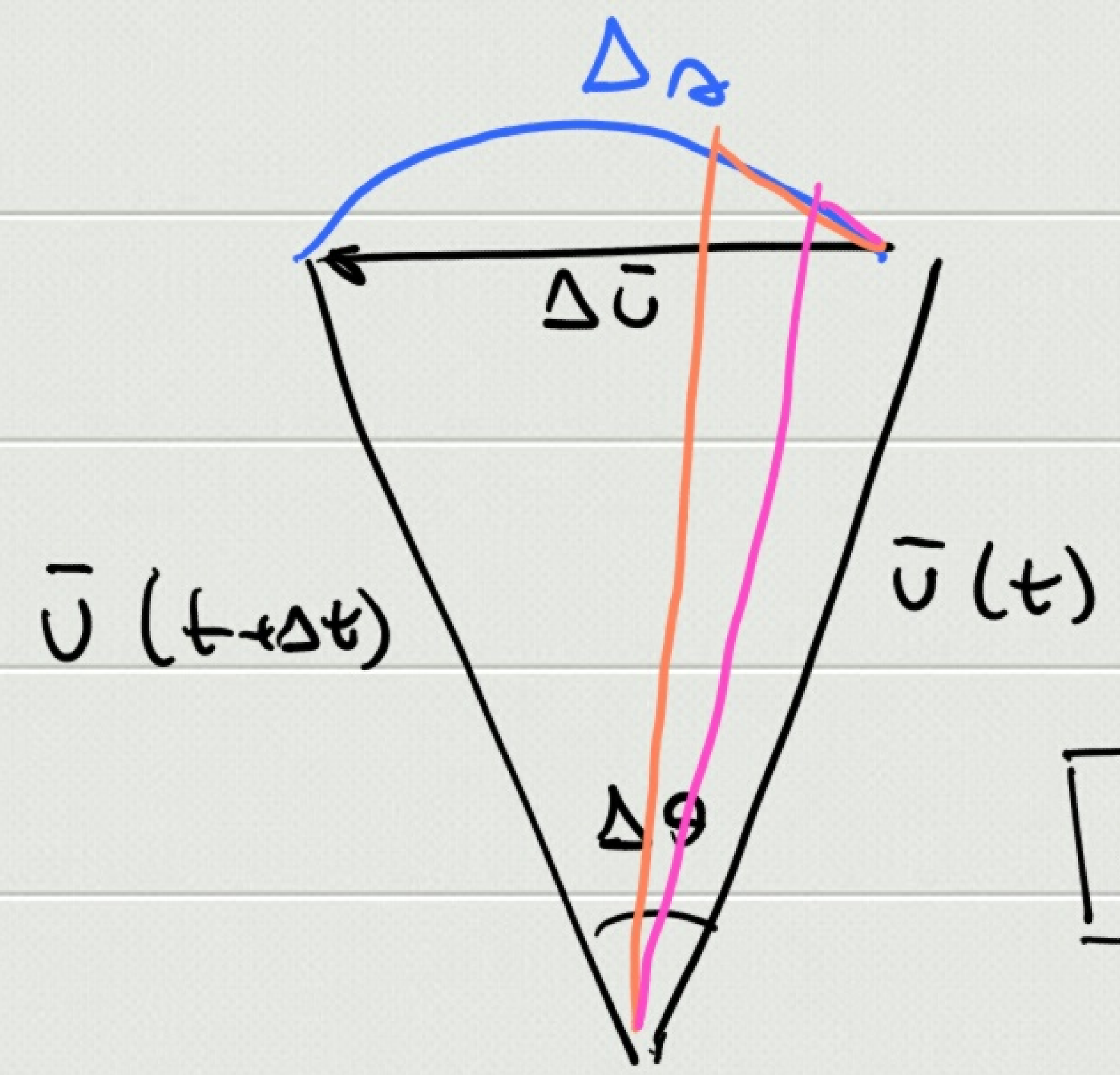


$$\frac{d\bar{u}}{dt} = \lim_{\Delta t \to 0} \frac{\bar{u}(t+\Delta t) - \bar{u}(t)}{\Delta t} = \lim_{\Delta t \to 0} \frac{\Delta \bar{u}}{\Delta t}$$

$$\boxed{d\bar{u} \perp \bar{u}}$$

$$\boxed{s = \alpha R}$$





$(R = 1)$

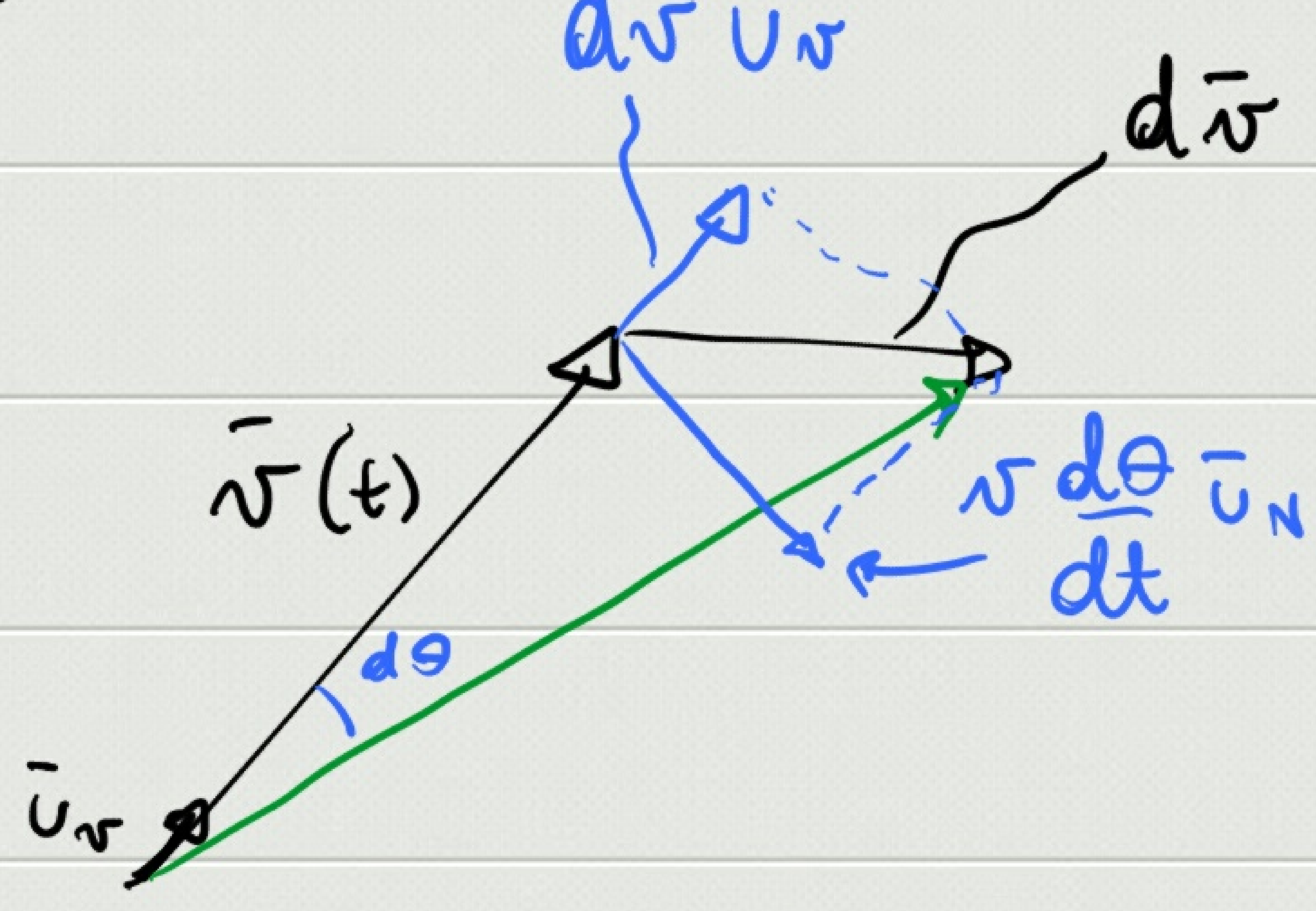
$$\boxed{\Delta s = |\bar{u}|\,\Delta\theta}$$

$\lim_{\Delta t \to 0}$: $\quad du = \lim_{\Delta t \to 0} |\Delta \bar{u}| = \lim_{\Delta t \to 0} \Delta s = ds = d\theta$

$$\frac{du}{dt} = \frac{d\theta}{dt}$$

$$\Rightarrow \boxed{\frac{d\bar{u}}{dt} = \frac{d\theta}{dt}\,\bar{u}_N} \qquad (\bar{u}_N \perp \bar{u})$$

$\bar{v} = v\,\bar{u}_v$



$$\frac{d\bar{v}}{dt} = \frac{dv}{dt}\,\bar{u}_v + v\,\frac{d\bar{u}_v}{dt} = \frac{dv}{dt}\,\bar{u}_v + v\,\frac{d\theta}{dt}\,\bar{u}_N$$

variazione del modulo

variazione della direzione

$$\left|\frac{d\bar{v}}{dt}\right| = \sqrt{\left(\frac{dv}{dt}\right)^2 + \left(v\,\frac{d\theta}{dt}\right)^2}$$

$$\frac{dv}{dt} = 0 \Rightarrow v = \text{cont} \Rightarrow \left|\frac{d\bar{v}}{dt}\right| = v\,\frac{d\theta}{dt}$$

$$\frac{d\theta}{dt} = 0 \Rightarrow \theta = \text{cont} \Rightarrow \left|\frac{d\bar{v}}{dt}\right| = \frac{dv}{dt}$$