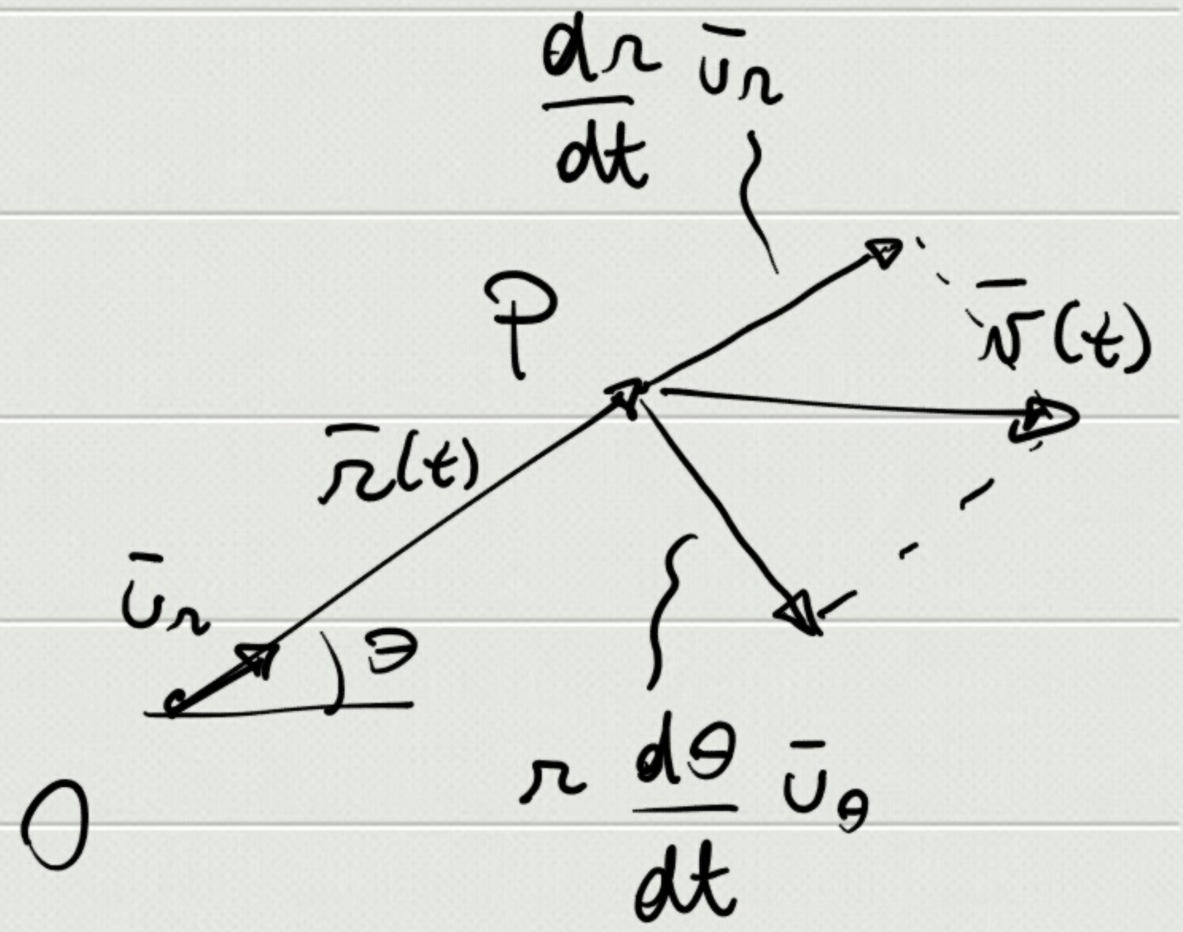


$$\bar{v}(t) = \frac{d\bar{r}}{dt} = \frac{d}{dt}\left(r(t)\,\bar{u}_r\right) = \frac{dr}{dt}\,\bar{u}_r + r\,\frac{d\bar{u}_r}{dt} =$$

$$= \frac{dr}{dt}\,\bar{u}_r + r\,\frac{d\vartheta}{dt}\,\bar{u}_\vartheta = \qquad \bar{u}_\vartheta \perp \bar{u}_r$$

$$= \bar{v}_r + \bar{v}_\vartheta$$

$\bar{v}_r$ → velocità radiale

$\bar{v}_\vartheta$ → velocità trasversa

$$\bar{a}_m = \frac{\Delta \bar{v}}{\Delta t}$$

$$\bar{a}(t) = \frac{d\bar{v}}{dt} = \frac{d^2\bar{r}}{dt^2}$$

$$d\bar{v} = \bar{a}(t)\,dt \Rightarrow \int_{\bar{v}_0}^{\bar{v}(t)} d\bar{v} = \int_{t_0}^{t} \bar{a}(t)\,dt$$

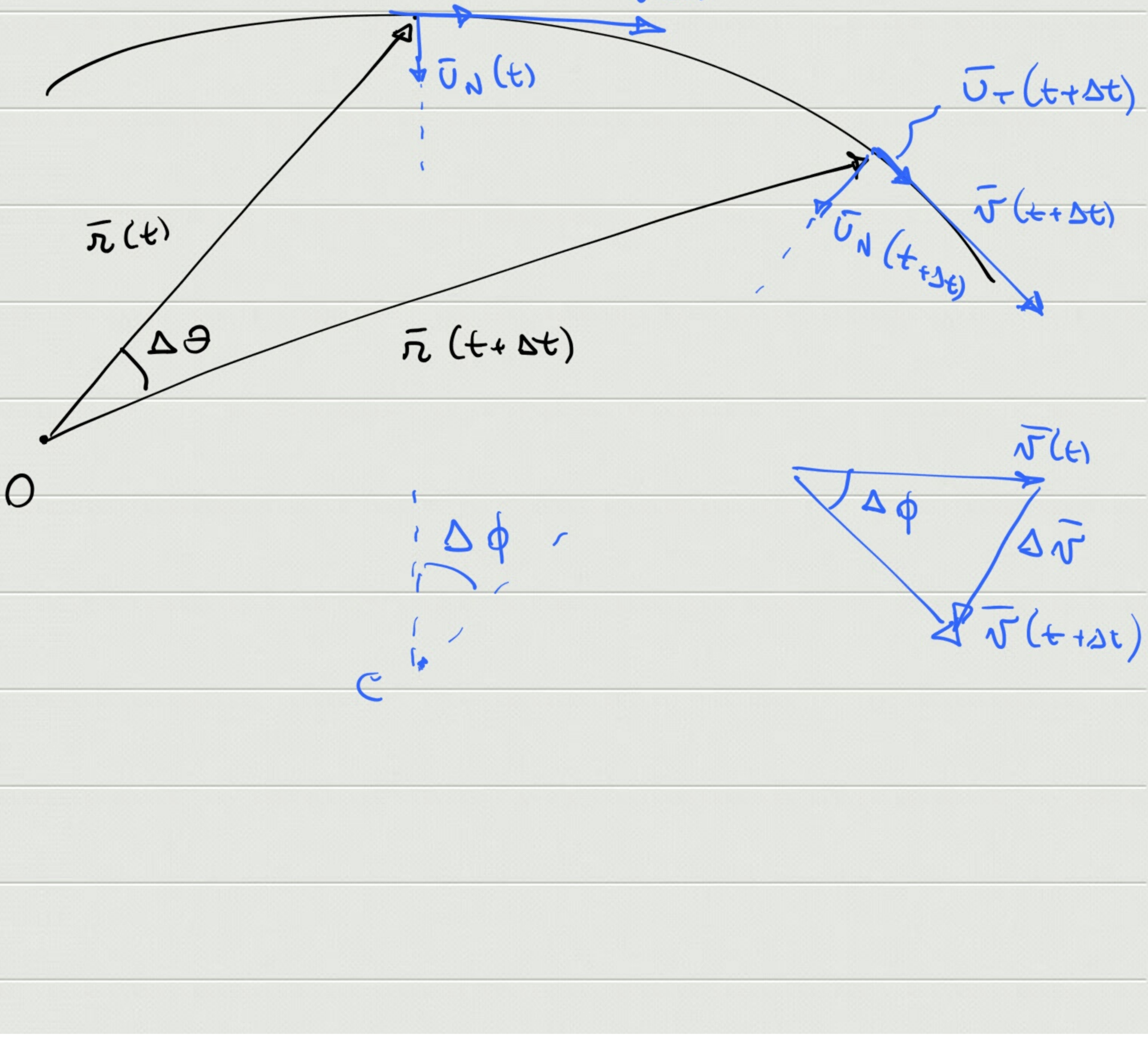
$$\bar{v}(t) = \bar{v}_0 + \int_{t_0}^{t} \bar{a}(t)\,dt \qquad \bar{v}_0 = \bar{v}(t_0)$$

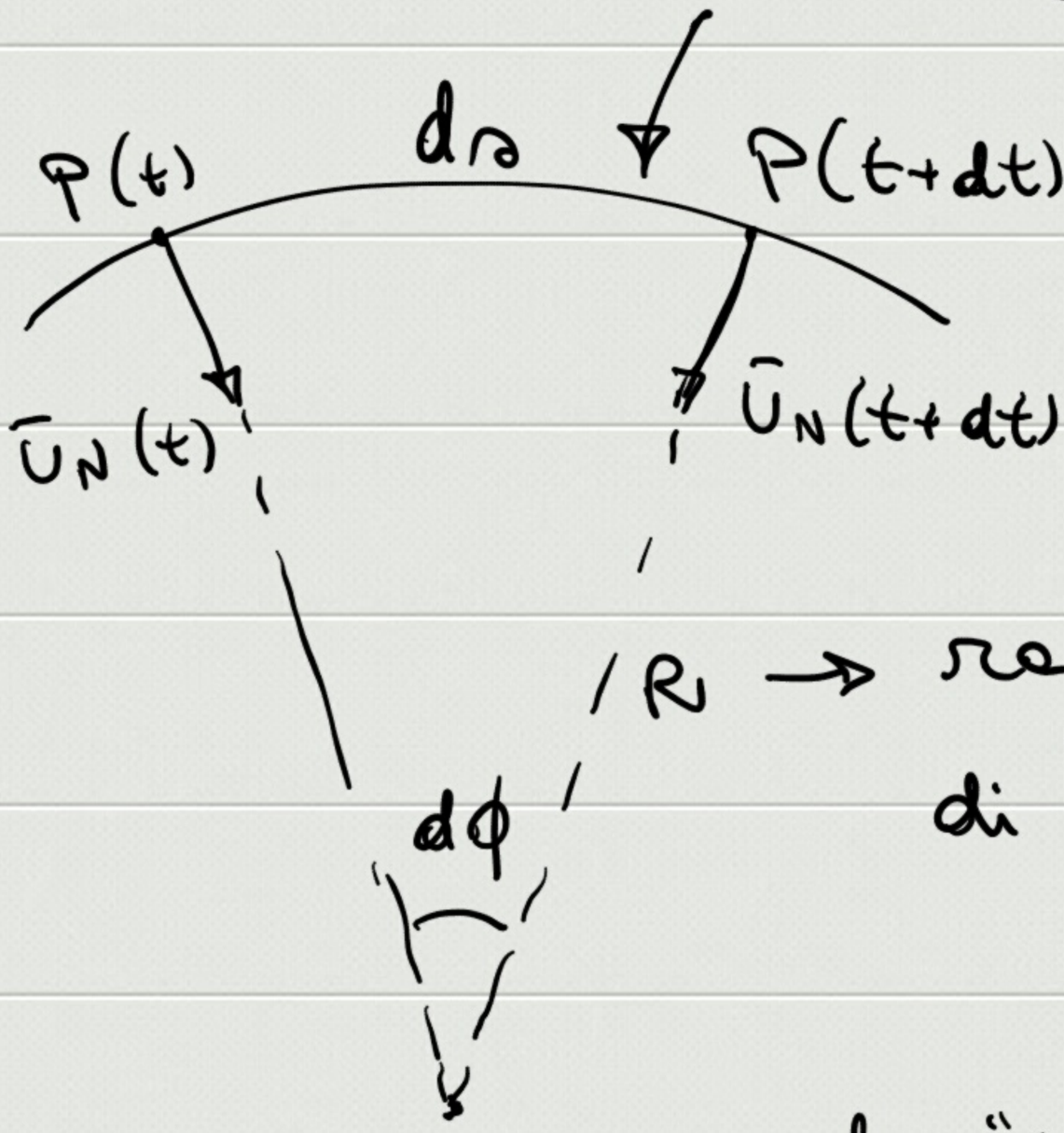
$$\bar{v} = v\,\bar{u}_\tau$$

$$\bar{a} = \frac{d\bar{v}}{dt} = \frac{d}{dt}\left(v\,\bar{u}_\tau\right) = \frac{dv}{dt}\,\bar{u}_\tau + v\,\frac{d\bar{u}_\tau}{dt} =$$

$$= \frac{dv}{dt}\,\bar{u}_\tau + v\,\frac{d\phi}{dt}\,\bar{u}_N = \qquad \bar{u}_N \perp \bar{u}_\tau$$

$$= \bar{a}_\tau + \bar{a}_N$$





$$ds = R\,d\phi \quad \Rightarrow \quad \frac{ds}{dt} = R\,\frac{d\phi}{dt}$$

$v \downarrow$

$$\Rightarrow \quad \frac{d\phi}{dt} = \frac{v}{R}$$

$$\bar{a}_N = v\,\frac{d\phi}{dt}\,\bar{u}_N = \frac{v^2}{R}\,\bar{u}_N$$

$$\Rightarrow \boxed{\bar{a}(t) = \frac{dv}{dt}\,\bar{u}_T + \frac{v^2}{R}\,\bar{u}_N = \bar{a}_T + \bar{a}_N}$$

$a_T \rightarrow$ accelerazione tangenziale

$a_N \rightarrow$ accelerazione normale o centripeta

$$a = |\bar{a}(t)| = \sqrt{\left(\frac{dv}{dt}\right)^2 + \left(\frac{v^2}{R}\right)^2}$$

Variazione modulo $\bar{v}$ — Variazione direzione $\bar{v}$