Cartesian coordinates : basis vectors ez, e, ez Lolor coordinates : bosig vectors ê, êg

 $\mathcal{X}\left(\mathcal{X},\mathcal{Y}\right)=\mathcal{X}_{\mathcal{Y}}\left(r,\varphi\right)=\mathcal{X}\left(\mathcal{X}(r,\varphi),\mathcal{Y}(r,\varphi)\right)$ 

In physics, assume ':  $\mathcal{L}(2, \gamma) = \chi(r, \varphi)$ 

 $r_{p}(r,d) = r(\mathcal{Z}(r,d), \gamma(r,d)) = \vec{e}_{z}r_{u}d + \vec{e}_{y}r_{u}d$ 

 $\vec{e}_r = \left( r \frac{\partial \vec{r}}{\partial r} \right) = \left( c_r \left( c_0 \phi \vec{e}_2 + 4i \phi \vec{e}_r \right) \right)$  $= \frac{1}{\sqrt{60^2 \phi + \dot{x}^2 \phi}} \left( \cos \phi \vec{e}_{x} + \sin \phi \vec{e}_{y} \right)$ 

= up ez + inder

 $\vec{e_{g}} = C_{g} \frac{\partial \vec{r}}{\partial g} \Big|_{r} = C_{g} \left( -r \sin g \vec{e_{x}} + r \cos g \vec{e_{y}} \right) = -i \beta \vec{e_{x}} + i \beta \vec{e_{y}}$  $-\sqrt{r^2}$  $\sqrt{(r \cos \phi)^2} + (r \cos \phi)^2$ 

 $r(r, d) = r \tilde{e}_r(q)$ 

avector is a collection of components and bosis vectors!

$$\frac{define}{di} = \frac{\partial r}{\partial x^{i}}$$

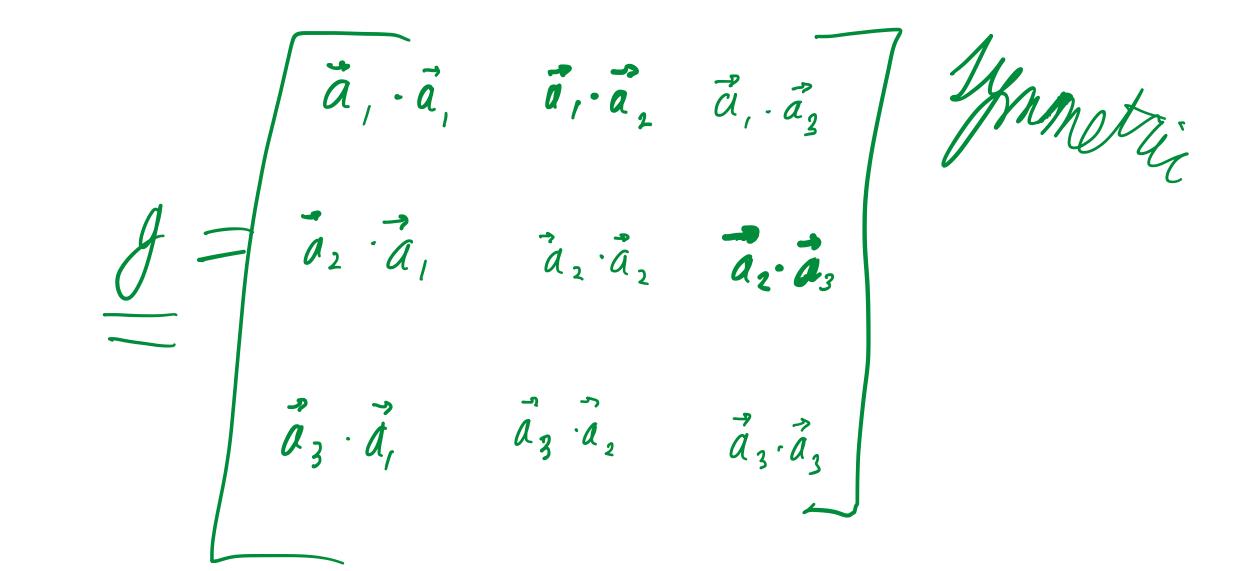
$$\frac{dr}{dt} = \frac{dx^{i}}{dt} = \frac{\partial r}{\partial x^{i}}$$

 $(\vec{a}, \vec{a}, \vec{a}, \vec{a})$  forms the covariant basis for  $(\mathcal{X}, \mathcal{X}, \mathcal{X}_3)$ 

$$\vec{a}_i = \frac{\partial \vec{x}}{\partial x^i}$$

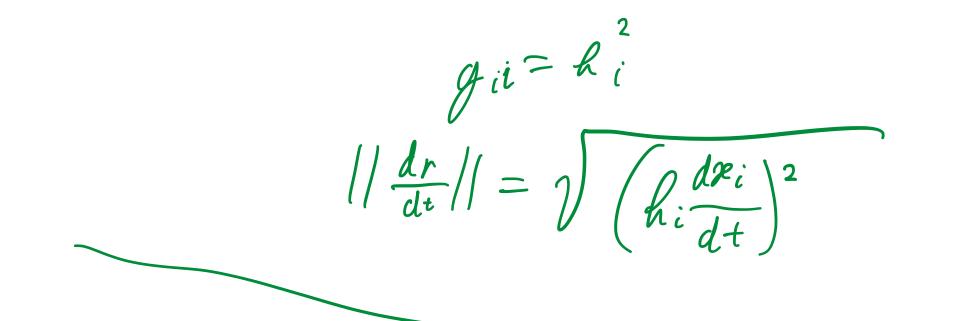
$$y_{\text{red}} = \sqrt{\frac{d\vec{r}}{dt} \cdot \frac{d\vec{r}}{dt}} - \sqrt{\frac{d\vec{r}}{dt}} \frac{\vec{a}_i \cdot \frac{d\vec{r}}{dt}}{dt} \frac{\vec{a}_i}{dt} = \sqrt{\frac{d\vec{r}}{dt}} \frac{d\vec{r}}{dt} \frac{\vec{a}_i \cdot \vec{a}_j}{dt} = \sqrt{\frac{d\vec{r}}{dt}} \frac{d\vec{r}}{dt} \frac{d\vec{r}}{dt} \frac{d\vec{r}}{dt} \frac{d\vec{r}}{dt}$$

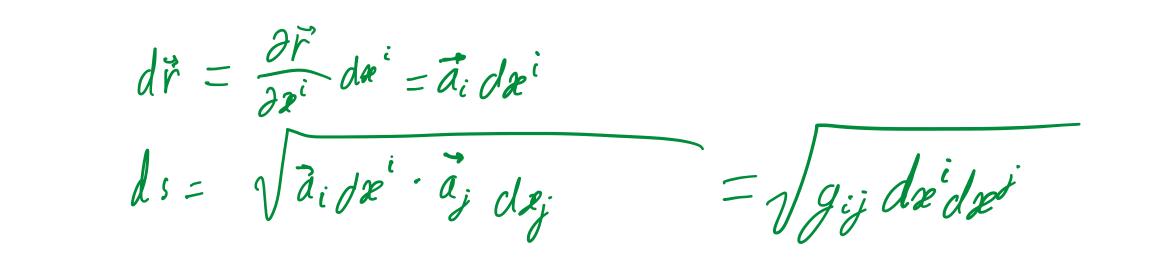




ortho - availaneer yours (OCL): a: a; = o if i + j

h := //ai// : lengths of cororiant losis vertors (rale factors / Camé cefficients)





in OCL coordinates $ds = \sqrt{\xi (ki dz^i)^2}$