

$$h_* \partial_x = \frac{\partial x}{\partial r} \partial_r + \frac{\partial x}{\partial \theta} \partial_\theta + \frac{\partial x}{\partial \varphi} \partial_\varphi = \sin \theta \cos \varphi \partial_r + r \cos \theta \cos \varphi \partial_\theta - r \sin \theta \sin \varphi \partial_\varphi$$

$$h_* \partial_y = \sin \theta \sin \varphi \partial_r + r \cos \theta \sin \varphi \partial_\theta + r \sin \theta \cos \varphi \partial_\varphi$$

$$h_* \partial_z = \cos \theta \partial_r - r \sin \theta \partial_\theta$$

$$\begin{aligned} h_* v_1 &= r \sin \theta \sin \varphi (\cos \theta \partial_r - r \sin \theta \partial_\theta) - r \cos \theta (\sin \theta \sin \varphi \partial_r + r \cos \theta \sin \varphi \partial_\theta - r \sin \theta \cos \varphi \partial_\varphi) = \\ &= (r \sin \theta \sin \varphi \cos \theta - r \cos \theta \sin \theta \sin \varphi) \partial_r + (-r^2 \sin^2 \theta \sin \varphi - r^2 \cos^2 \theta \sin \varphi) \partial_\theta + r^2 \sin \theta \cos \varphi \partial_\varphi = \\ &= -r^2 \sin \varphi \partial_\theta + r^2 \sin \theta \cos \varphi \partial_\varphi \end{aligned}$$

$$\begin{aligned} h_* v_2 &= r \sin \theta \cos \varphi (\cos \theta \partial_r - r \sin \theta \partial_\theta) - r \cos \theta (\sin \theta \cos \varphi \partial_r + r \cos \theta \cos \varphi \partial_\theta - r \sin \theta \sin \varphi \partial_\varphi) = \\ &= (r \sin \theta \cos \varphi \cos \theta - r \cos \theta \sin \theta \cos \varphi) \partial_r + (-r^2 \sin^2 \theta \cos \varphi - r^2 \cos^2 \theta \cos \varphi) \partial_\theta + r^2 \cos \theta \sin \theta \sin \varphi \partial_\varphi = \\ &= -r^2 \cos \varphi \partial_\theta + r^2 \cos \theta \sin \theta \sin \varphi \partial_\varphi \end{aligned}$$

Числа $\partial_x, \partial_y, \partial_z$ $v_3 = x \partial_y - y \partial_x$

$$\begin{aligned} h_* v_3 &= r \sin \theta \cos \varphi (\sin \theta \sin \varphi \partial_r + r \cos \theta \sin \varphi \partial_\theta + r \sin \theta \cos \varphi \partial_\varphi) - \\ &\quad - r \sin \theta \sin \varphi (\sin \theta \cos \varphi \partial_r + r \cos \theta \cos \varphi \partial_\theta - r \sin \theta \sin \varphi \partial_\varphi) = \\ &= r^2 \sin^2 \theta \partial_\varphi \end{aligned}$$