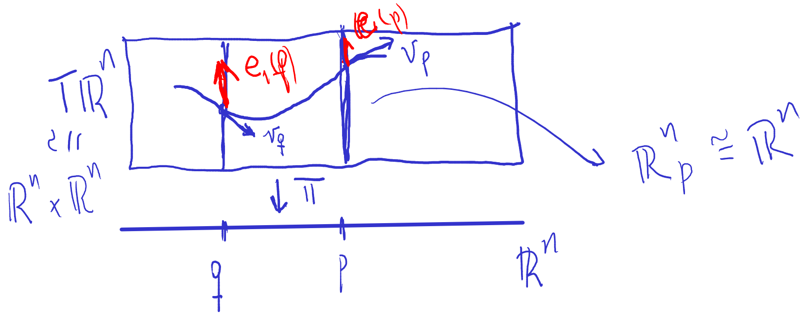


$$\pi : T\mathbb{R}^n \to \mathbb{R}^n$$
$$(p, v_p) \longmapsto p$$

$$\mathfrak{Z} : \mathbb{R}^n \to T\mathbb{R}^n \qquad \mathbb{R}^n_p = \mathrm{span}\{e_1(p), \ldots, e_n(p)\}$$
$$p \to (p, v_p)$$
$$v_p = \sum_{i=1}^{n} v_p^i \, e_i(p).$$

$$F : \mathbb{R}^n \to T\mathbb{R}^n$$
$$p \to (p, F_p(p))$$
$$F_p(p) = \sum_{i=1}^{n} F^i(p) . e_i(p)$$

$\mathbb{R}^3$

$$\nabla = \left(\frac{\partial}{\partial x}, \frac{\partial}{\partial y}, \frac{\partial}{\partial z}\right), \quad F = (F^1, F^2, F^3)$$

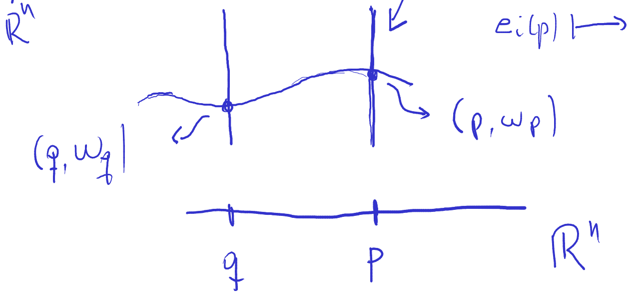
$$\nabla \times F = \begin{vmatrix} e_1 & e_2 & e_3 \\ \partial x & \partial y & \partial z \\ F_1 & F_2 & F_3 \end{vmatrix} = \left(\frac{\partial F_3}{\partial y} - \frac{\partial F_2}{\partial z}, \frac{\partial F_1}{\partial z} - \frac{\partial F_3}{\partial x}, \frac{\partial F_2}{\partial x} - \frac{\partial F_3}{\partial z}\right)$$

$$\varphi(w) = \det(v_1, \ldots, v_{n-1}, w)$$

$\bigcup_{p \in \mathbb{R}^n} \Lambda^k(\mathbb{R}^n_p)$ $\quad \Lambda^k(\mathbb{R}^n_q)$ $\quad \Lambda^k(\mathbb{R}^n_p)$ é esp. vet.

$e_i(p) \longmapsto \varphi_i(p)$ $\qquad \varphi_{i_1}(p) \wedge \ldots \wedge \varphi_{i_k}(p)$

$1 \leq i_1 < i_2 < \ldots < i_k \leq n$



$$\mathcal{T}^2(\mathbb{R}^n_p) \qquad d\varphi_1 \otimes d\varphi_1 + \ldots + d\varphi_n \otimes d\varphi_n$$