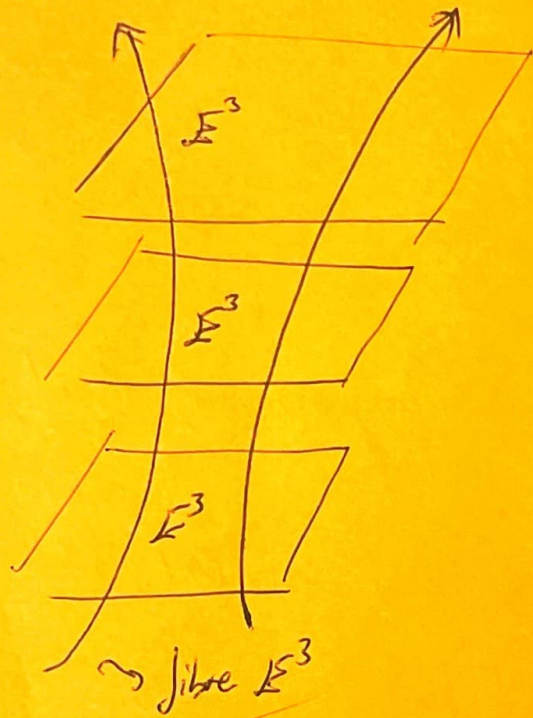


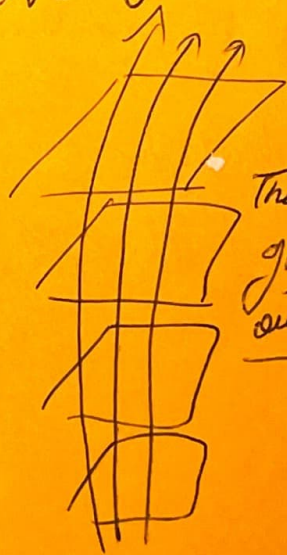
Base space



Newton-Cartan Spacetime N

is a bundle with a phase space E^1 and fibre E^3 . Its structure is provided by the family of motions (inertial) in Einstein's sense

Its structure is completely equivalent to that of G .



The special case of Newtonian gravitational field constant over all space.

3+1 Decomposition can be viewed as a trivial fiber bundle.

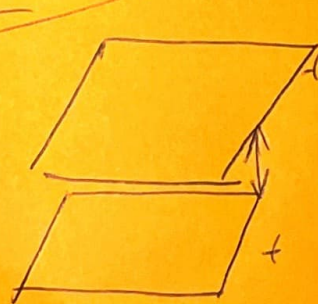
$$\gamma_\mu = -\alpha \gamma_\mu$$

$$\alpha = (-g^{\mu\nu} \gamma_\mu \gamma_\nu)^{1/2}$$

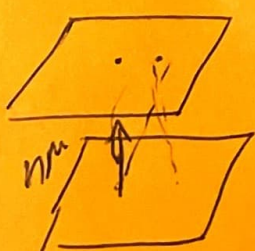
$$\gamma_\mu = \gamma_\mu^a \partial_a \text{ "handle one form"}$$

$$\pi: M \rightarrow \mathbb{R} \quad M \cong \mathbb{R} \times \Sigma_t$$

$\downarrow$ time $\downarrow$ spatial
 three manifolds
 equipped with
 Riemannian metrics
 $\gamma_t(dx)$



$\rightarrow dt$ the proper time that this is called the lapse ending $d\tau = \alpha(t, x) dt$



$dx^i = -\beta^i(t, x) dt$
 So, slide every fresh sheet sideways before you glue it on
 is our three vector shift. It tells how the point labelled x^i on one slice is relocated on the next.

time vector $\downarrow$

$$t^M = \alpha n^M + \beta^M$$

G is our coordinate time.

Setting $\alpha=1$, $\beta^i=0$, $\gamma_{ij} = \delta_{ij}$. Once again every sheet is the Rigid galileo sheet. Stack is flat and all normals are parallel.

Switch on a uniform Newtonian field and only across bond; in full GR both across and slips may twist.