

08/02/03

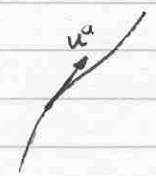
Today: pressure & gravity
cosmological constant
deSitter & anti-deSitter spaces
maximally symmetric spaces
Killing vector

$$G_{ab} = 8\pi G T_{ab}$$



$$\nabla \cdot g = -4\pi G \rho$$

$$\text{tidal} = \frac{\ddot{V}}{V} = \text{tr}^2 \Phi = -R_{ab} u^a u^b$$



to make right analogy:

R_{ab} is responsible for tidal, not R .

so: $R_{ab} = 8\pi G (T_{ab} - \frac{1}{2} T g_{ab})$

and $\boxed{\frac{\ddot{V}}{V} = -R_{ab} u^a u^b = -4\pi G \underbrace{(2\rho_E + T)}_{\rho_{\text{eff}}}}$

$\rho_E = T_{ab} u^a u^b$
 $T = T^a_a$

examples:

• dust: $T_{ab} = \rho_E u_a u_b$, $T = -\rho_E$

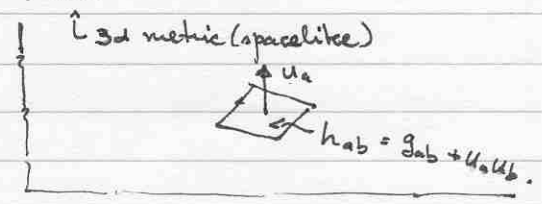
$\rightarrow \rho_{\text{eff}} = 2\rho_E - \rho_E = \rho_E$ (only energy density contributes)

• fluid with isotropic pressure:
(perfect fluid)

$$\begin{aligned} T_{ab} &= \rho_E u_a u_b + P(g_{ab} + u_a u_b) \\ &= (\rho_E + P) u_a u_b + P g_{ab} \\ &= \rho_E u_a u_b + P h_{ab} \end{aligned}$$

$$T = -\rho_E - P + 4P = 3P - \rho_E$$

$\rightarrow \boxed{\rho_{\text{eff}} = 2\rho_E + T = \rho_E + 3P}$



P doesn't contribute for non-relativistic fluids.

• Radiation fluid:

for EM (Maxwell), $T^a_a = 0 \Rightarrow P = \frac{1}{3} \rho_E$

$\boxed{\rho_{\text{eff}} = 2\rho_E}$