

The Cosmological Const.: (CC)

* The standard form of EFE are not unique

* Einstein added the CC term to have a static cosmological sol.

$$G_{\mu\nu} + \Lambda g_{\mu\nu} = \kappa T_{\mu\nu} \quad (\nabla_\alpha g_{\mu\nu} = 0)$$

$\hookrightarrow$ universal const.

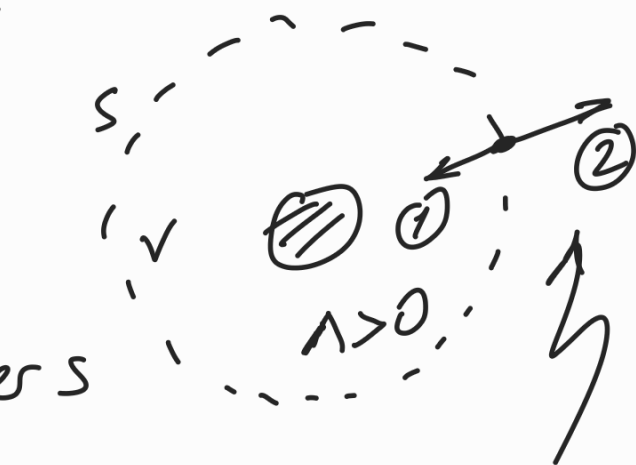
$\Downarrow$ in the NL

$$\nabla^2 \phi = 4\pi G\rho - \Lambda c^2$$

$$\Downarrow \quad \vec{g} = -\vec{\nabla}\phi$$

$\Downarrow$ integrating over S

$$\vec{g} = - \underbrace{\frac{GM}{r^2} \hat{r}}_{(1)} + \underbrace{\frac{c^2 \Lambda}{3} r \hat{r}}_{(2)}$$



repulsive
force
if $\Lambda > 0$

* From observations, we know

$$|\Lambda| \leq 10^{-52} \text{ m}^{-2}$$

Some Exact Sols.:

* Now, w/o deriving, let's write some exact sols. of GR.

($T_{\mu\nu} = 0$ vacuum)

$$\underline{G_{\mu\nu} = 0 \ (\Lambda = 0)}$$

Minkowski

Sch. (M)

$$\underline{G_{\mu\nu} + \Lambda g_{\mu\nu} = 0 \ (\Lambda \neq 0)}$$

(Anti)-de Sitter (Λ)

Sch. (A)dS (M, Λ)

$G_{\mu\nu} = 0$
 $\nabla_\mu F^{\mu\nu} = 0$ Reissner-Nordstrom (RN)

(M, Q)

RN (A)dS (M, Q, Λ)

Kerr (M, J)

Kerr (A)dS (M, J, Λ)

Kerr-Newman (M, Q, J)
(KN)

KN (A)dS (M, Q, J, Λ)

Mañandar-Papapetrou Sol.

(Charged multi BH.
Sols.)

in cosmology

Kasner-Traschen
Sol.

