Robertson Walker metric

$$dl^2 = -c^2 dt^2 + a^2(t)\, d\Gamma^2$$

comoving coord. Γ so gal. "co-ord" distance is Γ_0 always

"regular" (Minkowski) metric from SR

But modified to include the expansion of the Univ. via scale factor $a(t)$

time is cosmic time — measured by observer at rest, seeing the Univ. expand uniformly away from him/her.

proper distance — length of geodetic (shortest distance — light path) at a fixed time, t (so — a measuring stick would measure this value)

proper distance in a flat Univ. can be found from the RWM

"...fixed time, t..." $\Rightarrow dt = 0$

so $dl = a(t)\, d\Gamma$

note: l is a func. of t $l(t)$ [though we often want to evaluate it now, $t = t_0$]

integrate to find l

$$\int dl = \int a(t)\, d\Gamma$$

$$l(t) = a \int_0^\Gamma d\Gamma = a(t)\, \Gamma$$

since $a(t_0) = 1$ $l(t_0) = \Gamma = \Gamma_0$