**Chapter 2 : Fundamental Observations**

Redshift :

Hubble constant / parameter :

Hubble time :

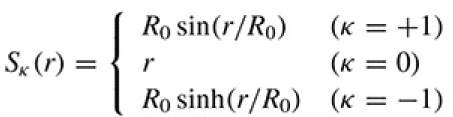
Hubble distance :

**Chapter 3 : Newton versus Einstein**

Robertson–Walker metric

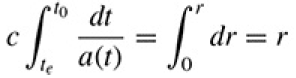


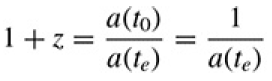




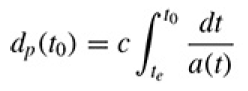
Light travel along a null geodesic, with ds = 0 :

=>



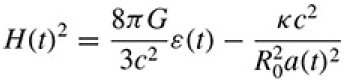


Current proper distance from you (the observer) to the galaxy (the light source) :

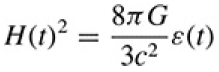


**Chapter 4 : Cosmic Dynamics**

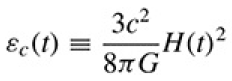
Friedmann Equation :



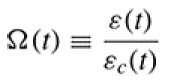
Friedmann Equation for flat universe (κ = 0) :



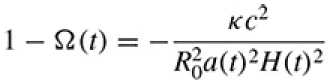
Critical density :



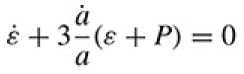
Density parameter :



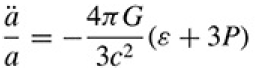
Friedmann equation in terms of Ω :



Fluid equation :



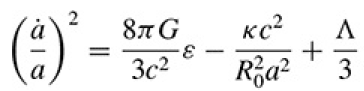
Acceleration equation :



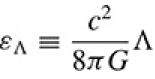
Equations of State :

**Lambda**

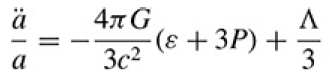
Friedmann equation with Λ term :



Note : adding the Λ term is equivalent to adding a new component to the universe with energy density (constant with time):



Acceleration equation with Λ term :



(fluid equation is unaffected by the presence of a Λ term).

**Chapter 5 : Model Universes**

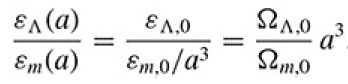
Energy density of matter :



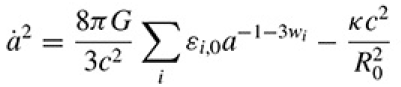
Energy density of radiation :

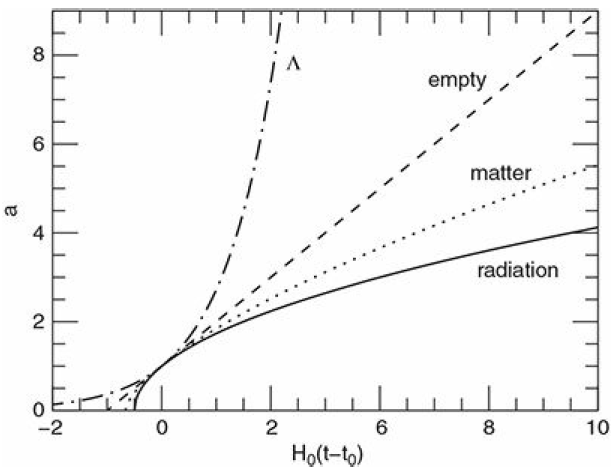


Relation between energy density of matter and lambda :

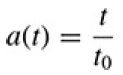


Friedmann Equation for a universe with many components :



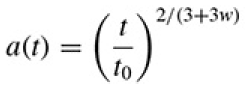


Empty universe



Single-component Universes (flat)

If w !=-1:



If w=-1 :



Multiple-component Universes

Friedmann equation for universes with matter (w = 0), radiation (w = 1/3), and a cosmological constant (w = −1) :