**Volume of infinite universe**

Let us consider matter dominated universe

Mass density of matter dominated universe varies with respect to time due to the cause of expansion

If the universe is [matter-dominated](http://en.wikipedia.org/wiki/Matter-Dominated_Era), then the mass density of the universe **ρ** can just be taken to include matter so

 **ρm** = **ρm0** **/ a3**....................................(1)

Here**ρm =**Mass density of universe which vary with respect to time’t’, **ρm0** **=**Present mass density of universe ,**a**=Scale factor of universe(which is the function of time)

Density parameter for matter present in universe is given by

**Ωm = ρm0** **/ρc**...................................................................(2)

Here**ρc=**Critical density of universe

**ρm** = **Ωm ρc/ a3** .............................................................(3)

The critical density is the watershed between an expanding and a contracting Universe.

Critical density of universe is given by

 **ρc=3HO2/8 ΠG**.............................................................(4)

Here **HO=** Hubble parameter(it indicates rate of expansion of universe),**G**=Universal gravitational constant .

Thus (3) becomes

**ρm** = **Ωm3HO2/ 8 ΠG a3**.............................................(5)

By multiplying the equation (5) by **C2**

Here **C=** Speed of light in vaccum**(3\*108m/s)**

We get

**ρm C2**= **Ωm3HO2 C2/ 8 ΠG a3**...................................(6)

Vacuum energy is an underlying background [energy](http://en.wikipedia.org/wiki/Energy) that exists in [space](http://en.wikipedia.org/wiki/Space) even when devoid of [matter](http://en.wikipedia.org/wiki/Matter) (known as [free space](http://en.wikipedia.org/wiki/Free_space)). The vacuum energy is deduced from the concept of [virtual particles](http://en.wikipedia.org/wiki/Virtual_particle#Virtual_particles_in_the_vacuum), which are themselves derived from the [energy-time uncertainty principle](http://en.wikipedia.org/wiki/Uncertainty_principle#Energy-time_uncertainty_principle). Its effects can be observed in various phenomena (such as [spontaneous emission](http://en.wikipedia.org/wiki/Spontaneous_emission), the [Casimir effect](http://en.wikipedia.org/wiki/Casimir_effect), the [van der Waals bonds](http://en.wikipedia.org/wiki/Van_der_Waals_force), or the [Lamb shift](http://en.wikipedia.org/wiki/Lamb_shift)), and it is thought to have consequences for the behavior of the [Universe](http://en.wikipedia.org/wiki/Universe) on [cosmological scales](http://en.wikipedia.org/wiki/Physical_cosmology).

The vaccum energy is constant and given by

**ρvaC**=**Λ C2/8 ΠG**........................................................(7)

Here **Λ=**Cosmological constant(dark energy).

**ρvaC / Λ** = **C2/8 ΠG**

Recent observations indicate that this expansion is accelerating because of [dark energy](http://en.wikipedia.org/wiki/Dark_energy), and that most of the matter in the Universe may be in a form which cannot be detected by present instruments, and so is not accounted for in the present models of the universe; this has been named [dark matter](http://en.wikipedia.org/wiki/Dark_matter).

Thus(6)becomes

**ρm C2**= **Ωm3HO2 ρvaC / a3 Λ**.....................................(8)

Cosmological (Dark energy)density parameter is given by

**Ω Λ= Λ C2/3HO2**

**3HO2/ Λ= C2/ Ω Λ**......................................................(9)

Thus (8) becomes

**ρm C2**= **ΩmρvaC C2 / a3 Ω Λ**.....................................(10)

**ρm** = **ΩmρvaC / a3 Ω Λ**..............................................(11)

Let us know consider matter and dark energy dominated universe

Density parameter for matter and dark energy dominated universe is given by

**Ω = Ωm+ Ω Λ**............................................................(12)

Thus (11) becomes

**ρm a3/ ρvac = (Ω**- **Ω Λ) / Ω Λ**....................................(13)

**ρm a3/ ρvac= (Ω / Ω Λ**-1).......................................(14)

Mass density of universe is defined as mass of matter distributed per unit volume of universe and it is mathematically given by

 **ρm=M/V**

Here **V=**Volume of universe

Thus (13) becomes

**V**= **M a3/ ρvaC(Ω / Ω Λ**-1)........................................(15)

Here **M=**  Mass of matter in universe which vary with respect to time’t’.

 **a=**Scale factor of universe

 **ρvac=** vaccum energy

 **Ω=** Density parameter for matter and dark energy present in universe

 **Ω Λ=** Density parameter for dark energypresent in universe