# **Calculating Dark matter and Dark Energy using Hubble Constant & Critical density, and its implications** Alex Kim dongk99@gmail.com

## **Abstract**

This paper outlines the determination of the energy and mass of dark energy (DE) and dark matter (DM) without relying on causality-breaking assumptions or tachyonic interpretations of spacetime. Using foundational principles of thermodynamics, quantum field theory, and observational cosmology, we demonstrate that DE and DM can be understood as manifestations of the quantum fields governing the universe and strictly adheres to Energy-Mass equivalence principle.

## **Introduction**

The universe’s energy composition is dominated by dark energy (68%) and dark matter (27%), with baryonic matter contributing only 5%. Despite this, the precise nature of DE and DM remains elusive. This work aims to determine their mass and energy contributions using direct inferences from critical density and thermodynamic laws, without invoking speculative causality-breaking constructs such as tachyonic fields or parallel universes.

We explore their local and cosmic-scale effects, reconcile their roles in the universe’s expansion and contraction, and emphasize their consistency with the cyclical universe model.

## **Key Principles**

### **1. Critical Density of the Universe**

The critical density of the universe is defined as:

where:

* : Hubble constant, where: ≈67.4km/s/Mpc (CMBR),[1] 73.0km/s/Mpc (SH0ES)[2]
* : Gravitational constant (≈6.67430 × 10-11M3kg-1s-2)

### **2. Energy and Mass Density Contributions of DE/DM/Baryonic matter**

According to Planck Collaboration [2018] et al,

* Dark energy: 68%
* Dark matter: 27%
* Baryonic matter: 5%

### **3. Volume of the Observable Universe**

The macroscopic volume of universe (ignoring gravitational lens-related variation, assuming homogeneous scale) can be calculated using Hubble constant. This paper will be using both values.  
  
Radius of observable universe can be calculated using formula   
We will now calculate radius of observable universe using Cepheid/Supernovae-derived Hubble constant, and Early CMBR-derived data, which is 73km/s/Mpc, and 67.4km/s/Mpc, respectively.   
  
≈ 4.11 ×103 Mpc  
  
≈ 4.45 × 103 Mpc  
  
Volume, can be calculated by using V=× π × R3 ;  
  
V(SH0ES) = π (1.27 × 1026)3 = 8.580 × 1078 m3  
V(CMBR) = π (1.37 × 1026)3 = 1.076 × 1079 m3

**4. Critical density.**Critical density should not be used since we can observe that the universe is clearly expanding. However for sake of calculation we will assume that our universe is on a steady-state for a brief time.  
Again, we will be using both CMBR-derived Hubble constant and Cepheid-derived hubble constant.  
  
*P*crit =

Converting Hubble constant (73 × 103 m/s/Mpc) ;  
*H*0 (SH0ES) = 73km/s/Mpc × ≈ 2.3655 × 10-18*H*0 (CMBR) = 67.4km/s/Mpc × ≈ 2.1841 × 10-18Plugging this value to *P*crit results in:  
  
≈ = 1.00078 × 10-26  
  
≈= 8.25504 × 10-27

## **Total energy of observable universe** Before we begin calculation, we first double-check Total energy of observable universe. This assumes flat universe at critical density. This can be obtained by: = 9.69155 × 1069 J = 6.37454 × 1069 J

## **Calculations**

Dark energy: 68%  
Dark matter: 27%  
Baryonic matter: 5%

### **1. Energy quantity of Dark Energy**

Total energy of Dark energy can be found by taking percentage of total observable energy of our universe.  
  
9.69155 × 1069 J × 68% = 6.59025 × 1069 J  
  
6.37454 × 1069 J × 68% = 4.33469 × 1069 J2. Energy quantity of Dark Matter  
Again, the total energy of dark matter can be derived by taking percentage of total observable energy of our universe.  
  
9.69155 × 1069 J × 27% = 2.61672 × 1069 J  
  
6.37454 × 1069 J × 27% = 1.72113 × 1069 JWe will now find total mass of dark matter by using rearranged Mass-Energy equivalence.  
  
= 2.90747 × 1052 Kg.  
  
= 1.91236 × 1052 Kg

Now we will try to solve for C, again, with a rearranged equation of Mass-Energy equivalence.  
  
X = = C  
  
 X = = 501,847,984m/s

## **Discussion**

### **Thermodynamic Consistency**

* The calculations confirm that the energy and mass distributions of DE and DM align with the laws of thermodynamics (specifically, Mass-Energy equivalence) of DE = DM × C2 in Cepheid/Supernovae-derived Constant.  
    
  Implication
* However, when early-universe derived Hubble constant was used to calculate rate of causality, the result suggests a higher speed of causality than is currently accepted.  
  This finding has significant implication for our understanding of cosmology and modern physics. It is imperative for scientific community to further research this phenomenon.

**References**   
  
1. Planck 2018 results. VI. Cosmological parameters

2. Riess et al., 2019, Large Magellanic Cloud Cepheid Standards Provide a 1% Foundation for the Determination of the Hubble Constant and Stronger Evidence for Physics Beyond LambdaCDM