# Deriving the age of the universe using the heat equation of an infinite rod


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**Abstract:** In this paper, I prove the cosmological evolution of the universe, and the heat equation of the universe, using Infinite Spatial Domains, and an Infinite Rod Thermal Distribution.


The following is the derivation of all matter states based on matter phase state transitions.

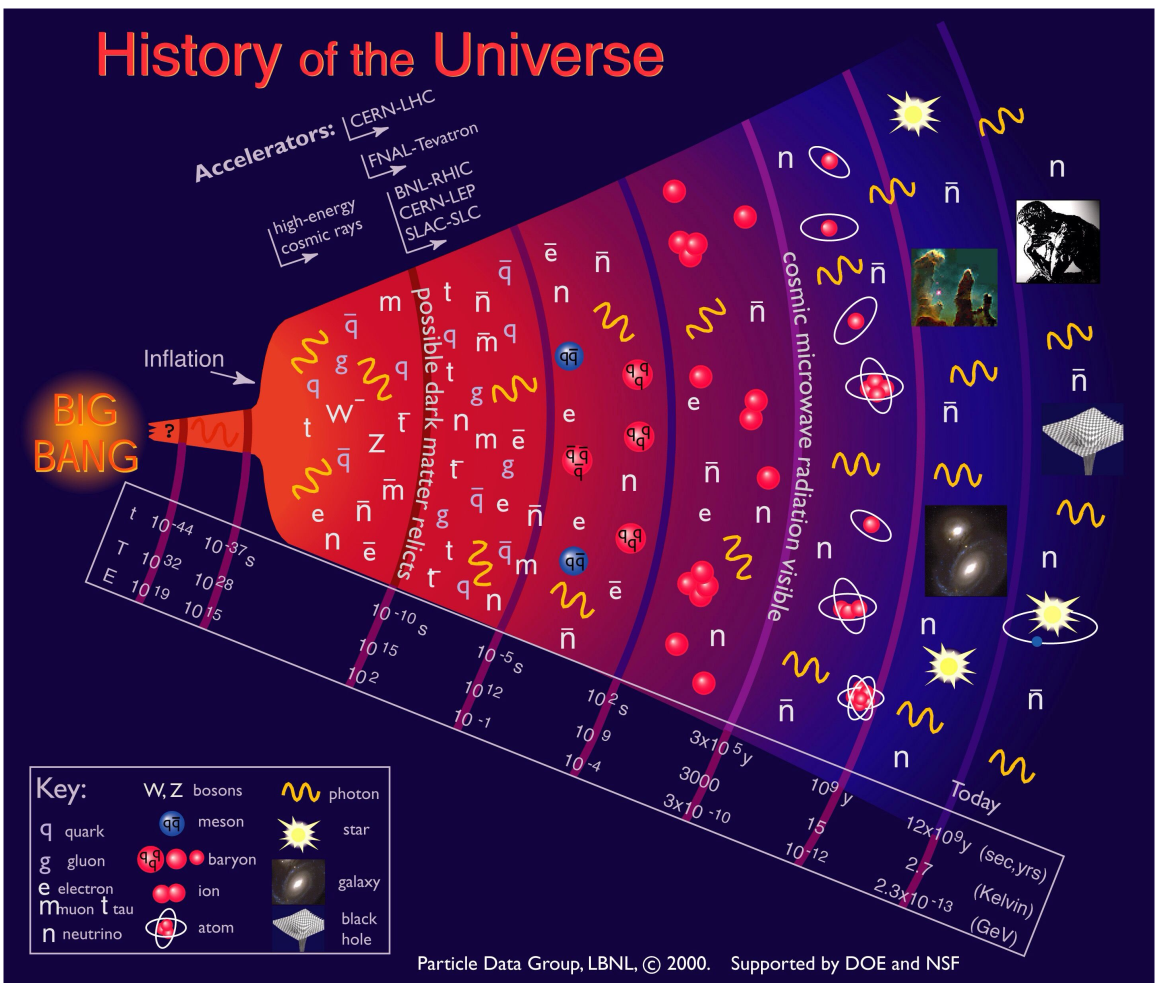


**Fig. 1 the Cosmological Evolution of the Universe.**

*Credit to Particle Data Group for allowing us to use this photo if acknowledged.*

We Begin by solving the Heat Kernel. Which while provide us the solution to study the distribution of heat in the universe. I used the following two papers.
Deriving the Heat Kernel in 1 Dimension by Ophir Gottliev **[1]** and Infinite Spatial Domains and the Fourier Transform by Matthew J. Hancock **[2]**

The solution for the Gaussian heat distribution is as follows:

$$\gamma = \frac{1}{t}$$

$$\alpha = \beta = \frac{1}{\sqrt{t}}$$

$$G(x,t) = \frac{1}{\sqrt{t}} Q(\varepsilon)$$

$$\varepsilon = \frac{x}{\sqrt{t}}$$

$$G_t = k\Delta G$$

$$G_t = -\frac{1}{2} t^{\frac{-3}{2}} Q - \frac{1}{2} t^{\frac{-3}{2}} (t^{\frac{-1}{2}} x) Q'$$

$$G_t = -\frac{1}{2} t^{\frac{-3}{2}} Q - \frac{1}{2} t^{\frac{-3}{2}} (\varepsilon) Q'$$

$$G_t = -\frac{1}{2} t^{\frac{-3}{2}} (Q + \varepsilon Q')$$

$$G_{xx} = t^{\frac{-3}{2}} Q''$$

$$-\frac{1}{2} t^{\frac{-3}{2}} (Q + \varepsilon Q') = k t^{\frac{-3}{2}} Q''$$

$$Q + \varepsilon Q' + 2kQ'' = 0$$

$$(\varepsilon Q)' + 2kQ'' = 0$$

$$\varepsilon Q + 2kQ' = c$$

Now we note that we expect $G(\infty, t) = 0$ . Consequently, we expect $Q' = 0$ as $x \to \infty$ . Therefore c = 0. We have the ODE

$$\varepsilon Q + 2kQ' = 0$$

$$2kQ' = -\varepsilon Q$$

$$Q' = \frac{-\varepsilon Q}{2k}$$

$$\frac{Q}{Q}' = \frac{-\varepsilon}{2k}$$

Integrating and simplifying we get:

$$\ln Q = -\frac{\varepsilon^2}{4k} + C$$

$$Q(\varepsilon) = Ce^{-\frac{\varepsilon^2}{4k}}$$

Where $t = \frac{1}{4k}$ creates the initial function.

$$Q(\varepsilon) = Ce^{-\frac{x^2}{4kt}}$$

As the Velocity Increases the heat radiation diminishes. Where x is the velocity of the matter particle. As the velocity decreases radiation acceptance increases.

$$Q \to x$$

$$x \to Q$$

$$Q(x,t) = \frac{Ce^{-\frac{x^2}{4kt}}}{\sqrt{t}}$$

We can solve for the initial constant as follows.
Given a probability distribution, by conservation of energy and probability theory says that the probability distribution is equal to one when the curve is integrated, we find.

$$\int_{-\infty}^{\infty} Q(x,t) = 1$$

$$\int_{-\infty}^{\infty} \frac{Ce^{-\frac{x^2}{4kt}}}{\sqrt{t}} = 1$$

$$t = \frac{1}{4k}$$

Plugging in for t, and solving for the Gaussian Function we get:

$$\int_{-\infty}^{\infty} \sqrt{4k}Ce^{-x^2} = 1$$

$$\int_{-\infty}^{\infty} e^{-x^2} = \sqrt{\pi}$$

$$\sqrt{4k\pi}C = 1$$

$$C = \frac{1}{\sqrt{4k\pi}}$$

$$Q(x,t) = \frac{e^{-\frac{x^2}{4kt}}}{\sqrt{4kt\pi}}$$

*Johann Carl Friedrich Gauss derived the following expression which we will use to derive the equation that describes the energetic distribution of the entire universe.*

$$f(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{1}{2}\left(\frac{x-\mu}{\sigma}\right)^2}$$

$$u(x,0) = f(x) = \begin{cases} u_0/\varepsilon & |x| \le \varepsilon/2 \\ 0 & |x| > \varepsilon/2 \end{cases}$$

$$u(x,t) = \int_{-\infty}^{\infty} \frac{f(s)}{\sqrt{4k\pi t}} e^{\left(\frac{-(x-s)^2}{4kt}\right)} ds$$

$$= \frac{u_o}{\varepsilon\sqrt{4k\pi t}} \int_{-\varepsilon/2}^{\varepsilon/2} e^{\left(\frac{-(x-s)^2}{4kt}\right)} ds$$

Let,

$$z = (x-s)/\sqrt{4kt}$$

$$-\left(\sqrt{4kt}\right)dz = ds$$

$$u(x,t) = \frac{u_o}{\varepsilon\sqrt{\pi}} \int_{x-\varepsilon/2}^{x+\varepsilon/2} e^{-z^2} dz$$

$$= \frac{u_o}{\varepsilon\sqrt{\pi}} \left[ \int_0^{\frac{x+\varepsilon/2}{\sqrt{4kt}}} e^{-z^2} dz + \int_{\frac{x-\varepsilon/2}{\sqrt{4kt}}}^{0} e^{-z^2} dz \right]$$

$$= \frac{u_o}{\varepsilon\sqrt{\pi}} \left[ \int_0^{\frac{x+\varepsilon/2}{\sqrt{4kt}}} e^{-z^2} dz - \int_0^{\frac{x-\varepsilon/2}{\sqrt{4kt}}} e^{-z^2} dz \right]$$

We can use the definition of Gauss's Error Function to multiply by square root of pie over two.

$$erf(x) = \frac{2}{\sqrt{\pi}} \int_0^x e^{-x^2} dx$$

$$\frac{\sqrt{\pi}}{2} \bullet erf(x) = \int_0^x e^{-x^2} dx$$

Using the definition of the integral we solve:

$$u(x,t) = \frac{u_o}{2\varepsilon} \left[ erf(\frac{x+\varepsilon/2}{\sqrt{4kt}}) - erf(\frac{x-\varepsilon/2}{\sqrt{4kt}}) \right]$$

Using the definition of the Gauss error function:

$$erf(z) = \frac{2z}{\sqrt{\pi}} e^{-z^2}$$

Where the speed of light is used to calculate the energetics of the distribution of heat in the universe.

$$x = c$$
$$\varepsilon = c$$

$$u(x,0) = f(x) = \begin{cases} u_0/\varepsilon & |x| \le \varepsilon/2 \\ 0 & |x| > \varepsilon/2 \end{cases}$$

We get:

$$u(x,t) = \frac{u_o}{\varepsilon\sqrt{4\pi kt}} \left[ (x+\frac{\varepsilon}{2})\exp\left( -\frac{(x+\varepsilon/2)^2}{4kt} \right) - (x-\frac{\varepsilon}{2})\exp\left( -\frac{(x-\varepsilon/2)^2}{4kt} \right) \right]$$

$$= \frac{u_o}{\varepsilon\sqrt{4\pi kt}} \left[ (\frac{\varepsilon}{2}) \left( \exp\left( -\frac{(x+\varepsilon/2)^2}{4kt} \right) + \exp\left( -\frac{(x-\varepsilon/2)^2}{4kt} \right) \right) \right]$$

$$= \frac{u_o}{2\sqrt{4\pi kt}} \left[ \left( \exp\left( -\frac{(x+\varepsilon/2)^2}{4kt} \right) + \exp\left( -\frac{(x-\varepsilon/2)^2}{4kt} \right) \right) \right]$$

Where k is part of an acceleration constant.

$$k = \frac{1}{16\pi}$$

Plugging in for epsilon and x

$$u(x,t) = \frac{u_o}{\sqrt{t}}\left[\left(\exp\left(-\frac{(c+c/2)^2 \bullet 4\pi}{t}\right) + \exp\left(-\frac{(c-c/2)^2 \bullet 4\pi}{t}\right)\right)\right]$$

$$= \frac{u_o}{\sqrt{t}}\left[\left(\exp\left(-\frac{(c^2+c^2+c^2/4)\bullet 4\pi}{t}\right) + \exp\left(-\frac{(c^2-c^2+c^2/4)\bullet 4\pi}{t}\right)\right)\right]$$

$$\frac{u_o}{\sqrt{t}}\left[\left(\exp\left(-\frac{(2c^2+c^2/4)\bullet 4\pi}{t}\right) + \exp\left(-\frac{(c^2/4)\bullet 4\pi}{t}\right)\right)\right]$$

$$= \frac{u_o}{\sqrt{t}}\left[\left(\exp\left(-\frac{(9c^2/4)\bullet 4\pi}{t}\right) + \exp\left(-\frac{(c^2/4)\bullet 4\pi}{t}\right)\right)\right]$$

$$= \frac{u_o}{\sqrt{t}}\left[\left(\exp\left(-\frac{(9c^2/4)\bullet 4\pi}{t}\right) + \exp\left(-\frac{(c^2/4)\bullet 4\pi}{t}\right)\right)\right]$$

$$= \frac{u_o}{\sqrt{t}}\left[\left(\exp\left(-\frac{(9c^2)\bullet \pi}{t}\right) + \exp\left(-\frac{(c^2)\bullet \pi}{t}\right)\right)\right]$$

Which yields, **The Heat Equation of The Universe**

$$u(x,t) = \frac{u_o}{t^{3/2}}\left[\left(\exp\left(-\frac{(9c^2)\bullet \pi}{t}\right) + \exp\left(-\frac{(c^2)\bullet \pi}{t}\right)\right)\right]$$

It is important to note that the time is cubed because we are considering the heat diffusion in 3 dimensions. It is also important to understand that heat and kinetic energy are interchangeable.**[3]** http://hyperphysics.phy-astr.gsu.edu/hbase/Kinetic/maxspe.html#c2

If we plug in the energy of the big bang (which is the square of the speed of light) and the time I calculated for the age of the universe, we can calculate today's Protons Energy.

$$u(x,t) = \frac{u_o}{t^{3/2}}\left[\left(\exp\left(-\frac{(9c^2)\bullet\pi}{t}\right) + \exp\left(-\frac{(c^2)\bullet\pi}{t}\right)\right)\right]$$

In the beginning, the big bang signal started out as light and then it condensed to matter.

$$M_{bigbangparticle} = 1$$

$$M_{bigbangparticle}c^2 = hf_{resonant}$$

$$c^2 = hf_{resonant}$$

$$u_o = c^2 = 299792458^2 = 8.987551787 \bullet 10^{16}$$

$$t = (15.35 \bullet 10^9\, years)(365 days)(24 hours)(3600 \sec onds)$$

$$= 4.840776 \bullet 10^{17} \sec$$

$$\frac{u_0}{t^{3/2}} = 2.66851 \bullet 10^{-10}$$

$$\exp\left(\frac{-9c^2\pi}{t}\right) = 5.25009 \bullet 10^{-3}$$

$$\exp\left(\frac{-c^2\pi}{t}\right) = 5.58066 \bullet 10^{-1}$$

**In 15.35 Billion years the energy of the particles cooled down throughout the age of the universe to:**

$$u(x,t) = 1.50321 \bullet 10^{-10}\, joules$$

**The energy of a proton today is:**

$$m_{proton} = 1.6726219 \bullet 10^{-27}\, kg$$

$$c^2 = 299792458^2 = 8.987551787 \bullet 10^{16}$$

$$m_{proton}c^2 = 1.503277595 \bullet 10^{-10}\, joules$$

The cosmic microwave background radiation shows that the energy is isotropic. This is due to the evolution of matter particles made of light that evolved from the big bang.

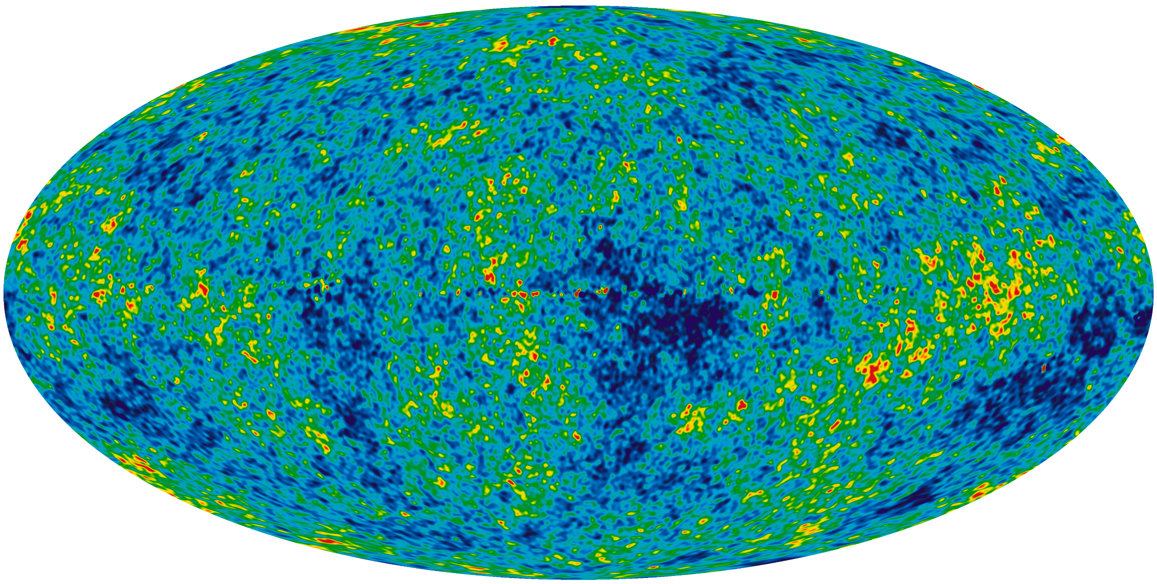

**Fig. 2: The Cosmic Microwave Background**

Recent experiments show that matter can be made from light. **[4]**
Another proof is found in my paper. If there was another epsilon derivation for energetic distribution the kinematics of the universe would not work. **[5]**

$$\varepsilon = \frac{x}{\sqrt{t}}$$

**Data Availability:**

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

**References:**


1. Ophir Gottliev, 3/20/2007, Deriving the Heat Kernel in 1 Dimension
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5. David Eduardo Toro, 2021, Derivation of Galilean and Newtonian Mechanics with Infinite Energy Distributions.