# Planck Dimensional Analysis of The Speed of Light

Espen Gaarder Haug*
Norwegian University of Life Sciences

June 4, 2017

**Abstract**

This is a short note to show how the speed of light $c$ can be derived from dimensional analysis from the Gravitational constant, the Planck constant and the Planck length.

**Key words:** The speed of light, Big G, Planck constant, Planck lenght, Dimensional analysis.

## 1 Dimensional Analysis

Here we will find the speed of light $c$ from the Planck length $l_p$ (see [1]), and the reduced Planck constant $\hbar$ and the gravitational constant $G$ by using dimensional analysis. The dimensions of $c$ and the three other constants are

$$[c] = \frac{L}{T}$$

$$[G] = \frac{L^3}{MT^2}$$

$$[\hbar] = M\frac{L^2}{T}$$

$$[l_p] = L$$

Based on this, we have

$$\begin{aligned} c &= l_p^{\alpha} G^{\beta} \hbar^{\gamma} \\ \frac{L}{T} &= L^{\alpha} \left(\frac{L^3}{MT^2}\right)^{\beta} \left(M\frac{L^2}{T}\right)^{\gamma} \end{aligned} \tag{1}$$

Based on this, we obtain the following three equations

$$\text{Lenght}: \quad 1 = \alpha + 3\beta + 2\gamma \tag{2}$$

$$\text{Mass}: \quad 0 = -\beta + \gamma \tag{3}$$

$$\text{Time}: \quad -1 = -2\beta - \gamma \tag{4}$$

This gives us

$$\alpha = -\frac{2}{3}$$

$$\beta = \frac{1}{3}$$

$$\gamma = \frac{1}{3}$$

which means

*e-mail espenhaug@mac.com. Thanks to Victoria Terces for helping me edit this manuscript.

$$c = \frac{(G\hbar)^{\frac{1}{3}}}{l_p^{\frac{2}{3}}} = 299792458 \text{ m/s} \tag{5}$$

Haug [2, 3, 4] has suggested that Newton's gravitational constant (Big $G$) [5] can be written as

$$G = \frac{l_p^2 c^3}{\hbar}$$

and we see from this that

$$c = \frac{(\frac{l_p^2 c^3}{\hbar}\hbar)^{\frac{1}{3}}}{l_p^{\frac{2}{3}}} = \frac{(l_p^2 c^3)^{\frac{1}{3}}}{l_p^{\frac{2}{3}}} = c \tag{6}$$

# References


[1] M. Planck. *The Theory of Radiation*. Dover 1959 translation, 1906.

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