Planck Units and Their Significance

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Planck units are derived from physical constants in the universe. The quantities associated with each Planck unit are important in demonstrating the quantization of mass, distance, and time, as well as the limits of modern theories in physics, such as general relativity and quantum mechanics.

1 Planck Units and Constants

Three important natural constants from which Planck units are derived are the following [1, 2, 5, 9, 10]:

Description	Symbol	Value
Speed of Light	c	$299,297,458m/s$
Gravitational Constant	G	$6.67428 \cdot 10^-11m^3/kg \cdot s^2$
Planck's Constant	$\hbar$	$1.0545 \cdot 10^-34m^2kg/s$

Combining these constants results in Planck units for length, mass, and time [1, 2, 9, 10]:

Description	Symbol	Value
Planck length	l_p	$\sqrt{\frac{\hbar \cdot G}{c^3}}$
Planck mass	m_p	$\sqrt{\frac{\hbar \cdot c}{G}}$
Planck time	t_p	$\sqrt{\frac{\hbar \cdot G}{c^5}}$

There are also other dimensions that can be calculated using natural constants, such as energy (E_p) [2, 8]. All of the resulting Planck units are the smallest possible units of their respective dimensions; while time, space, and matter may appear continuous to an observer, according to Planck values the universe functions in small, indivisible quantities [2, 4]. Such a division of a continuous sequence into discrete values is called quantization, a phenomenon which Max Planck, the namesake of the Planck constant and set of units, observed while studying blackbody radiation [2, 4, 7].

2 Planck Units and Dimensionality

When performing calculations at Planck scales, the units of the physical constants can all become equal to one, resulting in $c = G = \hbar = 1$ [3, 5, 10]. If these quantities are set equal to one, the dimensions of the unit disappear and the quantities become dimensionless numerical values [3, 4, 5, 10].

3 Planck Scales and Theoretical Physics

There are some theories in physics that propose the Planck scale is the point at which quantum mechanics and gravity converge [8]. It has been suggested that quantum field theory and general relativity, two theories that predict different physical phenomena at different scales, may reconcile at Planck scales, perhaps producing interactions governed by quantum gravity, for which there is no observational evidence due to the extremely small distances predicted by l_p [6]. In fact, due to the resolving power of technology, interactions at Planck scales may never be directly observed [6]. However, due to such miniscule scales, the mathematics of Planck unit calculations offer an interesting perspective on what may be a pivotal point for new and developing physics theories, since the fact that there is not a widely-recognized theory that combines relativity and quantum mechanics is a major unsolved problem in physics [6, 8].

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