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A Precise and Exact Gamow's Formula Adapted to the Classical Mechanics Context of the Rh=ct Thermodynamic Quantum Cosmology

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A Precise and Exact Gamow's Formula Adapted to the Classical Mechanics Context of the Rh=ct Thermodynamic Quantum Cosmology

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Abstract

We propose to heuristically fix the constant radiation of Gamow formula, which we then demonstrate, to adapt it consistently to the Rh=ct thermodynamic quantum cosmology witch is in the field of classic mechanics at any cosmic time t_{Rh}=1/H where H is the Hubble parameter. It has the potential to offer an alternative theoretical framework in which the validity of Gamow's formula could be reevaluated and tested.

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1. Introduction

Einstein said about thermodynamics: "A theory is the more impressive the greater the simplicity of its premises is, the more different kinds of things it relates, and the more extended is its area of applicability. Therefore, the deep impression which classical thermodynamics made upon me. It is the only physical theory of universal content concerning which I am convinced that within the framework of the applicability of its basic concepts, it will never be overthrown." [1]

Gamow's formula continues to serve as a foundational instrument in comprehending primordial nucleosynthesis and the chemical evolution of the universe. Its implementation in the rh=ct quantum thermodynamic cosmological model has the potential to provide novel insights and encourage a reevaluation of established parameters in cosmology. Despite the fact that the rh=ct model has not yet achieved universal acceptance, it has the potential to offer an alternative theoretical framework in which the validity of Gamow's formula could be reevaluated and tested.

2. Background

In 2015, Tatum et al. [2] proposed an equation for the CMB temperature, noted T_{cmb}, that has since been formally derived from the Stefan-Boltzmann law by Haug and Wojnow [3,4].

$$T_{cmb} = T_{Rh} = \frac{\hbar c}{k_b 4\pi\sqrt{R_h 2l_{Pl}}} \tag{1}$$

Witch can be derived as follows:

$$T_{cmb} = T_{Rh} = \frac{\hbar}{k_b 4\pi\sqrt{t_{Rh}\, 2t_{Pl}}} \tag{2}$$

Where $\hbar$ is the reduced Planck constant, c is the speed of light in a vacuum, k_b is Boltzmann's constant, the Hubble radius is defined by $R_h = \frac{c}{H}$ where H is the Hubble parameter, T_{Rh} is the temperature of the Hubble sphere, l_{Pl} is the Planck length, t_{Rh} is the Hubble time defined by $t_{Rh} = \frac{1}{H}$, and t_{Pl} is the Planck time.

From Eq.2 we derive directly:

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$$t_{Rh} = \frac{\hbar^2}{T_{cmb}^2 k_b^2 16\pi^2 2 t_{Pl}} \quad (3)$$

We simply assume that before and after the appearance of the CMB, i.e., the Cosmic Microwave Background temperature, is the temperature of the Hubble sphere, T_{Rh}:

$$t_{Rh} = \frac{\hbar^2}{T_{Rh}^2 k_b^2 16\pi^2 2 t_{Pl}} \quad (4)$$

Subsequently, we will make a partial return to the exemplary work of E. G. Haug, as illustrated by equation 4 of this preprint [5].

$$H^2 = \frac{8\,\pi\, G\,\rho_c}{3} = \frac{8\,\pi\, G\, a_b\, T_{Rh}^4}{3\, c^2} \quad (5)$$

Where G is the gravitational constant, ρ_c is the critical density, expressed in volumetric mass for an universe with no cosmological constant and zero spatial curvature, i.e., when ρ_c is given by Friedemann [6] equation , and $a_b = 4\sigma = \frac{\pi^2 k_b^4}{15\, c^3\, \hbar^3}$ is the constant radiation.

2. Heuristic Formula of Constant Radiation and Its Demonstration in Gamow Formula in Accordance with Rh=ct Thermodynamic Quantum Cosmology

The first part of the work had consisted of searching for constant numbers to adapt a_b at the Eq.5 when $H = \frac{1}{t_{Rh}}$. In this particular context, it is imperative to underscore the utilization of the interdependent equations 2 and 4. We found:

$$a_b = \frac{3 * 128\, \pi^3\, k_B^4}{c^3\, \hbar^3} \quad (6)$$

With Eq.2 and Eq.6, we derive Eq.5 as follows:

$$H^2 = \frac{8\,\pi\, G * 3 * 128\, \pi^3\, k_B^4\, \hbar^4}{3\, c^2\;\; c^3\, \hbar^3\;\; k_B^4\, 4^4\, \pi^4\, t_{Rh}^2\, 2^2\, t_{Pl}^2} \quad (7)$$

Given that 128 multiplied by 8 equals 1024 and 4^4 multiplied by 2^2 equals 1024, Eq.7 can be simplified as follows:

$$H^2 = \frac{G\, k_B^4\, \hbar^4}{c^5\, \hbar^3\;\; k_B^4\;\, t_{Rh}^2\;\, t_{Pl}^2} \quad (8)$$

Then we simplified Eq.8 as follows:

$$H^2 = \frac{G\;\, \hbar}{t_{Rh}^2\;\, c^5\;\, t_{Pl}^2} \quad (9)$$

Since $t_{Pl} = \sqrt{\frac{\hbar\, G}{c^5}}, t_{Pl}^2 = \frac{G\,\hbar}{c^5}$ so Eq.9 is equals to:

$$H^2 = \frac{1}{t_{Rh}^2} \quad (9)$$

i.e. $H = \frac{1}{t_{Rh}}$, by definition.

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3. Conclusion

We have proved the validity of our formula in this Rh=ct thermodynamic quantum cosmology in the domain of classical mechanics. The next step will consist of verifying the validity of this adaptation in the work of E.G. Haug [7] which is close to the correct evaluation of BBN abondance of light elements or for example by the tunnel effect adapted to our thermodynamic quantum cosmology model.

References

1. Albert Einstein, Stephen W. Hawking (2007). "A Stubbornly Persistent Illusion: The Essential Scientific Works of Albert Einstein", p.353, Running Press
2. Tatum, E., Seshavatharam, U. and Lakshminarayana, S. (2015) The Basics of Flat Space Cosmology. International Journal of Astronomy and Astrophysics, 5, 116-124. https://www.scirp.org/journal/PaperInformation?PaperID=57071.
3. Espen Gaarder Norwegian University of Life Sciences Haug, Stéphane Wojnow. How to predict the temperature of the CMB directly using the Hubble parameter and the Planck scale using the Stefan-Boltzman law. 2023. ⟨hal-04269991⟩
4. Haug, E.G. CMB, Hawking, Planck, and Hubble Scale Relations Consistent with Recent Quantization of General Relativity Theory. *Int J Theor Phys* **63**, 57 (2024). https://doi.org/10.1007/s10773-024-05570-6.
5. Haug, E. (2025). The Gamow (1948) Temperature Formula, Adjusted for the CMB Photon Density Parameter, Predicts the CMB Temperature Now and in the Past. Cambridge Open Engage. doi:10.33774/coe-2025-jlff7
6. A. Friedmann. Über die krüng des raumes. Zeitschrift für Physik, 10:377, 1922. https://doi.org/10.1007/BF01332580
7. Haug, E. (2025). Does Nucleosynthesis in a New Thermodynamic R_{H_t} = ct Cosmology Solve the Lithium Problem? Cambridge Open Engage. doi:10.33774/coe-2025-l266q