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The Hubble Sphere Radiation Pressure Law is Consistent With the Cosmological Redshift $z = \sqrt{\frac{R_H}{R_t}} - 1$

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Abstract: Haug and Wojnow [1] have recently demonstrated that there exists a law for the Hubble sphere very similar to the Ideal Gas Law, which they have called the Hubble Sphere Radiation Pressure Law. In this paper, we will demonstrate that the Haug and Tatum cosmological redshift: $z = \sqrt{\frac{R_H}{R_{H,t}}} - 1$ can be derived from their framework.

Keywords: cosmological redshift; ideal gas law; hubble sphere; hubble pressure law; ideal gass constant

1. Introduction

Haug and Wojnow [1] have demonstrated a law similar to the ideal gass law is consistent with the Hubble sphere in certain subgroups of $R_H = ct$ cosmology, their Hubble pressure law is given by:

$$P_{c,t}V_{H_t} = n_{H_t}RT_t = N_{H_t}k_bT_t \tag{1}$$

where R is the ideal gas constant, $P_{c,t} = \frac{3H_t^2c^2}{8\pi G}$ is Hubble radiation pressure. $V_{H_t} = \frac{4}{3}\pi R_{H,t}^3 = \frac{4}{3}\pi\frac{c^3}{H_t^3}$ is the Hubble sphere volume. Further, $N_{H,t} = \frac{E_c}{E_{cmb}}$, where $E_c = \frac{c^5}{2GH_t}$ is the critical Friedmann energy and $E_{cmb,t} = k_bT_t$ is the energy of the CMB temperature at time t. Also, we follow the $R_{H,t} = ct$ principle, where then $H_t = \frac{1}{t}$. Further, $n_{H,t} = \frac{N_{H,t}}{N_A}$, where N_A is Avogadro's constant.

Further, Haug and Wojnow have demonstrated that in $R_{H,t} = ct$ black hole cosmology, we obtain consistency with the CMB temperature formula: $T_0 = \frac{T_p}{8\pi}\sqrt{\frac{2l_p}{R_{H,t}}}$, where $T_p = \frac{1}{k_b}\sqrt{\frac{\hbar c^5}{G}} = \frac{m_pc^2}{k_b}$ is the Planck [2,3] temperature, and $l_p = \sqrt{\frac{G\hbar}{c^3}}$ is the Planck length (see [4–7] for the CMB temperature formula itself). This CMB temperature formula can predict the CMB temperature at present, something the Λ-CDM model cannot do. This leads to the following relation to the ideal gas constant:

$$R = \frac{mass \times length^2}{amount \times temperature \times time^2} = \frac{M_{c,t} \times R_t^2}{n_H \times T_t \times t_t^2} \tag{2}$$

where $M_{c,t} = \frac{c^3}{2GH_t}$ is the critical mass, $R_{H,t} = \frac{c}{H_t}$ is the Hubble radius and $t_{H,t} = \frac{1}{H_t}$ is the Hubble time, and $n_H = \frac{M_{c,t}c^2}{E_{cmb}} = \frac{M_{c,t}}{m_{cmb}}$, where $E_{cmb} = k_bT_t$, this all in a universe where we have $R_{H,t} = ct$, so we get:

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$$
\begin{aligned}
R &= \frac{M_{c,t} \times R_{H,t}^2}{n_H \times T_t \times t_{H,t}^2} \\
R &= \frac{\frac{c^3}{2GH_t} \times \frac{c^2}{H_t^2}}{\frac{N_H}{N_A} \times T_t \times \frac{1}{H_t^2}} \\
1 &= \frac{\frac{c^5}{2GH_t}}{N_H \frac{R}{N_A} T_t} \\
1 &= \frac{E_t}{\frac{E_t}{E_{cmb,t}} k_b T_t} \\
1 &= \frac{E_{cmb,t}}{k_b T_t} \qquad (3)
\end{aligned}
$$

Next we take advantage of the observed relation that we have $T_t = T_0(1+z)$ see [8–10]. So replacing T_t with $T_0(1+z)$ we get:

$$
\begin{aligned}
1 &= \frac{E_{cmb,t}}{k_b T_0(1+z)} \\
z &= \frac{E_{cmb,t}}{E_{cmb,0}} - 1 \qquad (4)
\end{aligned}
$$

Further $E_{cmb,0} = k_b T_0 = \frac{E_p}{8\pi}\sqrt{\frac{2l_p}{R_{H,0}}}$ and $E_{cmb,t} = k_b T_t = \frac{E_p}{8\pi}\sqrt{\frac{2l_p}{R_{H,t}}}$, where $E_p = \sqrt{\frac{\hbar c^5}{G}}$ is the Planck energy, this leads to:

$$
\begin{aligned}
z &= \frac{\frac{E_p}{8\pi}\sqrt{\frac{2l_p}{R_{H,t}}}}{\frac{E_p}{8\pi}\sqrt{\frac{2l_p}{R_{H,0}}}} - 1 \\
z &= \sqrt{\frac{R_H}{R_{H,t}}} - 1 \qquad (5)
\end{aligned}
$$

Which is the cosmological redshift first presented by Haug and Tatum [11], which they have demonstrated can be used to match the full distance ladder of SN Ia with a single value of H_0. In other words, it has been used to resolve the Hubble tension. This paper also demonstrates that their redshift is fully consistent with the Hubble sphere radiation pressure law presented by Haug and Wojnow.

2. Conclusions

We have demonstrated that the Hubble sphere radiation pressure law, which is linked to the ideal gas law, is consistent with the cosmological redshift of Haug and Tatum: $z = \sqrt{\frac{R_H}{R_{H,t}}} - 1$, and that this is yet another important piece falling into place in the development of $R_{H,t} = ct$ cosmology. Black hole $R_{H,t} = ct$ cosmology seems robust in addition to outperforming the Λ-CDM model on a series of points (see [12]).

References

1. E. G. Haug and S. Wojnow. Application of the ideal gas law to the hubble sphere leads to a new hubble sphere radiation pressure law. *Cambridge engage, pre-print*, 2025. URL https://www.cambridge.org/engage/coe/article-details/679c7c8dfa469535b987c3fb.

2. M. Planck. *Natuerliche Masseinheiten*. Der Königlich Preussischen Akademie Der Wissenschaften: Berlin, Germany, 1899. URL https://www.biodiversitylibrary.org/item/93034#page/7/mode/1up.
3. M. Planck. *Vorlesungen über die Theorie der Wärmestrahlung*. Leipzig: J.A. Barth, p. 163, see also the English translation "The Theory of Radiation" (1959) Dover, 1906.
4. E. T. Tatum, U. V. S. Seshavatharam, and S. Lakshminarayana. The basics of flat space cosmology. *International Journal of Astronomy and Astrophysics*, 5:116, 2015. URL http://dx.doi.org/10.4236/ijaa.2015.52015.
5. E. G. Haug. CMB, Hawking, Planck, and Hubble scale relations consistent with recent quantization of general relativity theory. *International Journal of Theoretical Physics, Nature-Springer*, 63(57), 2024. URL https://doi.org/10.1007/s10773-024-05570-6.
6. E. G. Haug and S. Wojnow. How to predict the temperature of the CMB directly using the Hubble parameter and the Planck scale using the Stefan-Boltzman law. *Journal of Applied Mathematics and Physics*, 12:3552, 2024. URL https://doi.org/10.4236/jamp.2024.1210211.
7. E. G. Haug and E. T. Tatum. The hawking Hubble temperature as a minimum temperature, the Planck temperature as a maximum temperature and the CMB temperature as their geometric mean temperature. *Journal of Applied Mathematics and Physics*, 12:3328, 2024. URL https://doi.org/10.4236/jamp.2024.1210198.
8. I. de Martino and et. al. Measuring the redshift dependence of the cosmic microwave background monopole temperature with Planck data. *The Astrophysical Journal*, 757:144, 2012. URL https://doi.org/10.1103/PhysRevE.108.044112.
9. L. Yunyang. Constraining cosmic microwave background temperature evolution with Sunyaev–Zel'dovich galaxy clusters from the ATACAMA cosmology telescope. *The Astrophysical Journal*, 922:136, 2021. URL https://doi.org/10.3847/1538-4357/ac26b6.
10. D.A. Riechers, A. Weiss, and F. et al. Walter. Microwave background temperature at a redshift of 6.34 from H_2O absorption. *Nature*, 602:58, 2022. URL https://doi.org/10.1038/s41586-021-04294-5.
11. E. G. Haug and E. T. Tatum. Solving the Hubble tension using the PantheonPlusSH0ES supernova database. *Accepted and forthcoming Journal of Applied Mathematics and Physics, vol 13, no. 2*, 2025.
12. E. G. Haug and E. T. Tatum. How a new type of $R_h = ct$ cosmological model outperforms the Λ-CDM model in numerous categories and resolves the Hubble tension. *preprints.org*, 2024. URL https://doi.org/0.20944/preprints202410.1570.v1.