Vitruvian Cogitationes - RVC

The error of John Horgan: the author of the prediction of 3 K temperature of the Universe was McKellar and not McCullough

El error de John Horgan: el autor de la predicción de la temperatura de 3 K del Univreso era McKellar e no McCullough

O erro de John Horgan: o autor da predição da temperatura de 3 k do universo era McKellar e não McCullough

Marcos Cesar Danhoni Neves
Universidade Estadual de Maringá – UEM; macedane@yahoo.com
https://orcid.org/0000-0002-3724-5373

Daniel Gardelli
Universidade Estadual de Maringá – UEM; dgardelli2@uem.br
https://orcid.org/0000-0002-7832-9645

Ricardo Francisco Pereira
Universidade Estadual de Maringá – UEM; ricardoastronomo@gmail.com
https://orcid.org/0000-0001-7540-6601

Josie Agatha Parrilha da Silva
Universidade Estadual de Ponta Grossa – UEPG; japsilva@uepg.br
https://orcid.org/000-0002-8778-6792

Wilson Guerra
Universidade Estadual de Maringá – UEM; wilsonguerra@gmail.com
https://orcid.org/0000-0001-6462-9682

Ana Claudia Danhoni Neves
Universidade Tecnológica Federal do Paraná – UTFPR, anadanhoni@gmail.com
https://orcid.org/0009-0005-3888-2349

Resumo: Esta breve comunicação foi escrita no interesse do Ensino de Astronomia e da divulgação da ciência astronômica para corrigir uma informação presente no popular livro de John Horgan (originalmente publicado em 1996), *The end of science: facing the limits of knowledge in the twilight of the science age*, a respeito da previsão da temperatura da radiação

Vitruvian Cogitationes, Maringá, v. 5, n. 1, p. 23-30, 2024 │ISSN 2675-9616
DOI: https://doi.org/10.4025/rvc.v5i1.71182

cósmica de fundo (CBR) antes de Arno Penzias e Robert Wilson. Horgan citou Andrew McCullough. O nome correto é Andrew McKellar. Outro erro é o ano da publicação do artigo de McKellar: 1940 (na revista *Astronomical Society of the Pacific*) e não 1941, como Horgan havia citado em seu livro. Também são discutidas as previsões mais precisas da temperatura da CBR realizadas antes de Penzias & Wilson usando um modelo de Universo não-Big Bang.
Palavras-chave: Ensino de Astronomia, Horgan, McKellar, Temperatura de 3 K, predições.

Resumen: *Esta breve comunicación fue escrita en interés de la enseñanza de la Astronomía y la difusión de la Ciencia de la Astronomía para corregir una información presente en el popular libro escrito por John Horgan (originalmente publicado en 1996), The end of science: facing the limits of knowledge in the twilight of the science age, respect a la previsión de la temperatura cósmica de fondo CBR anterior a Arno Penzias y Robert Wilson. Horgan citó a Andrew McCullough. El nombre correcto es Andrew McKellar. Otro error es el año de publicación del artículo de McKellar: 1940 (en la revista Astronomical Society of the Pacific) y no 1941 como cita Horgan en su libro. También se discuten las buenas predicciones de la temperatura CBR hechas antes de que Penzias & Wilson usaran un modelo del Universo que no aquel del Big Bang.*
Palabras-clave: *Enseñanza de la Astronomía, Horgan, McKellar, Temperatura de 3 K, predicciones.*

Abstract: *This short communication was written to the interest of the Astronomy teaching or the dissemination of the Astronomy Science to correct an information present in the popular book wrote by John Horgan (originally in 1996),* The end of science: facing the limits of knowledge in the twilight of the science age*, respect to the prevision of the CBR temperature prior to Arno Penzias and Robert Wilson. Horgan quoted Andrew McCullough. The correct name is Andrew Mckellar. Another error is the year of the publication of the McKellar's paper: 1940 (in the* Astronomical Society of the Pacific journal*) and not 1941 as he quoted in his book. It is also discussed the good predictions of the CBR temperature made prior to Penzias & Wilson using a not Big Bang's model of the Universe.*
Keywords: *Astronomy teaching, Horgan, McKellar, 3K temperature, predictions.*

1 INTRODUCTION

The aim of this paper is to correct an information present in the book wrote by John Horgan, originally in 1996: *The end of science: facing the limits of knowledge in the twilight of the science age*. In the chapter titled, *The end of Cosmology*, *Horgan wrote*, respect to a Canadian astronomer that made a correct prevision of the CBR temperature prior to Arno Penzias and Robert Wilson. Horgan quoted *Andrew McCullough*, but the correct name of the astronomer was *Andrew Mckellar*. Another error in the original edition of the book was the year of the publication of the McKellar's paper: 1940 (in the *Astronomical Society of the Pacific* journal) and not 1941 as he quoted in Horgan's book.

In the edition of 2016, Horgan corrected these misinformation but he did not make an alert to the readers of the past editions of his book.

Vitruvian Cogitationes, Maringá, v. 5, n. 1, p. 23-30, 2024 │ISSN 2675-9616
DOI: https://doi.org/10.4025/rvc.v5i1.71182

2 HORGAN'S MISINFORMATION ABOUT MCKELLAR

Unfortunately, the chapter dedicated to the Cosmology (*The end of Cosmology*) is an acid critic against the person of Fred Hoyle and his theory about the stationary Universe. The narration of a meeting with Hoyle and Dicke, Horgan wrote, in the original edition of 1996 (and present in the Portuguese translation made in Brazil):

> Hoyle also seemed obsessed with how close he had come to discovering the cosmic microwave background. It was 1963, and during an astronomy conference Hoyle fell into a conversation with Robert Dicke, a physicist from Princeton who was planning to search for the cosmic microwaves predicted by the big bang model. Dicke told Hoyle that he expected the microwaves to be about 20 degrees above absolute zero, which is what most theorists were predicting. Hoyle informed Dicke that in 1941, a Canadian radio astronomer named Andrew McCullough had found interstellar gas radiating microwaves at 3 degrees, not 20.
> To Hoyle's everlasting regret, neither he nor Dicke, during their conversation, spelled out the implication of McCullough's finding: that the microwave background might be 3 degrees. "We just sat there drinking coffee," Hoyle remembered, his voice rising. "If either of us had said, 'Maybe it *is* 3 degrees,' we'd have gone straightaway and checked it, and then we'd have had it in 1963." A year later, just before Dicke turned on his microwave experiment, Arno Penzias and Robert Wilson of Bell Laboratories discovered the 3-degree microwave radiation, and achievement for which they later received the Nobel Prize. "I've always felt that was one of the worst misses of my life," Hoyle sighed, shaking his head slowly" (Horgan, 1996; 1998, p. 139).

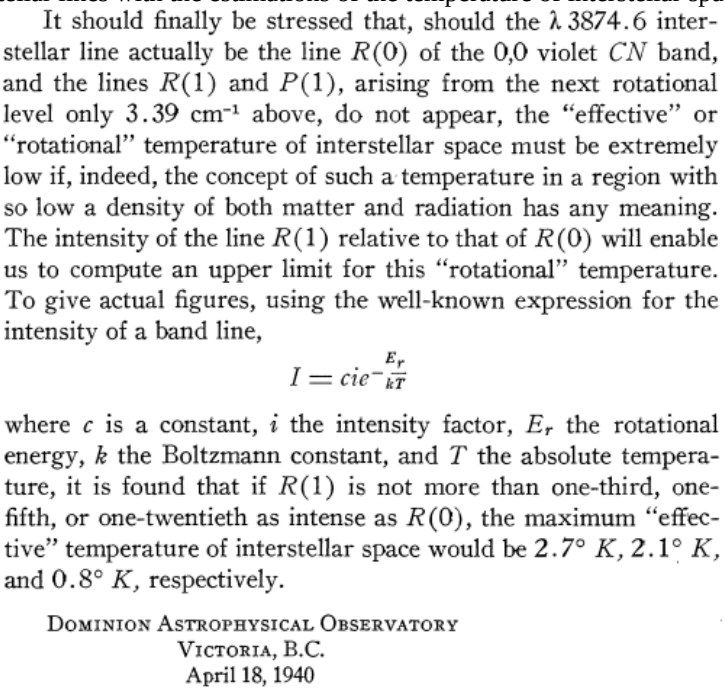
Assis & Neves (2008) mentioned correctly McKellar prediction by means of a quotation of Herzberg (1941). They wrote:

> Here we would like to mention briefly the work of Herzberg in 1941 (based on observations made by A. McKellar) discussing cyanogen measurements in interstellar space. Herzberg found a temperature of 2.3 K characterizing the observed degree of excitation of the CN molecules if they were in equilibrium in a heat bath (Herzberg): "The observation that in interstellar space only the very lowest rotational levels of CH, CH+, and CN are populated is readily explained by depopulation of the higher levels by emission of the far infrared rotation spectrum (see p. 43) and by the lack of excitation to these levels by collisions or radiation. The intensity of the rotation spectrum of CN is much smaller than that of CH or CH+ on account of the smaller dipole moment as well as the smaller frequency [due to the factor v4 in (I, 48)]. That is why lines from the second lowest level (K = 1) have been observed for CN. From the intensity ratio of the lines with K = 0 and K = 1, a rotational temperature of 2.3 K follows, which has of course only a very restricted meaning". Obviously, there is a great meaning in this result, although it was not recognized by Herzberg. This is discussed by Sciama (1971). It should only be stressed that once more, this result was not obtained utilizing the Big Bang cosmology (Assis; Neves, 1995; 2008).

We found the original work of McKellar, in the *Astronomical Society of the Pacific* journal, as showed in Figure 1.

Vitruvian Cogitationes, Maringá, v. 5, n. 1, p. 23-30, 2024 │ISSN 2675-9616
DOI: https://doi.org/10.4025/rvc.v5i1.71182

Figure 1 – Final part of the McKellar work about the evidence for the molecular origin of some hitherto unidentified interstellar lines with the estimations of the temperature of interstellar space: 2.7K, 2.1K, 0,8K



It should finally be stressed that, should the λ 3874.6 interstellar line actually be the line $R(0)$ of the 0,0 violet CN band, and the lines $R(1)$ and $P(1)$, arising from the next rotational level only 3.39 cm^{-1} above, do not appear, the "effective" or "rotational" temperature of interstellar space must be extremely low if, indeed, the concept of such a temperature in a region with so low a density of both matter and radiation has any meaning. The intensity of the line $R(1)$ relative to that of $R(0)$ will enable us to compute an upper limit for this "rotational" temperature. To give actual figures, using the well-known expression for the intensity of a band line,

$$I = cie^{-\frac{E_r}{kT}}$$

where c is a constant, i the intensity factor, E_r the rotational energy, k the Boltzmann constant, and T the absolute temperature, it is found that if $R(1)$ is not more than one-third, one-fifth, or one-twentieth as intense as $R(0)$, the maximum "effective" temperature of interstellar space would be 2.7° K, 2.1° K, and 0.8° K, respectively.

DOMINION ASTROPHYSICAL OBSERVATORY
VICTORIA, B.C.
April 18, 1940

Source: McKellar (1940).

When Assis & Neves, wrote the first paper about the estimations of the temperature of the Universe in 1993, during an International Conference at Princeton about Cosmology and the Physics of Plasma, they summarized some important physicists that predicted the temperature of the space, as we can see in the Table 1:

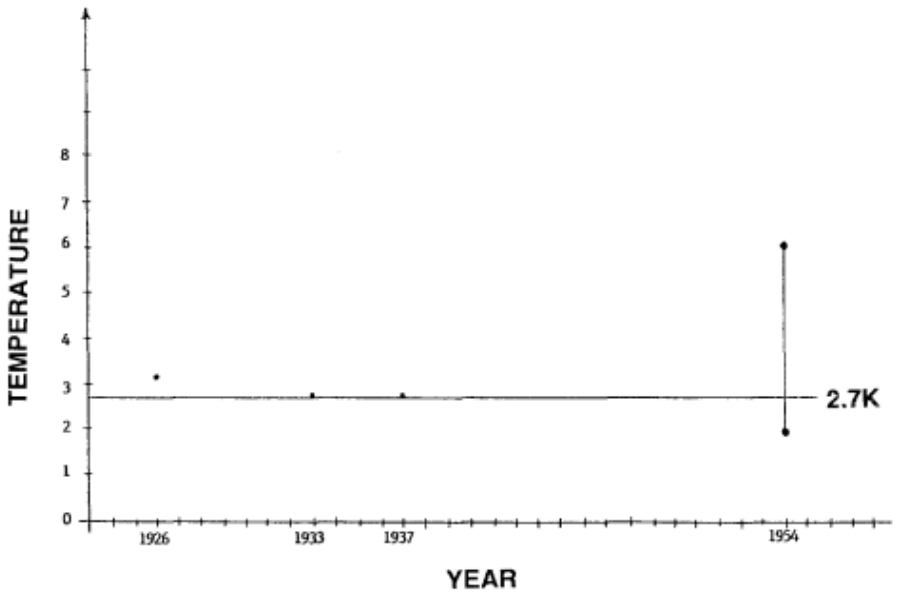
Table 1 – Predictions of the temperature of the CBR according to different models of the Universe and different authors

year	stationary universe	big bang	temperature
1926	Eddington		3.2 K
1933	Regener		2.8 K
1937	Nernst		2.8 K
1949		Alpher and Hermann	$T \geq 5$ K
1953		Gamow	7 K
1954	Finlay-Freundlich		1.9 $K \leq T \leq 6.0$ K
1961		Gamow	50 K

Source: Assis; Neves (1995a).

Vitruvian Cogitationes, Maringá, v. 5, n. 1, p. 23-30, 2024 | ISSN 2675-9616
DOI: https://doi.org/10.4025/rvc.v5i1.71182

Figure 2 – Estimations of the temperature of the space by Assis & Neves.



Source: Assis; Neves (1995a).

Two years after this international Conference, Assis & Neves (1995b) published in *Apeiron* journal, a more detailed history of the predictions quoted the works of McKellar (1940) and Herzberg (1941). They discovered an impressive early estimation of the temperature of the space made by Guillaume in 1896! Guillaume wrote in his paper entitled:

> We conclude that the radiation of the stars alone would maintain the test particle we suppose might have been placed at different points in the sky at a temperature of 338/60 = 5.6 abs. = 207º.4 centigrade. We must not conclude that the radiation of the stars raises the temperature of the celestial bodies to 5 or 6 degrees. If the star in question already has a temperature that is very different from absolute zero, its loss of heat is much greater. We will find the increase of temperature due to the radiation of the stars by calculating the loss using Stefan's law. In this way we find that for the Earth, the temperature increase due to the radiation of the stars is less than one hundred-thousandth of a degree. Furthermore, this figure should be regarded as an upper limit on the effect we seek to evaluate (Guillaume a*pud* Assis; Neves, 1995b).

After nearly three decades, Eddington, wrote in his book entitled *The Internal Constitution of the Stars*, published in 1926, using the Stefan's law as imagined by Guillaume:

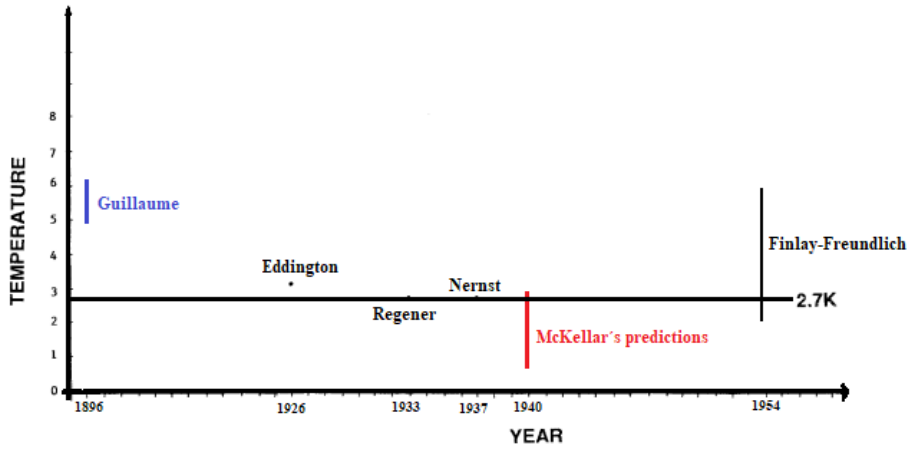
> Accordingly the total radiation of the stars has an energy-density
> $$2000 \times 3.83 \times 10^{-16} = 7.67\ 10^{-13}\ \text{ergs/cm}^3$$
> By the formula $E = sT^4$ the effective temperature corresponding to this density is 3º.18 absolute. In a region of space not in the neighborhood of any star this constitutes the whole field of radiation, and a black body, e. g. a black bulb thermometer, will there take up a temperature of 3º.18 so that its emission may balance the radiation falling on it and absorbed by it. This is sometimes called the 'temperature of interstellar space' (Eddington a*pud* Assis; Neves, 1995b).

Vitruvian Cogitationes, Maringá, v. 5, n. 1, p. 23-30, 2024 │ISSN 2675-9616
DOI: https://doi.org/10.4025/rvc.v5i1.71182

3 CONCLUSIONS

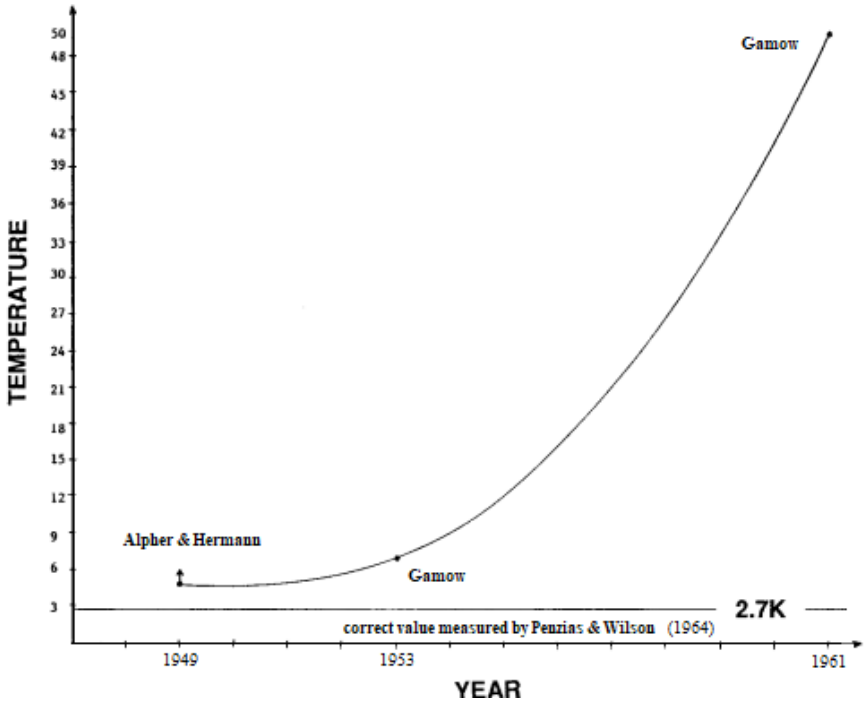
As we can see, the early predictions of the temperature of the space were made by great scientists of the past (including two Nobel Prizes, Guillaume and Nernst – see Figure 3), until the year of 1954. In this decade De Broglie and Max Born suspected that the cosmic background radiation was in the range of microwaves (Assis; Neves, 1995a,b; 2008; Meyers, 2004), as it will be discovered a ten years after by Penzias and Wilson. For the graph presented at the Figure 4 it is possible to observe the bad predictions of astronomers that used an inflationary model of Universe to estimate the temperature of the space.

Figure 3 – Predictions of the temperature of the space before Arno & Penzias using no inflationary scenarios.



Source: Assis; Neves (1995a).

Figure 4 – The discrepancies (curve) observed to the prediction of the temperature of the space.



Source: Assis; Neves (1995a).

Vitruvian Cogitationes, Maringá, v. 5, n. 1, p. 23-30, 2024 | ISSN 2675-9616
DOI: https://doi.org/10.4025/rvc.v5i1.71182

In the original book of John Horgan (1996), especially in the chapter, *The end of Cosmology*, not only the name of McKellar was wrong (and the year of the prediction of the value near 2.7 K), but also his approach against a great astronomer and physicist like Fred Hoyle[1]. The Hoyle arguments against the model of the Big Bang appears nowadays almost prophetic after the new discoveries made by James Webb Space Telescope (Lerner, 2022; O'Callaghan, 2022).

ACKNOWLEDGEMENTS

We would like to acknowledge the support provided by the Brazilian Public Agencies to the improvement of Science: CAPES, CNPq, SESu and ARAUCÁRIA.

REFERENCES

ASSIS, A. K. T.; NEVES; M. C. D. History of the 2.7 K Temperature Prior to Penzias and Wilson, **Apeiron**, v. 2, n. 3, p. 79-87, 1995a.

ASSIS, A. K. T.; NEVES; M. C. D. The redshift revisited. **Astrophysics and Space Science** v. 227, p. 13-24, 1995b.

ASSIS, A. K. T.; NEVES; M. C. D. To infinity and beyond... A little-known development in the history of cosmology. **Annals of Science & Democracy Conference**, Napoli, 2008.

HERZBERG, G. **Molecular Spectra and Molecular Structure – Vol. I**: Spectra of Diatomic Molecules. New York: D. Van Nostrand Company, 1941.

HORGAN, J. **The end of science: facing the limits of knowledge in the twilight of the science age.** New York: Broadway Books, 1996.

HORGAN, J. **O fim da ciência: uma discussão sobre os limites do conhecimento científico**. São Paulo: Cia. das Letras, 1998.

LERNER, E. J. **Big Bang didn't happen:** What do the James Webb images really show? Iai News. August 11, 2022. *In*: https://archive.ph/gs1jv

McKELLAR, A. Evidence for the molecular origin of some hitherto unidentified interstellar lines. **Astronomical Society of the Pacific**, p. 187-192, 1940.

MEYERS, R. **Universe: The Cosmology Quest.** Episodes 1 and 2. Los Angeles: Floating World Films, 2004.

O'CALLAGHAN, J. JWST's first glimpses of early galaxies could break cosmology. **Scientific American**. 2022. *In*: https://www.scientificamerican.com/article/jwsts-first-glimpses-of-early-galaxies-could-break-cosmology

[1] We must to remember that Fred Hoyle was a great writer of Sci-Fi. Some his remarkable books: *The Black Cloud, A for Andromeda, Fifth Planet, Element 79, ecc.*

Submetido em: 21/12/2023
Aprovado em: 12/02/2024
Publicado em: 20/02/2024