On the Earth Microwave Background: Absorption and Scattering by the Atmosphere

Pierre-Marie Robitaille

Dept. of Radiology, The Ohio State University, 130 Means Hall, 1654 Upham Drive, Columbus, Ohio 43210, USA

E-mail: robitaille.1@osu.edu

The absorption and scattering of microwave radiation by the atmosphere of the Earth is considered under a steady state scenario. Using this approach, it is demonstrated that the microwave background could not have a cosmological origin. Scientific observations in the microwave region are explained by considering an oceanic source, combined with both Rayleigh and Mie scattering in the atmosphere in the absence of net absorption. Importantly, at high frequencies, Mie scattering occurs primarily with forward propagation. This helps to explain the lack of high frequency microwave background signals when radio antennae are positioned on the Earth's surface.

1 Introduction

The absorption of radiation by the atmosphere of the Earth has been highly studied and exploited [1–3]. In the visible region, atmospheric absorption accounts for significant deviations of the solar spectrum from the thermal lineshape. These deviations are removed when viewing the spectrum from the outer atmosphere. Under these conditions, the solar spectrum now differs from the ideal lineshape only slightly. The remaining anomalies reflect processes associated with the photosphere itself.

In the microwave region, absorption of radiation is primarily associated with reversible quantum transitions in the vibrational-rotational states of gaseous molecules, particularly oxygen and water. Intense absorption occurs in several bands. The high frequency microwave bands are consequently less suited for signal transmission to, or from, satellites [1].

2 The Microwave Background

The microwave background [4] is currently believed to be of cosmic origin. The Earth is viewed as immersed in a bath of signal arising continuously from every possible direction, without directional preference. This is an intriguing physical problem in that it represents a steady state condition, not previously considered relative to atmospheric absorption. Indeed, all other atmospheric absorption problems involve sources which are temporally and spatially dependent. Such sources are radically different from the steady state.

Since the microwave background is temporally continuous and spatially isotropic, and since the vibrational-rotational transitions of gases are reversible, the steady state scenario leads to the absence of net absorption of microwave radiation in the atmosphere. An individual absorbing species, such as molecular oxygen or water, acts simply as a scatterer of radiation. Any radiation initially absorbed will eventually be re-emitted. There can be no net absorption over time. Only the effects of direct transmission and/or scattering can exist. Herein lies the problem for assigning the microwave background to a cosmic origin. The steady state results in a lack of net absorption by the atmosphere. Thus, if the signal was indeed of cosmic origin, there could be no means for the atmosphere to provide signal attenuation at high frequency. Assuming frequency independent scattering, a perfect thermal spectrum should have been received, even on Earth. Nonetheless, the high frequency components of the microwave background, on the ground, are seriously attenuated. Only at the position of the COBE satellite has a nearly perfect thermal spectrum been recorded [5].

3 Oceanic origin of the Microwave Background

It has previously been advanced that the microwave background is of oceanic origin [6–8]. Under this hypothesis, the oceans of the Earth are emitting a signal which mimics a blackbody source. This radiation is being emitted over all possible angles. The path length that radiation travels through the atmosphere can therefore be quite substantial, especially at the lower emission angles. Arguably, this oceanic signal, with its 2.7K apparent temperature, indirectly reflects the presence of translational and rotational degrees of freedom in the liquid. The weak hydrogen bonds between water molecules, and their associated vibrational degrees of freedom, are likely to be the underlying physical oscillators fundamentally responsible for this spectrum.

At low frequencies, oceanic radiation travels into the atmosphere where Rayleigh scattering may occur. This results in a substantial fraction of backscattering, since Rayleigh scattering is multidirectional. Consequently, the low frequency signals can easily be detected on Earth. However, at high microwave frequencies, Mie scattering dominates increasingly. Mie scattering, at the elevated frequencies, results primarily in forward propagation of the incident signal. The presence of forward scattering accounts for the lack of high frequency signals detected for the microwave background on

Earth. Forward scattering produces a preferential directionality away from the surface of the Earth. The variation of atmosperic density with elevation may also contribute to this observation. As a result, the high frequency portion of the microwave background is not well detected from the Earth. Since the problem is once again in the steady state regimen, there can be no net absorption in the atmosphere. Given sufficient scattering at all frequencies, at the position of COBE [5], the signal examined must be isotropic. At elevated frequencies, perfect scattering of the oceanic signals is being ensured by the absorption and re-emission of radiation by atmospheric gases. These processes follow substantial forward scattering. Of course, Rayleigh scattering is also being produced by small matter and scatterers in the lower atmosphere, particularly for the lower frequencies.

4 Conclusion

Given steady state, there can be no net absorption of microwave signals by the atmosphere. Yet, on Earth, the microwave background cannot be properly detected in the high frequency region. This directly implies that the microwave background cannot arise from the cosmos. Conversely, if one considers that the signal is oceanic in nature, the observed behavior of the microwave background on Earth is easily explained using a combination of absorption, re-emission, Rayleigh and Mie scattering, wherein forward propagation is also invoked. An oceanic signal followed by scattering also helps to explain the phenomenal signal to noise observed by the COBE FIRAS instrument [5]. Powerful signals imply proximal sources. This constitutes further evidence that the microwave background [4] is of Earthly origin [6–8]. We will never know the temperature of the Universe.

Dedication

This work is dedicated to Patricia Anne Robitaille.

Submitted on March 14, 2007
Accepted on March 16, 2007
First published online on March 17, 2007

References

1. Ulaby F. T., Moore R. K. and Fung A. K. Microwave remote sensing active and passive. Volume 1–3. London, Artech House, 1981–1986.
2. Janssen M. A. Atmospheric remote sensing by microwave radiometry. John Wiley, New York, 1993.
3. Iribane J. V. and Cho H.-R. Atmospheric physics. D. Reidel, Dodrecht, Holland, 1980.
4. Penzias A. A. and Wilson R. W. A measurement of excess antenna temperature at 4080 Mc/s. *Astrophys. J.* 1965, v. 1, 419–421.
5. Fixen D. L., Gheng E. S., Gales J. M., Mather J. C., Shafer R. A. and Wright E. L. The Cosmic Microwave Background spectrum from the full COBE FIRAS data set. *Astrophys. J.*, 1996, v. 473, 576–587.
6. Robitaille P.-M. L. The collapse of the Big Bang and the gaseous Sun. *New York Times*, March 17, 2002 (accessed online from http://www.thermalphysics.org/pdf/times.pdf).
7. Robitaille P.-M. L. On the origins of the CMB: insight from the COBE, WMAP, and Relikt-1 Satellites. *Progr. in Phys.*, 2007, v. 1, 19–23.
8. Rabounski D. The relativistic effect of the deviation between the CMB temperatures obtained by the COBE satellite. *Progr. in Phys.*, 2007, v. 1, 24–26.