On the Nature of the Microwave Background at the Lagrange 2 Point. Part I

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In this work, the nature of the microwave background is discussed. It is advanced that the 2.725 K monopole signal, first detected by Penzias and Wilson, originates from the Earth and therefore cannot be detected at the Lagrange 2 point (L2). Results obtained by the COBE, Relikt-1, and WMAP satellites are briefly reviewed. Attention is also placed on the upcoming PLANCK mission, with particular emphasis on the low frequency instrument (LFI). Since the LFI on PLANCK can operate both in absolute mode and in difference mode, this instrument should be able to unequivocally resolve any question relative to the origin of the 2.725 K monopole signal. The monopole will be discovered to originate from the Earth and not from the Cosmos. This will have implications relative to the overall performance of the PLANCK satellite, in particular, and for the future of astrophysics, in general.

1 Introduction

In 1965, a thermal signal of unknown origin, which appeared to completely engulf the Earth, irrespective of angle of observation, was first reported to exist at microwave frequencies [1]. Immediately considered of great importance, the strange finding was rapidly attributed to the universe by Dicke et al. [2] in a communication which preceded the disclosure of the actual measurements by A. A. Penzias and R. W. Wilson [1]. The observation became known as the "Cosmic Microwave Background (CMB)" nearly from the instant of discovery [1, 2]. For years, it had been predicted that such a signal must exist, if the universe evolved from a Big Bang scenario. With the advent of the Penzias and Wilson measurement [1], the long sought signature of creation seemed discovered, and cosmology entered the realm of modern science.

Since that time, the "CMB" has become a cornerstone of astrophysics [3–6]. The background and its characteristic 2.725 K monopole temperature [7, 8], the "relic of the Big Bang", is believed to span the entire known universe. While the "CMB" was initially considered weak, it is now clear that the signal was in fact quite powerful, at least when viewed from Earth orbit (8). Indeed, few experimental signals of natural origin have surpassed the microwave background in absolute signal to noise [8]. For cosmology, the "CMB" is the most important "astrophysical" finding. Experimental confirmations of its existence and characterization have consumed vast amounts of both financial and human capital. As a result, a more detailed understanding of the microwave background has emerged.

In addition to its characteristic monopole temperature at 2.725 K [8], the background has associated with it a strong (3.5 mK) dipole which is ascribed to the motion of the Earth and the Sun through the local group [9]. This powerful dipole has been observed not only on Earth, and in Earth orbit [9], but also by instruments located well beyond the Earth, like the Soviet Relikt-1 [10] and the NASA WMAP [11] satellites. Consequently, there can be little question that the dipole is real, and truly associated with motion through the local group.

Beyond the dipole, cosmology has also placed significant emphasis on the multipoles visible at microwave frequencies [12]. Accordingly, the universe has now been characterized by anisotropy maps, the most famous of which have been reported by the COBE [7] and WMAP [11] satellites. These maps reflect very slight differences in microwave power of the universe as a function of observational direction.

The recent array of scientific evidence, in support of a microwave background of cosmological origin, appears tremendous, and cosmology seems to have evolved into a precision science [13–19]. Should the 2.725 K microwave background truly belong to the universe, there can be little question that cosmology has joined the company of the established experimental disciplines. Yet, these claims remain directly linked to the validity of the assignment for the "Cosmic Microwave Background". Indeed, if the "CMB" is reassigned to a different source, astrophysics will undergo significant transformations.

2 The origin of the microwave background

Recently, the origin of the "CMB" has been brought into question, and the monopole of the microwave background has been formally reassigned to the Earth [20–29]. Such claims depend on several factors, as follows:

1. The assignment of a 2.725 K temperature to the Penzias and Wilson signal constitutes a violation of Kirchhoff's Law of Thermal Emission [30, 31]. The proper

assignment of thermal temperatures requires, according to Kirchhoff [31], equilibrium with an enclosure [30]. This is a condition which cannot be met by the universe. Therefore, the absolute magnitude of the temperature should be considered erroneous;

2. The cosmological community, in general, and the COBE [33] and WMAP [34] teams, in particular, have advanced that the Earth can be treated as a ~300 K blackbody. In fact, since the Earth is 75% water covered, this assumption is not justified, based on the known behavior of sea emissions in the microwave region [26, 35]. The oceans exhibit thermal emission profiles, which depend on the Nadir angle, and are therefore not blackbody emitters at ~300 K. Indeed, the oceans can produce signals very close to 0 K [26, 35]. It remains of concern that the signature of the microwave background is completely devoid of earthly interference. Not a single artifact has been reported over the entire frequency range [8] which could be attributed to an earthly signal of oceanic origin. At the same time, it is well established that water is a powerful absorber of microwave radiation. Consequently, it is reasonable to expect that the oceans cannot be microwave silent relative to this problem;
3. Powerful signals imply proximal sources. When measured from the Earth the monopole of the microwave background has a tremendous signal to noise [8]. To require that such extensive power fill the entire universe argues in favor of a nearly infinite power source well outside anything known to human science. Conversely, if the signal arises from the Earth, it would be expected to be strong when viewed from Earth [8]. The powerful nature of the microwave background in Earth orbit [8], and the lack of oceanic contaminating signal could very easily be solved, if the Penzias and Wilson signal [1] was generated by the Earth itself [20–29];
4. In the experimental setting, thermal photons, once released, report the temperature of the source which produced them in a manner which is independent of time elapsed and of subsequent source cooling. Once photons are emitted, they cannot shift their frequencies to account for changes at the source. Yet, the Big Bang scenario requires a constant and systematic shifting of photon frequencies towards lower temperatures in a manner wherein the cooling of the source is constantly monitored and reported. This is without experimental evidence in the laboratory. Experimental photons, once produced, can no longer monitor the cooling of the source. Arguments relative to photon shifting, based on an expanding universe, are theoretical and are not supported by laboratory measurements. In considering stellar red shifts, for instance, it is commonly held that the sources themselves are moving away from the observer. Thus, the photons are being shifted *as they are being produced*. In sharp contrast, a microwave background of cosmic origin requires *continuous shifting of photon frequencies long after emission*;
5. The monopole of the microwave background is characterized by a thermal profile [8]. It is a well recognized observation of physics, that a Lyman process is required to produce a group of Lyman lines. Likewise, a nuclear magnetic resonance process is required to obtain an NMR line. Similarly, a thermal process must occur to produce a thermal line. On Earth, thermal emission spectra are generated exclusively in the presence of matter in the condensed state [30]. The existence of a Planckian line in the microwave requires a process analogous to that which results in a thermal spectrum from a piece of graphite on Earth [30]. Physics has not provided a known mechanism for the creation of a photon by graphite [30]. As a result, Planck's equation, unlike all others in physics, remains detached from physical reality [30]. In this regard, it is maintained [30] that a thermal profile can only be obtained as the result of the vibration of atomic nuclei within the confines of a lattice field (or fleeting lattice field in the case of a liquid). Condensed matter, either in the solid or liquid state, is required. This condition cannot be met within the framework of Big Bang cosmology. Universality in blackbody radiation does not hold [30, 31];
6. Measurements performed by the COBE satellite reveal a systematic error relative to the measured value of the microwave background monopole temperature, derived either from the monopole or the dipole [26, 27]. These measurements can be interpreted as implying that still another field exists through which the Earth is moving [26, 27];
7. Currently, the "Cosmic Microwave Background" is thought to be continuously immersing the Earth in microwave photons from every conceivable direction in space. Under this steady state scenario, there can be no means for signal attenuation at high frequencies, as has been observed on Earth [28]. This strongly argues that the "CMB" cannot be of cosmic origin [28];
8. The "CMB" anisotropy maps reported by the WMAP satellite display instabilities which are unacceptable, given the need for reproducibility on a cosmological timescale. The results fail to meet accepted standards for image quality, based on a variety of criteria [23–25]. These findings demonstrate that the stability observed in the monopole at 2.725 K is not translated at the level of the anisotropy maps, as would be expected for a signal of cosmologic origin. This implies that the monopole arises from a stable source, while the anisotropies arise from separate unstable sources.

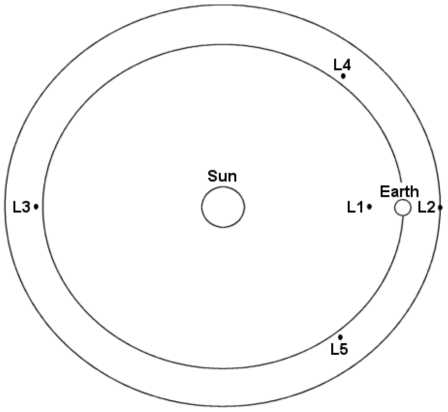

Fig. 1: Schematic representation of the Sun-Earth system depicting the position of the Lagrange 2 point, L2.

2.1 The CMB versus the EMB

Given this array of concerns relative to the assignment of the microwave background, it is clear that mankind must determine, without question, whether this signal is indeed of cosmic origin, or whether, as advanced herein and elsewhere [20–29], it is being generated by the Earth. Current satellite data make strong arguments relative to systematic errors [26, 27] and stability [25] that the monopole of the microwave background originates from the Earth. Conversely, the astrophysical community maintains that a cosmic origin remains the only valid explanation. This being said, it is perplexing that the thermal emission profile of the Earth itself, from space, has yet to be obtained. If the Earth's emission profile was obtained, over the infrared and microwave region, it would become evident that our planet is not a 300 K blackbody radiation source, as the COBE [33], WMAP [34], and PLANCK [36] teams assume. In this era of concern for global warming, it is critical to secure this data.

In the meantime, the PLANCK mission [36], planned by the European Space Agency, will provide the next opportunity to help resolve these questions. Because PLANCK [36] may well acquire the decisive evidence relative to an earthly origin for the monopole of the microwave background, it is important to understand this mission, relative to both COBE [7] and WMAP [11]. The area of greatest interest lies in the configuration of the PLANCK radiometers and the results which they should be able to deliver at the Lagrange 2 point (see Figure 1).

2.1.1 Scenario 1: a cosmic origin

The microwave background has always been viewed as a remnant of the Big Bang originating far beyond our own galaxy. The Earth, in this scenario, is being constantly bombarded by photons from every direction. The frequency distribution of these photons is represented by a 2.725 K blackbody [8]. Indeed, the "CMB" represents perhaps the most precise thermal radiation curve ever measured [8]. The Earth is traveling through the microwave background, as it continues to orbit the Sun and as the latter moves within the galaxy. This motion through the local group is associated with a strong dipole (3.346±0.017 mK) in the direction $l, b = 263.85^\circ \pm 0.1^\circ$, $48.25^\circ \pm 0.04^\circ$ [11], where l and b represent galactic longitude and latitude, respectively. In addition, the "CMB" is characterized by numerous multipoles derived from the analysis of the "CMB" anisotropy maps [11]. Under this scenario, the "CMB" field experienced at ground level, in Earth orbit, or at the Lagrange 2 point (see Figure 1), should be theoretically identical, neglecting atmospheric interference. If COBE [7] and Relikt-1 [10] were launched into Earth orbit, it was largely to avoid any interference from the Earth. The WMAP [11] and PLANCK [36] satellites seek a superior monitoring position, by traveling to the Lagrange 2 point. At this position, the Earth is able to shield the satellite, at least in part, from solar radiation.

2.1.2 Scenario 2: an earthly origin

Recently [20–29], it has been advanced that the microwave background is not of cosmic origin, but rather is simply being produced by the oceans of the Earth. Since the monopole can be visualized only on Earth, or in close Earth orbit [8], it will be referred to as the Earth Microwave Background or "EMB" [28]. In this scenario, the monopole of the Earth microwave background at 2.725 K (EMBM) reports an erroneous temperature, as a result of the liquid nature of the Earth's oceans. The oceans fail to meet the requirements set forth for setting a temperature using the laws of thermal emission [30–32]. For instance, Planck has warned that objects which sustain convection can never be treated as blackbodies [37]. A thermal signature may well appear, but the temperature which is extracted from it is not necessarily real. It may be only apparent. The fundamental oscillator responsible for this signature is thought to be the weak hydrogen bond between the water molecules of the oceans. The EMB has associated with it a dipole [9]. This dipole has been extensively measured from Earth and Earth orbit, and is directly reflecting the motion of the Earth through the local group, as above. Since the Earth is producing the monopole (EMBM), while in motion through the local group, the EMB dipole or "EMBD" would be expected to exist unrelated to the presence of any other fields.

At the Lagrange 2 point, the signal generated by the oceans (EMB) will be too weak to be easily observed [34, 38]. Nonetheless, L2 will not be devoid of all microwave signals. Indeed, at this position, a microwave field must exist. This field, much like noise, will not be characterized by a single temperature. Rather, it will be a weak field, best described through the summation of many apparent temperatures, not by a single monopole. In a sense, microwave noise will be found of significant intensity, but it will be devoid of the characteristics of typical signal. For the sake of clarity, this

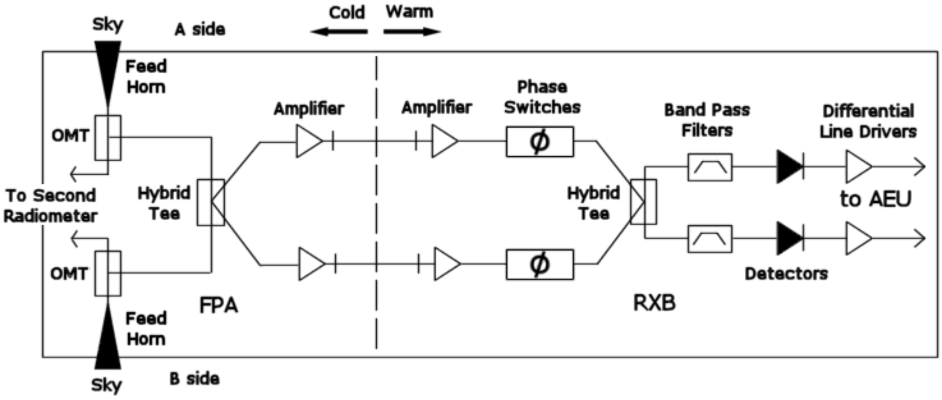

Fig. 2: Partial schematic representation of the WMAP pseudo-correlation differential radiometers [41]. Note that the signal from each horn first travels to an orthomode transducer (OMT) wherein two orthogonal outputs are produced, one for each radiometer. One output from the OMT then travels to the 180° hybrid tee before entering the phase-matched leg of the radiometer. Importantly, for the WMAP satellite, the signal from each horn is being compared directly to its paired counterpart. The satellite does not make use of internal reference loads and cannot operate in absolute mode. (Adapted from [34, 41].)

field will be referred to as the Weak Microwave Background (WMB). This weak background bathes, at least, our solar system, and perhaps much of the galaxy. However, it may or may not extend much power into intergalactic space. Interestingly, motion of the WMAP [11] or PLANCK [36] satellites through this WMB will be associated with the production of a dipole of exactly the same magnitude and direction as observed on Earth [9], since the nature of the motion through the local group has not changed at this point. As such, two dipoles can be considered. The first is associated with the EMB. It is referred to above by the acronym EMBD. The second is associated with the WMB and motion through the local group. It will be referred to henceforth as the WMBD. In actuality, even if the Earth did not produce the 2.725 K monopole, it would still sense the WMBD, as it is also traveling through the WMB. The fact, that both an EMBD and a WMBD are expected, has been used to reconcile the systematic error reported by the COBE satellite [26, 27].

In summary, under the second scenario, we now have a total of four fields to consider:

(1) the monopole of the Earth Microwave Background, the EMBM;
(2) the dipole associated directly with the Earth Microwave Background and motion through the local group, the EMBD;
(3) the Weak Microwave Background present at L2 and perhaps in much of the galaxy, the WMB, and finally
(4) the dipole associated when any object travels through the Weak Microwave Background, the WMBD.

2.1.3 The microwave anisotropies

Weak Microwave Background Anisotropies (MBA) are associated with either Scenario 1 or 2. The anisotropies form the basis of the microwave anisotropy maps now made famous by the WMAP satellite [11, 39, 40]. Under the first scenario, the MBA are tiny fluctuations in the fabric of space which represent relics of the Big Bang. However, careful analysis reveals that the anisotropy maps lack the stability required of cosmic signals [25], and are therefore devoid of cosmological significance. They represent the expected microwave variations, in the sky, associated with the fluctuating nature of microwave emissions originating from all galactic and extragalactic sources. These observations increase the probability that the second scenario is valid.

3 The WMAP versus PLANCK missions

3.1 WMAP

The WMAP satellite [11] is currently positioned at the Lagrange 2 point. WMAP operates in differential mode (see Figure 2), wherein the signal from two matched horns are constantly compared [34, 41]. In this sense, the WMAP satellite resembles the DMR instrument on COBE [33, 42]. Initially, WMAP was to rely exclusively on the magnitude of the dipole observable at L2, in order to execute the calibration of the radiometers (see Section 7.4.1 in [41]). Since the “CMB” and its 2.7 K signature are believed to be present at L2 by the WMAP team, then calibration involves the 1st derivative of the “CMB” and calculated temperature maps of the sky [41], describing the associated temperature variations based on the dipole [9]. Once WMAP reached L2, the initial approach to calibration appeared to be somewhat insufficient, and additional corrections were made for radiometer gains with the initial data release [45, 46].

WMAP is a pseudo-correlation differential spectrometer without absolute reference loads (see Figure 2). Correlation receivers are used extensively in radioastronomy, in part due to the inherent stability which they exhibit, when presented with two nearly identical signals [43, 44]. Since WMAP

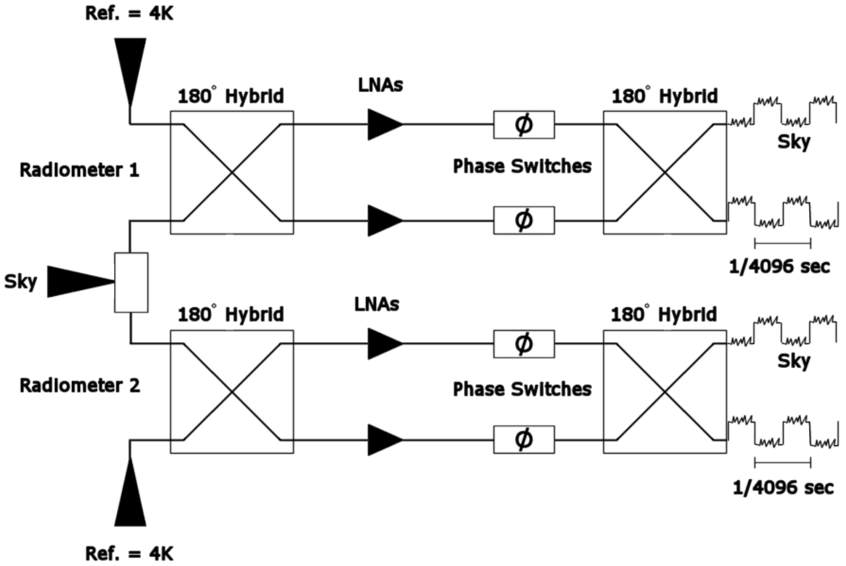

Fig. 3: Partial schematic representation of the PLANCK LFI pseudo-correlation differential radiometers [47, 48]. Prior to entering each radiometer, the signal from each sky horn travels to an orthomode transducer (OMT) where two orthogonal linearly polarized signals are produced. Each of these signals is then compared directly to a reference load maintained at 4 K. Unlike WMAP, PLANCK can operate both in absolute and differential mode. In absolute mode, PLANCK will be able to directly compare the amplitude signal observed from the sky with that produced by the reference loads. Importantly, in order to maintain a minimal knee frequency PLANCK assumes that the differences between the sky and reference signals will be small. (Adapted from [47–52].)

is devoid of reference loads, the satellite is unable to easily answer questions relative to the presence or absence of the 2.725 K "CMB" signal at the L2 point. Should only a WMB be present, WMAP could still be calibrated properly [41], because the magnitude and direction of the dipole itself ultimately governs the entire problem, independent of the underlying field. Because the dipole is being produced by motion through the local group, its magnitude and direction at L2 will be identical, irrespective of the scenario invoked above. This is true, of course, provided that the WMB exists. The WMAP team assumes the presence of a "CMB" monopole at L2 and uses its first derivative, in combination with an expected sky temperature difference map, based on the known dipole [41]. Alternatively, if only a WMB exists at L2, the dipole will still be present, and another set of theoretical constraints will also satisfy the requirements for calibration.

WMAP has been able to detect the dipole at the L2 point, but this is expected from both scenarios listed above. In any case, an objective analysis of the data products associated with this satellite reveals that, far from affirming the cosmic nature of anisotropy, WMAP refutes such conclusions [25]. The anisotropy maps derived from WMAP are much too unstable and unreliable to be fundamentally linked to signals of primordial origin [25]. WMAP has not been able to yield a definitive answer relative to the origin of the "CMB", and, to date, no signal has been measured which can be ascribed to the remnant of the Big Bang. Fortunately, it appears that the PLANCK satellite will be able to unambiguously resolve the issue.

3.2 PLANCK

Much like WMAP, the PLANCK satellite [36] is scheduled to be launched into an operational orbit at L2, the Lagrange 2 point of the Earth-Sun system. The satellite is equipped with two instruments, the low frequency instrument (LFI) and the high frequency instrument (HFI), scanning the sky at 30, 44, and 70 GHz [47–55] and 100, 143, 217, 353, 545, and 857 GHz [55–57], respectively. In contrast, the WMAP satellite scanned the 23, 33, 41, 61, and 94 GHz regions of the electromagnetic spectrum. Thus, PLANCK greatly extends the range of frequencies which will be sampled.

Still, more important differences exist between PLANCK and WMAP. The high frequency instrument on PLANCK is not differential, and frequencies from 100–857 GHz will be sampled in absolute mode, without subtraction. Moreover, while the low frequency instrument is designed to operate as a differential spectrometer, it can also function in absolute mode [47-54]. The low frequency instrument on PLANCK (see Figure 3) is also designed to function as a pseudo-correlation radiometer [47-53]. However, the signal from the sky, obtained by each horn, is being compared to a reference load maintained at 4 K (see Figure 3). These details constitute critical variations relative to the WMAP radiometer design.

Given that the LFI on PLANCK makes use of absolute reference loads, it resembles, in this important sense, the FIRAS Instrument on COBE [58]. Furthermore, since the LFI on PLANCK can operate either in absolute mode, or in difference mode [47–54], the spectrometer has a flexibility which appears to combine the best features possible for such an instrument. In absolute mode, the LFI on PLANCK will be able to quantify completely the signal originating from the sky relative to that produced by its 4 K references. Nonetheless, the LFI was designed to operate primarily in differential mode. This has implications for the quality of its data products based on whether or not the 2.725 K monopole signal is present at L2.

3.2.1 The PLANCK LFI

The PLANCK LFI is designed as a pseudo-correlation [52] receiver (see Figure 3). For this receiver, gain instabilities in the High Electron Mobility Transistor (HEMT) amplifier, within the receiver front end, result in $1/f$ noise. The $1/f$ noise, if not properly accounted for, can produce significant stripes in the final maps [47, 48]. These stripes are also dependent on scanning strategy. The behavior of the $1/f$ noise has been carefully analyzed for the PLANCK LFI [47, 48]. Since the LFI is designed to operate primarily in differential mode, it is important to minimize the difference between the reference load temperature, T_{ref}, and the sky temperature, T_{sky}.

Currently, the PLANCK team is making the assumption that $T_{sky} = 2.725$ K, as previously reported by the COBE group [7]. As such, they have chosen to use $T_{ref} = 4$ K. Any offset between T_{sky} and T_{ref} *"can be balanced before differencing either by a variable back-end gain stage with a feedback scheme to maintain the output power as close as possible to zero, or by multiplying in software one of the two signals by a so-called gain modulation factor"* [47].

If the differences between the sky temperature and the reference temperatures are large, then the idea of using back-end gain stage feedback, to balance the two channels, should introduce substantial noise directly into the system. The situation using software and a gain modulation factor would also introduce unexpected complications.

The gain modulation factor, r, is given by the following: $r = (T_{sky} + T_n)/(T_{ref} + T_n)$ where T_n corresponds to the radiometer noise temperature. The noise temperature of the radiometer, T_n, is a fundamental property of any receiver and is determined by the overall design and quality of the instrument. T_n is critical in establishing the sensitivity of the spectrometer. For instance, the radiometer sensitivity, ΔT_{rms}, over a given integration time, is directly dependent on both T_{sky} and T_n, as follows: $\Delta T_{rms} = 2\,(T_{sky} + T_n)/\sqrt{\beta}$, where β is the bandwidth of the radiometer (typically taken as 20%). Note that if T_n is large, then it will be easy to achieve gain modulation factors near 1. However, the radiometer sensitivity would be severely compromised. Low T_n values are central to the performance of any receiver. Under this constraint, the gain modulation factor will be strongly affected by any differences between the T_{sky} and T_{ref}.

PLANCK has the ability to calculate the gain modulation factor, r, directly from radiometer data acquired with the spectrometer operating in absolute mode [47]. Alternatively, r can be calculated from software, using up to three approaches including, for instance, minimizing the final differenced data knee frequency, f_k. The knee frequency is the frequency at which the value of $1/f$ noise and white noise contributions are equal.

In general, it is also true that for the PLANCK LFI *"the white noise sensitivity and the knee-frequency depend on the actual temperature in the sky"* [47]. Because excessive $1/f$ noise can degrade the final images and data products [47, 48], it is important to minimize its contribution. This can be achieved *"if the post detection knee frequency f_k (i.e. the frequency at which the $1/f$ noise contribution and the ideal white noise contribution are equal) is significantly lower than the spacecraft rotation frequency ($f_{spin} \sim 0.017$ Hz)"* [48]. If the f_k is greater than, or approximately equal to f_{spin}, a degradation in the final sensitivity of the satellite will occur [47]. As this inherently depends on the real sky temperature, there are some concerns relative to the performance of the PLANCK LFI instruments.

When the knee frequencies are too high, stripes will occur in the images generated by the satellite. It is true that algorithms do exist to help remove these artifacts, provided that they are not too strong [47]. Nonetheless, when the sky temperature and the reference temperatures are not balanced, the knee frequency will rise substantially. This could diminish the quality of the data products from this satellite.

The importance of maintaining a low knee frequency for the PLANCK LFI instruments cannot be overstated. *"If the knee frequency is sufficiently low (i.e. $f_k \leqslant 0.1$ Hz), with the application of such algorithms it is possible to maintain both the increase in rms noise within few % of the white noise, and the power increase at low multipole values (i.e. $l \leqslant 200$) at a very low level (two orders of magnitude less than the CMB power). If, on the other hand, the knee frequency is high (i.e. $\gg 0.1$ Hz) then even after destriping the degradation of the final sensitivity is of several tens of % and the excess power at low multipole values is significant (up to the same order of the CMB power for $f_k \sim 10$ Hz ...) Therefore, careful attention to instrument design, analysis, and testing is essential to achieve a low $1/f$ noise knee frequency"* [48]. The PLANCK team has emphasized this further, as follows: *"It is then of great importance to decrease as much as possible the impact of $1/f$ noise before destriping and $f_k = 0.01$ Hz is an important goal for instrument studies and prototypes."*

The manner in which the knee frequency is affected by both the gain modulation factor, r, and the absolute sky temperature [48], has been described algebraically:

$$f_k\,(T_n) = \beta \left[\frac{A\,(1-r)\,T_n}{2\,(T_{sky} + T_n)} \right]^2 . \tag{1}$$

In this equation, β corresponds to the bandwidth of the receiver, typically taken at 20%, T_n is the radiometer noise temperature, and A is a normalization factor for noise fluctuations [48]. Note that if the sky temperature, T_{sky}, is only some fraction of a Kelvin degree, this equation is moving towards:

$$f_k\left(T_n\right)=\beta\left[\frac{A\left(1-r\right)}{2}\right]^2. \tag{2}$$

Under test conditions, the PLANCK team estimated gain modulation factors ranging from 0.936 to 0.971 for the 30, 44, and 70 GHz radiometers [47]. In flight, T_n values of 7.5, 12, and 21.5 K are expected for the 30, 44, and 70 GHz radiometers [50]. This results in r values ranging from ~0.89–0.95, if T_{sky} is taken as 2.725 K and $T_{ref}=4$ K. Anticipated f_k values would therefore range from ~0.0032 Hz to ~0.0043 Hz, well below the 16 mHz requirement. This situation will not occur under Scenario 2, wherein T_{sky} at L2 is not 2.725 K, but rather only some fraction of a Kelvin degree.

As T_{sky} will have a much lower value than foreseen, the gain modulation factor, r, will be moving away from unity. It is also clear from Eqs. 1 and 2 that the knee frequency for the LFI radiometers would rise to values substantially above those currently sought by the PLANCK team.

In the extreme case, it is simple to consider the consequence of $T_{sky}\to 0$. In this instance, gain modulation factors would drop precipitously from ~0.89 to ~0.65 at 30 GHz, and from ~0.95 to ~0.84 at 70 GHz. This would translate into substantially elevated f_k values of ~50 mHz. Even an apparent T_{sky} value of 300 mK would result in r and f_k values in this range. Other than the direct measurement of the sky temperature by the PLANCK LFI in absolute mode, the drop in r values and the tremendous rise in f_k will constitute another indication that the 2.725 K signal does not exist at the L2 point.

Consequently, it is difficult to envision that the PLANCK team will be able to attain the desired image quality if T_{sky} is not at 2.725 K. The spectrometer is not designed to achieve maximal sensitivity in absolute mode, while in difference mode, both its r values and its f_k will be compromised. Destriping algorithms will have to be invoked in a much more central manner than anticipated.

Note that the situation with PLANCK is substantially different from WMAP. With WMAP (see Figure 2), the radiometers do not make use of an absolute reference load, but rather, the two sky horns are constantly and directly being differenced. Thus, the knee frequency for WMAP would be as predicted prior to launch. The WMAP horns are nearly perfectly balanced by the sky itself. Therefore, their performance would not be affected by the real nature of the signal at L2. This is not the case for the PLANCK satellite.

4 Conclusion

The WMAP satellite was designed as a differential spectrometer without absolute calibration. As a result, it is unable to ascertain the absolute magnitude of the microwave signals at the L2 point. The satellite has produced anisotropy maps [39, 40]. Yet, these maps lack the stability required of cosmological signals. Indeed, WMAP appears devoid of any findings relative to cosmology, as previously stated [25]. The only signal of note, and one which was not anticipated [21], is that associated with the dipole [9, 26, 27]. The dipole is important, since it can be used to quantify the motion of objects through the local group. Under the second scenario, this dipole signal implies that there is a Weak Microwave Background (WMB) at the L2 point.

In sharp contrast with WMAP, PLANCK has the advantage of being able to operate in absolute mode. In this configuration, it can directly determine whether or not there is a 2.725 K monopole signal at L2. If the signal is present, as expected by the PLANCK team, and as predicted in the first scenario, then the satellite should be able to acquire simply phenomenal maps of the sky. However, this will not occur. In the absence of a monopole, the PLANCK radiometers will be compromised when operating in difference mode, as their knee frequencies rise. This shall result in the presence of more pronounced image artifacts in the data products, which may not be easily removed through processing, potentially impacting the harvest from PLANCK. Nonetheless, PLANCK should be able to fully characterize the WMB predicted under the second scenario.

At the same time, since the 2.725 K monopole signature does not exist at the L2 point, PLANCK is poised to alter the course of human science. The satellite will help establish that there is no universality [30, 31]. The need to link Planck's equation to the physical world will become evident [30, 31]. It will be realized that the Penzias and Wilson signal did come from the Earth, and that liquids can indeed produce thermal spectra reporting incorrect temperatures. It is likely that a renewed interest will take place in condensed matter physics, particularly related to a more profound understanding of thermal emission, in general, and to the study of thermal processes in liquids, in particular. The consequences for astrophysics will be far reaching, impacting our understanding of stellar structure [59, 60], stellar evolution and cosmology. PLANCK, now, must simply lead the way.

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Dedication

This work is dedicated to my brother, Patrice, for his love and encouragement.

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