# Kirchhoff's Law of Thermal Emission and its Consequences for Astronomy, Astrophysics and Cosmology

## 1 Introduction

Kirchhoff's Law of Thermal Emission is a pillar of modern physics. In assuming its validity Max Planck went on to obtain his famous equation for thermal spectra, wherein he introduced the quantum of action. Quantum mechanics was then born, and the theoretical physics of thermal emission and beyond, fixed to universality of Planck's equation. By this universality, Planck's equation has been widely applied in physics and astronomy. Astronomers report the temperature of the Sun's photosphere at ≈5,800 K by means of Planck's equation. Cosmologists insist that there is an isotropic Cosmic Microwave Background Radiation pervading the universe, left over from a big bang creation event, having a blackbody spectrum (i.e. a planckian distribution of frequencies) at a temperature of ≈2.725 K. Astronomy and astrophysics apply universality of Planck's equation everywhere.

Planck's equation is his answer to the riddle of 'blackbody radiation', because it was upon black materials such as lampblack (i.e. soot) that Kirchhoff constructed his Law. Nonetheless, Kirchhoff permitted his Law to encompass not just black materials such as soot, but any opaque solid material. Planck's equation similarly came to hold within its ambit a vast array of solid materials other than carbon, gases, gaseous plasmas, quark-gluon plasmas, and various clouds of exotic particles that existed, according to big bang cosmology, in the first 400,000 years of the big bang universe, which created itself from nothing [1]. According to this theory, time, being a component of the Universe, did not exist before the big bang, because nothing existed before the big bang. The big bang delivered existence itself. Cosmology therefore 'counts time' from zero at the big bang.

Yet Planck's equation remains without a firm connexion to physical processes, for its æitiology is largely unknown. As Robitaille [2] has emphasised,

> "*In processes where light is emitted, there are five aspects to consider: 1) the physical setting, 2) separate energy levels created in this setting, 3) a transition species which will make use of these energy levels, 4) the production of a photon, and 5) an equation. For instance, for Lyman-α radiation these correspond to 1) the hydrogen atom, 2) the two electronic orbitals involved in the transition, principle quantum numbers N=2 and N=1, 3) the electron as the transition species, 4) the Lyman-α emission at 1216Å, and 5) the Rydberg formula. Alternatively, in speaking of the proton nuclear magnetic resonance line from water, these correspond to 1) the hydrogen atoms of the water molecules placed in a magnetic field, 2) the hydrogen nuclear spin up or spin down states, 3) the hydrogen nuclear spin as a transition species, 4) the hydrogen line at 4.85 ppm, and 5) the Larmor equation. Analogous entries can be made for any spectroscopic process in physics, with the exception of blackbody radiation. In that case, only the 4th and 5th entries are known: 4) the nature of the light and 5) Planck's equation.*"

The fundamental physics of thermal emission was established by the Scottish experimental physicist Balfour Stewart, who, in 1858, published the Law of Equivalence (i.e. Stewart's Law), which states that at thermal equilibrium radiative emission equals radiative absorption:

> "*The absorption of a plate equals its radiation, and that for every description of heat.*" [3, §19]

> "*That the absorption of a particle is equal to its radiation, and that for every description of heat.*" [3, §33]

Thus, at thermal equilibrium, the thermal energy absorbed by a material is equal to the thermal energy it emits.

In 1859, Kirchhoff [4] published his Law of Thermal Emission, which incorporated Stewart's Law. Although Kirchhoff was well aware of Stewart's work and publications, he did not cite him. This led to some acrimony between the two scientists. Moreover, Kirchhoff, using theory alone, went well beyond experimental findings, for Kirchhoff attributed to all opaque solids the universal property of 'blackbody radiation'; the radiation being dependent only upon the emitter's temperature, at thermal equilibrium. Kirchhoff thereby made all opaque solid materials blackbodies. It is this property that Planck embraced and which became a canon of theoretical physics, in the form of his equation for thermal spectra. Astronomy and cosmology subsequently did away with opaque solids and enclosures in order to admit free and bound gases and clouds of exotic particles into the blackbody fold, and finally became lax with the requirement of thermal equilibrium. In these ways cosmology has built its theoretical basis, not just upon Einstein's General Theory of Relativity, but even more so upon thermal emission. Without Kirchhoff's Law of Thermal Emission and universality of Planck's equation cosmology and astronomy are without firm foundations. It is therefore essential to ensure that the physics of thermal emission is correctly employed. Unfortunately, cosmology and astronomy have failed to do so, violating the physics of thermal emission at every turn, invoking *ad hoc* unrealistic processes and a swag of new particles *ad arbitrium* in their endeavours to shore up a theory that has become another canon to be maintained despite the evidence.

## 2 Kirchhoff's Law of Thermal Emission (Blackbody Radiation)

One is hard-pressed to find the correct statement of Kirchhoff's Law of Thermal Emission in textbooks and scientific papers. The best source of Kirchhoff's Law of Thermal Emission is Kirchhoff himself [5, §16]:

> "*If a space be entirely surrounded by bodies of the same temperature, so that no rays can penetrate through them, every pencil in the interior of the space must be so constituted, in regard to its quality and intensity, as if it had proceeded from a perfectly black body of the same temperature, and must therefore be independent of the form and nature of the bodies, being determined by the temperature alone . . . In the interior therefore of an opake red-hot body of any temperature, the illumination is always the same, whatever be the constitution of the body in other respects.*"

Figure 1 depicts three hollow enclosures: a box made of granite, a sphere made of carbon, and a pyramid made of highly polished silver. If a small hole be made in each so that the radiation within can be sampled from outside when all three cavities are at the same temperature, according to Kirchhoff, the radiation is the same from all three cavities, as if they were all made of carbon or lined with soot, since the nature and form of the cavity walls is irrelevant to the radiation field within them.

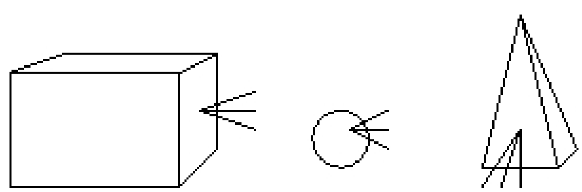

Fig. 1: Hollow objects: a granite box, a carbon sphere, and a highly polished silver pyramid. By Kirchhoff's Law of Thermal Emission, when all three cavities are at the same temperature, the radiation field within them is always the same: that of blackbody radiation: irrespective of the nature and form of the cavity, as if all were made of carbon.

The setting of Kirchhoff's Law of Thermal Emission is an opaque solid cavity at thermal equilibrium. Planck's equation for thermal spectra was forged upon this setting. For Kirchhoff and Planck the nature and form of an arbitrary cavity at thermal equilibrium is irrelevant to the radiation it contains. Their cavities all behave as if they were lined with lampblack at the same temperature. Thus, all thermally equilibrated cavity radiation is black, even the theoretical cavity made from a perfect reflector. This is the essential feature of Kirchhoff's Law and the basis for universality of Planck's equation. The only restriction on cavity form is that it must be large enough so that the effects of diffraction are unimportant. In addition, when conduction or convection are present, materials responding under their influence cannot ever be blackbodies [6, 7]. A blackbody can maintain thermal equilibrium only by radiative means.

> "*For the heat of the body depends only on heat radiation, since, on account of the uniformity in temperature, no conduction of heat takes place.*" [7]

To these cavities arcanum Kirchhoff attached what he thought to be a a profound physical property: that the (black) radiation therein is a function of only temperature and frequency. This relation subsumes Stewart's Law of Equivalence.

“*The ratio between the emissive power and the absorptive power is the same for all bodies at the same temperature . . .* ” [5, §3]

Kirchhoff rendered this relation mathematically as,

$$\frac{E}{A} = e, \tag{1}$$

where he called $E$ ‘emissive power’, $A$ ‘absorptive power’, and $e$ is an unknown universal function of only temperature $T$ and frequency $\nu$, for all cavities constucted from opaque solid materials, irrespective of their nature and form. Finally he set $A = 1$ so that $E = e$ acquires the mysterious property of universality, because neither $E$ nor $e$ are unity. The elucidation of the universal function $e$ Kirchhoff believed to be of great scientific importance. It was Planck who finally gave $e$ a definite form. However, when $A = 0$ Kirchhoff’s universal function is undefined, and his terminology is otherwise confounding. In modern notation Kirchhoff’s ‘universal function’ is given by,

$$\frac{E_\nu}{\alpha_\nu} = f(T,\nu), \tag{2}$$

where $E_\nu$ is emissive power, $\alpha_\nu$ is the unitless absorptivity, and $e = f(T,\nu)$ [6].

In 1901 Max Planck [54] adduced his equation for blackbody radiation. He elaborated on it in his book in 1914 [7]. The spectral density $u$ of radiation is given by [7]:

$$u = \frac{8\pi h\nu^3}{c^3}\frac{1}{e^{h\nu/kT} - 1}, \tag{3}$$

where $c$ is the speed of light, $T$ the temperature, $\nu$ the frequency, $h$ Planck’s constant, and $k$ Boltzmann’s constant; all being quantities independent of the nature and form of the cavity.

Furthermore, Planck [7, §10], contrary to Kirchhoff’s thesis and the experimental facts, permitted even transmissive solids to be blackbodies, by means of their ‘thickness’:

“*. . . the blackbody must have a certain minimum thickness depending on its absorbing power, in order to insure that the rays after passing into the body shall not be able to leave it again at a different point of the surface. The more absorbing a body is, the smaller the value of this minimum thickness, while in the case of bodies with vanishingly small absorbing power only a layer of infinite thickness may be regarded as black.*”

Yet the absorptivity of any material is not a function of thickness. Kirchhoff [5, §2] argued that only the surfaces of materials absorb and emit radiation:

“*This investigation will be much simplified if we imagine the enclosure to be composed, wholly or in great part, of bodies which, for infinitely small thickness, completely absorb all rays which fall upon them.*”

Physically speaking, there can be no narrower layer of a material than an atomic layer. In pure geometry a surface has no thickness at all because a geometric surface is 2-dimensional. Purely geometric surfaces cannot absorb or emit radiation, because they are not physical. Moreover, real materials are not all black, not because they are not sufficiently thick, but because they possess reflection, which occurs at their surfaces. This includes the ‘perfect reflector’, which can only reflect, as its absorbing and emitting powers are naught. The perfect absorber (i.e. a blackbody) is opaque and absorbs all incident radiation at its surface because its reflective power is naught.

There has never been a theoretical or experimental proof of Kirchhoff’s Law of Thermal Emission. Kirchhoff formulated his Law from theorising alone. Planck’s theoretical proof of Kirchhoff’s Law does not hold because, ironically, he violated the physics of thermal emission and of optics [6]. Moreover, there has always been ample experimental evidence that Kirchhoff’s Law is false, since if it was true, then resonant cavities would not exist because all cavities at thermal equilibrium would be blackbodies, incapable of producing standing waves. Conversely, if standing waves are present within a cavity, the radiation is not black. Resonant devices and associated microwave technologies attest to the falsity of Kirchhoff’s Law.

Although the details of the mechanism of thermal emission are unknown, as already pointed out in §1 above, it is known that thermal emission requires a lattice [11]. Only condensed matter possesses a lattice. Gases do not have a lattice structure. Consequently, gases do not emit a planckian spectrum. Gases emit generally in narrow bands, as shown for hydrogen gas in figure 2.

The blackbody spectrum is a continuous spectrum. Astronomy and cosmology nonetheless invoke blackbody spectra for the Sun and stars modelled as balls of hot gaseous plasma, and for the so-called ‘Cosmic Microwave Background’ (CMB). Statistical mechanics treats a ‘photon gas’ within a thermally equilibrated cavity as a blackbody spectrum, by assuming *a*

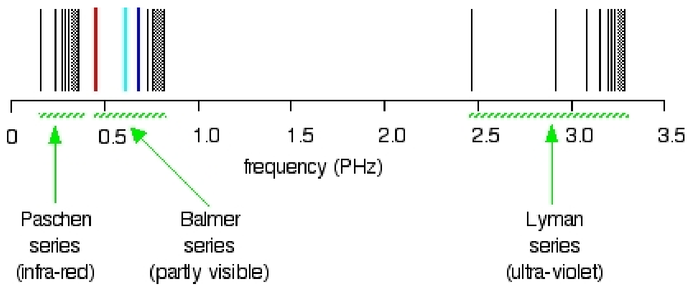


Fig. 2: The spectrum of hydrogen gas is not continuous. Gases do not possess a lattice.

*priori* that the material nature of the enclosure is irrelevant [12, §9.2]. This necessarily leads to universality of Planck's equation by the logical fallacy of *petitio principii*. A general equation for thermal spectra must account for the material nature of the enclosure. Physics has not ascertained such an equation. Planck's equation strictly pertains only to a blackbody in the setting of thermally equilibrated cavities. Otherwise, any temperature obtained from Planck's equation is, in general, uncertain.

When investigating cavity radiation Kirchhoff and Planck permitted all the energy in the walls thereof to be available to thermal emission. Pumping heat into these walls causes them to increase their temperature and this heat Kirchhoff and Planck made immediately available to exchange with the cavity radiation. In doing so they instantly made all cavities black because soot essentially has this property. Moreover, this is the reason why their cavities are independent of the nature of the walls. At thermal equilibrium the radiation density of any cavity is the same as if the cavity was made of or lined with carbon. The only difference between the views of Kirchhoff and Planck is that the latter permitted cavities made from transmissive solids, subject to 'thickness', whereas the former maintained that only the surface of an opaque solid emits and absorbs thermal radiation; a physical 'surface' being very thin. Planck's 'thickness' argument has no basis in physical reality, as the experiments of Stewart and Kirchhoff himself attest. Indeed, to this day there is no evidence whatsoever for Planck's 'thickness' hypothesis. Transmissive materials are not black, not because they are not very thick, or 'infinitely thick', but because they have low emissivity. In the case of the perfect reflector, it cannot produce blackbody cavity radiation because it has an emissivity of zero - it cannot emit any thermal radiation within a cavity of otherwise. Radiation from a perfect reflector is entirely reflected radiation. In relation to the 'Cosmic Microwave Background Radiation' which he calls "*a diffuse background of radio static left over from near the beginning of the universe*", Weinberg [13] repeats the fundamental error in the usual fashion:

> "*Inside a box with opaque walls, the intensity of the radio noise at any given wavelength depends only on the temperature of the walls - the higher the temperature, the more intense the static.*"

Real materials possess reflectivity. By failing to understand reflectivity, thereby neglecting it entirely, Kirchhoff and Planck incorrectly made all cavities black. If $\rho$ is reflectivity and $\epsilon$ is emissivity, then for opaque materials $\epsilon + \rho = 1$: the total thermal energy issuing from a material surface is a combination of that which is emitted and that which is reflected. A receiver of this radiation cannot discern which part is due to emission and which due to reflection, without knowing beforehand the nature of the material involved. In the case of a blackbody, $\rho = 0$, so its emissivity is 1. In the case of a perfect reflector, $\rho = 1$, so its emissivity is 0. All other opaque materials lie within the given range subject to the constraint $\epsilon + \rho = 1$. When heat is injected into the walls of an arbitrary cavity, the temperature of the walls rises, but not all of this energy is convertible to the thermal radiation field. In general, there is always energy within the walls of a thermally equilibrated cavity that is not available to exchange with the emission field inside the cavity. Energetic degrees of freedom exist within the walls which are not coupled to one another. Consequently, the radiation field within an arbitrary thermally equilibrated cavity does not report the true temperature of the cavity walls; only an apparent temperature. Nuclear Magnetic Resonance (NMR) and Magnetic Resonance Imaging (MRI) are thermal processes. For this very reason Felix Bloch called T1 the 'thermal relaxation constant'. Nonetheless, physics since Bloch has forgotten this, and astronomy and cosmology have never realised this. Robitaille [14] has made the fact stark - if Kirchhoff's Law of Thermal Emission is true, then MRI would be impossible. But MRI exists and is used in medicine every day. NMR and MRI are facilitated by means of spin-lattice relaxation, from which it follows that there is energy within the walls of an arbitrary cavity that is not available to thermal emission. The clinical existence of MRI is proof alone that Kirchhoff's Law of Thermal Emission has always been false. Consequently, Planck's equation is not universal. But without Kirchhoff's 'Law', and hence the universality of Planck's equation, big bang cosmology is invalidated in one stroke, without any need to consider the mathematical obfuscations of Einstein's General Theory of Relativity. Big bang cosmology is a product entire of General Relativity. It follows that Einstein's is a theory built upon sand. The properties of energy are the downfall of the General Theory of Relativity, for not only does it, in one way or another, invoke violations of the physics of thermal emission, it also violates the usual conservation of energy and momentum for a closed system [15–17]; thereby in conflict with a vast array of experiments. Moreover, Robitaille [18,19] has proven by means of a simple experiment that Kirchhoff's Law of Thermal Emission is certainly false.

Thermal spectra do not in general reveal the temperature of the emitter [6]. Only in the case of a known black solid, such as soot or graphite, at thermal equilibrium within a cavity, is the temperature certain. All other temperatures extracted from thermal spectra are uncertain - they are only apparent temperatures. The Sun is a case in point. Solar scientists report that the photosphere has a temperature of about 5,800 K [20], from the Sun's 'blackbody spectrum'. But the Sun is not within an enclosure and is not in thermal equilibrium with an enclosure. Although the solar spectrum has a planckian distribution, it is not a blackbody spectrum. The temperature extracted from the solar spectrum is therefore only apparent. To appear to have a temperature of 5,800 K, the photosphere must be hotter than 5,800 K because it must have a temperature high enough to look like a true blackbody at 5,800 K. Only if the photosphere is composed of a solid black material, such as graphite, is a temperature of 5,800 K absolute. Since the photosphere is not graphite, it is not at 5,800 K. Moreover, according to the standard solar model, the Sun is a ball of hot gaseous plasma, in which case it does not have a lattice structure and is therefore unable to emit a planckian spectrum. Yet the solar spectrum is continuous, mimicking a blackbody at 5,800 K. The sprectra for several stars are illustrated in figure 3.

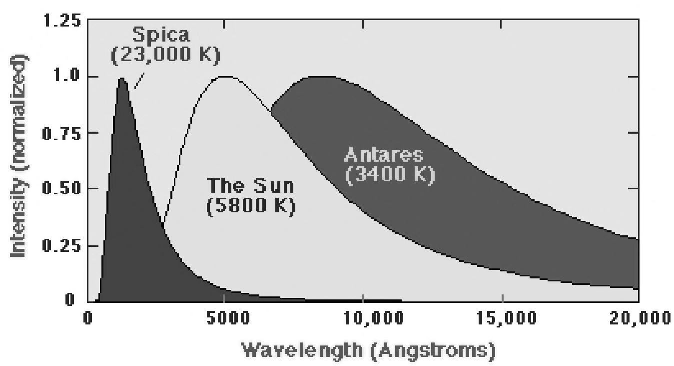


Fig. 3: The spectra of three stars. Note that they are continuous and follow a planckian distribution. The temperatures are not real, only apparent, because stars are not blackbodies and are not at thermal equilibrium within an enclosure.

The conclusion is that the Sun is not gaseous - it must be condensed matter. The gaseous model of the Sun is an example of the misapplication of Kirchhoff's Law of Thermal Emission, even if the Law be true, and misinterpretation of its thermal spectrum, by the incorrect assumption of universality of Planck's equation. To mimic a blackbody at 5,800 K the Sun must have an emission mechanism similar to graphite - at the very least it must possess a lattice structure. Only condensed matter possesses a lattice. Matter that is not condensed cannot emit a planckian spectrum. Robitaille [2, 8, 9] has argued cogently that the Sun is condensed matter, mostly likely liquid metallic hydrogen. Liquid metallic hydrogen has a hexagonal-planar structure similar to graphite. This structure accounts very well for the observational evidence from the Sun. Different star types have different lattice structures.

By means of microwave ovens in the home and submarine radio communications it is well known that water is a good absorber of microwaves. It is also well known from the laboratory that a good absorber is a good emitter, and at the same frequencies. Thus, water is a good emitter of microwaves. Approximately 70% of the Earth's surface is covered by water. This water is not microwave silent. It is in steady state with the atmosphere. Microwave emissions from the oceans are scattered by the atmosphere, producing an isotropic microwave bath therein. It therefore does not matter from which direction or at what time of day or of season, when sampled from the ground, this microwave signal is present and robust. Water is condensed matter. As with all liquids, it has a fleeting lattice. In the case of water there are two bonds: (1) the hydroxyl bond, (2) the hydrogen bond. The strengths of these two bonds are not the same. The hydrogen bond has a force constant that is $\approx$100 times weaker than the hydroxyl bond. Figure 1 depicts the fleeting lattice of water. Each water molecule forms four hydrogen bonds with surrounding water molecules, in the essentially linear subunits, O-H$\cdot\cdot\cdot$O, schematically depicted in figure 4.

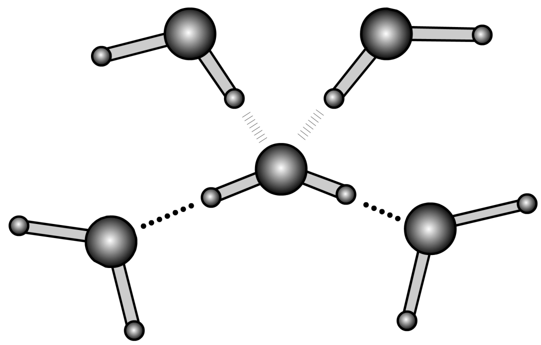

Fig. 4: The water lattice. Each water molecule acts to accept and donate four hydrogen bonds. The subunit O-H· · ·O is essentially linear. Reproduced from Robitaille [32], with permission.

The energy in the hydroxyl bond is not available to microwave emission, whereas the hydrogen bond, acting as an oscillator, is responsible for microwave emissions from water [32, 33]. The water dimer is depicted in figure 5.

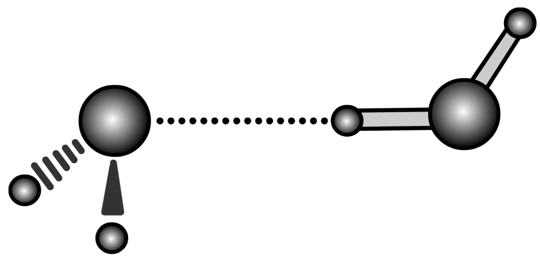

Fig. 5: Schematic representation of the trans-linear water dimer. The subunit O-H···O is essentially linear. Reproduced from Robitaille [32], with permission.

Water is an example of energetic degrees of freedom being uncoupled. Since the hydrogen bonds form a lattice, water emits microwaves in a planckian distribution. From this spectrum a Wein's temperature can be mathematically extracted. However, most of the water's energy is contained in the microwave inaccessible hydroxyl bond. If $E_1$ is the energy in the hydroxyl bond, $E_2$ the energy in the hydrogen bond, $k_1$ and $k_2$ the respective bond force constants, then the ratio of the energies, and hence of the temperatures, is equal to the ratio of the force constants [32, 33]:

$$\frac{E_1}{E_2} = \frac{T_1}{T_2} = \frac{k_1}{k_2}. \tag{4}$$

Since it is known that $k_1/k_2 = 100$ [32], and if the mean temperature of the oceans is ≈300 K, then,

$$T_2 \approx \frac{300K}{100} \approx 3K.$$

> "*Consequently, a mechanism for creating isotropy from an anisotropic ocean signal is indeed present for the oceanic ≈3 K Earth Microwave Background.*" [32]

Hence, the spectrum from the hydrogen bond does not report the temperature of the body of water emitting microwaves. This temperature is only an apparent temperature - it is not the temperature of anything; illustrating the fact that Planck's equation is not universal. The consequences of this for cosmology are dire, for it was from the ground, in 1964, that Penzias and Wilson [34] detected what has since been dubbed the Cosmic Microwave Background (CMB) radiation. They assigned an absolute temperature of 3.5 ± 1 K to their residual signal. In assigning an absolute temperature they violated the physics of thermal emission because they knew nothing of the source of the signal. Only from a known black solid at thermal equilibrium can an absolute temperature be assigned with certainty. Temperatures extracted from spectra of unknown sources are uncertain, since the source might not be black, near black, or in thermal equilibrium.

## 3 The 'Cosmic Microwave Background'

Cosmology asserts that there is an isotropic cosmic microwave signal (CMB) pervading the Universe and that it has the profile of a blackbody spectrum at an absolute temperature of ≈2.725 K, produced by a big bang creation event:

> "*According to the big bang theory, the universe was in thermal equilibrium during its early stages. A searing light pervaded all locations and traveled in all directions, with the characteristics of a blackbody at very high temperature.*" [21]

It is said to be the thermal remnant of a big bang creation event, "*the fading archive of the Universe's fiery beginning billions of years ago*" [20], "*an all-pervasive hum of radiation with a temperature equivalent of a little more than 3 degrees Kelvin (three degrees above absolute zero) . . . a faded snapshot of the universe as it was some three hundred thousand years after the big bang*" [21]. Cosmology claims to be able to reconstruct its big bang universe right back to the tender age of $10^{-43}$ seconds [20]. Between this 'time' and some 380,000 years after *creation ex nihilo*, the big bang universe was occupied only by particle-exotica such as neutrinos, quarks, gluons, leptons, atomic nuclei, and photons (i.e. electromagnetic radiation) [13, 20, 22]. To invoke the thermal equilibrium requirement of Kirchhoff's Law of Thermal Emission and Planck's equation, it is merely claimed that these primæval particles were in thermal equilibrium: "*According to big bang theory, the universe was in thermal equilibrium during its early stages.*" [21]. No explanation is given as to how thermal equilibrium was achieved, bearing in mind that cosmology also asserts that "*At the big bang itself, the universe is thought to have had zero size, and so to have been infinitely hot*" [23]. Since temperature is a manifestation of the kinetic energy, and hence the speed, of particles other than photons (i.e. particles that, according to cosmologists, have 'rest mass'), one can only wonder how fast these particles must have been moving in order to be 'infinitely hot', all the while occupying and speeding through zero volume, at thermal equilibrium! That which has zero size has no volume and hence cannot contain mass or have a temperature. According to the physicists and the chemists, temperature is the motion of atoms or molecules. The more energy imparted to the atoms or molecules the faster they move about and so the higher the temperature. In the case of a solid the atoms or molecules vibrate about their equilibrium positions in a lattice structure and this vibration increases with increased temperature. Pauling [24] conveys this:

> "*As the temperature rises, the molecules become more and more agitated; each one bounds back and forth more and more vigorously in the little space left for it by its neighbours, and each one strikes its neighbours more and more strongly as it rebounds from them.*"

Increased energy causes atoms or molecules of a solid to break down the long range order of its lattice structure to form a liquid or gas. Liquids have short range order, or long range disorder. Gases have a great molecular or atomic disorder. In the case of an ideal gas its temperature is proportional to the mean kinetic energy of its molecules [12, 25, 26]:

$$\frac{3}{2}kT = \frac{1}{2}m\left\langle v^2\right\rangle,$$

where $\left\langle v^2\right\rangle$ is the mean squared molecular speed, $m$ the molecular mass, and $k$ is Boltzmann's constant. But that which has zero size has no space for atoms or molecules to exist in or for them to move about in. And just how fast must atoms and molecules be moving about to be infinitely hot? Nothing can have zero size and infinite hotness. Nonetheless, according to Misner, Thorne and Wheeler [27],

> "*One crucial assumption underlies the standard hot big-bang model: that the universe 'began' in a state of rapid expansion from a very nearly homogeneous, isotropic condition of infinite (or near infinite) density and pressure.*"

Just how close to infinite must one get to be "*near infinite*"? Infinite and 'near infinite' density and pressure are no more meaningful than infinite hotness of zero size.

At the age of ≈380,000 years, called the 'time of decoupling' or the 'time of recombination', the supposed expanding universe became transparent to radiation, thereby setting free the CMB. Continued expansion of the 'spacetime' of this universe effectively stretched the wavelength of its CMB, reducing its 'temperature':

> "*. . . the 'hot big bang model.' This assumes that the universe is described by a Friedmann model, right back to the big bang. In such models one finds that as the universe expands, any matter or radiation in it gets cooler.*" [23]

However, since thermal spectra can only be produced by condensed matter, it is impossible for a blackbody spectrum to be produced by the exotic non-condensed matter of which the Universe was then only supposedly comprised. Cosmology however, to bring matter that is not condensed into the fold of blackbody radiation, simply and incorrectly asserts that "*Blackbody radiation arises whenever particles collide with each other very rapidly in thermal equilibrium*" [21]. Weinberg [13] asserts that "*Any sort of body at any temperature above absolute zero will always emit radio noise, produced by the thermal motion of electrons within the body*". Soot and graphite are blackbodies. Anything that produces a blackbody spectrum must have a structure similar to that of soot or graphite. Particle collisions do not fall within the necessary structural character. Anything that produces a planckian spectrum must possess a lattice [11]. Free particles do not have lattice structure, neither do thermal electrons. Particles colliding "*with each other very rapidly in thermal equilibrium*" do not produce a continuous spectrum, let alone a planckian one.

Penzias and Wilson [34] discovered that the residual signal in their antenna did not vary with the time of day, the direction of their antenna, or with the seasons. In the same issue of the journal that published their findings, in the pages immediately before their paper, the theoretical cosmologists Dicke, Peebles, Roll and Wilkinson [35], assigned the signal to the Cosmos, as the remnant of a big bang creation event, to accord with the Friedmann-Robertson-Walker metric obtained as a cosmological solution to a certain set of Einstein's General Theory of Relativity field equations. They too insisted that the spectrum is that of a blackbody, so that the temperature extracted from it is absolute. But Earth takes its atmosphere and its oceans with it as it orbits the Sun and rotates on its axis. From the ground, the microwave emissions from the oceans, scattered to isotropy in the atmosphere by the atmosphere [39, 40] are independent of time of day, of seasons, and of antenna direction, just as Penzias and Wilson reported. Shown in figure 6 is Earth. Approximately 70% of the surface of Earth is covered by water. The oceans are not microwave silent.

Fig. 6: Approximately 70% of the surface of Earth is covered by water. This water is not microwave silent. That COBE did not report any microwave interference from Earth is precisely because Earth is the source of the signal, from its oceans.

Penzias and Wilson in fact sampled the microwave emissions of the oceans, present isotropically in the atmosphere due to atmospheric scattering, but eventually came to believe that this signal has a cosmic origin, because they did not realise that the source of their signal was proximal. The signal is not of cosmic origin. Subsequent detection of the 'CMB' monopole signal by the Earth orbiting COBE satellite, at an altitude of ≈900 km, reaffirmed that the signal is the oceanic microwave emission profile, even though the COBE Team also assigned it to the Cosmos, on the basis of big bang predilection and concomitant oversight of the nature of oceanic water. The immediate consequence of this is that big bang cosmology is again invalidated.

The CMB is mathematically modelled by means of an infinite series of spherical harmonics. The first term in the series is the monopole signal, the second is the dipole signal, after which come the quadrupole, the hexadecapole, and so on in the multipoles. This mathematical model, *ipso facto*, does not fix the same physical causation to each component of the infinite series. The existence of the dipole signal does not mean that the 'CMB' monopole signal detected by COBE-FIRAS must exist throughout the Universe. The dipole signal is, according to cosmology, on its assumptions for the CMB monopole, due to a Doppler effect associated with motion of the local galactic group through the CMB.

"*If the Earth is moving, however, there is a smooth variation in temperature across the sky, because of the*

*Doppler effect. In the direction in which the Earth is moving, the cosmic background looks warmer; in the direction of recession, cooler. ...The amount of warming and cooling is proportional to the speed of motion compared to the speed of light, and the direction of the dipole lines up with the direction of motion. ...the sky was warmest in the direction of Leo and coolest in the direction of Aquarius, which means that the Earth was moving toward the former and away from the latter. That is not the direction in which the Galaxy rotates. ...Not only is the entire Galaxy rotating, as it should be, but, unexpectedly, it is also moving through space. And it is moving very fast - six hundred kilometers a second, or more than a million miles an hour. ...while Earth and the Solar System are moving toward Leo at about 350 kilometers per second - more than ten times the velocity of the Earth going around the Sun - the Milky Way galaxy is traveling about 600 kilometers per second. ...And the Mily Way is not alone in its extreme velocity. About a dozen neighboring galaxies - the Local Group - are also moving presumably under the influence of the distant unseen structure.*" [21]

The dipole signal is not isotropic, and had been detected by instruments aboard balloons, planes and rockets, before COBE. The Soviet Relikt-1 satellite, for instance, detected the dipole signal [36]; COBE confirmed the finding, and from its measurements its 'temperature' at 3.353±0.024 mK in the direction $(l, b) = (264.26^o \pm 0.33^o, 48.22^o \pm 0.13^o)$ galactic longitude and latitude. Since Earth is in fact the source of the strong monopole signal detected by COBE-FIRAS, cosmology's mathematical model of the CMB bears no relation to reality, despite the existence of the dipole signal. The cause of the dipole signal must lie elsewhere [41]. Merely aligning it to a component of the mathematical model does not make its ultimate ætiology the same, explicitly or implicitly, as the strong monopole detected very near Earth. Cosmology's mathematical model simply reflects the assumptions by which it was constructed. Nothing in the mathematical model compels the assumptions for it to be true.

# 4 The Cosmic Background Explorer satellite

On November 18, 1989, the Cosmic Background Explorer satellite (COBE) was launched, commissioned to survey cosmic microwaves and infrared signals at an altitude of ≈900 km above Earth. It carried two instruments for microwave purpose; (1) the Far Infrared Absolute Spectrophotometer (FIRAS), (2) the Differential Microwave Radiometers (DMR). FIRAS was to sample the CMB monopole signal and DMR primordial anisotropies in the CMB. Both instruments returned data for the dipole signal. Figure 7 is a schematic of COBE-FIRAS.

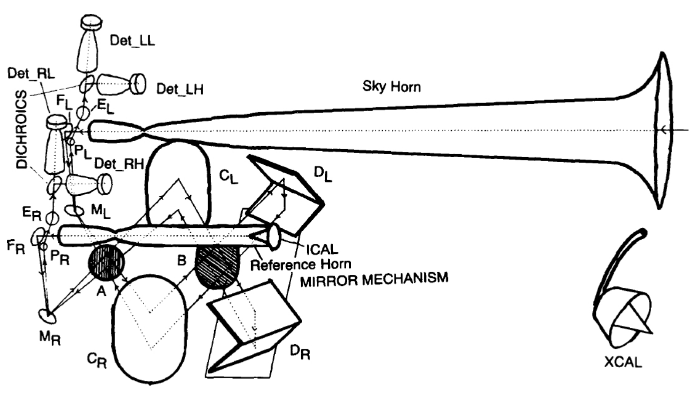


Fig. 7: Salient components of FIRAS: Sky horn, reference horn, Ical (2 thermometers), and Xcal (3 thermometers) (Ical = Internal calibrator, Xcal = External calibrator). From [38], courtesy of NASA and the COBE Science Working Group. Accessed online 16th August 2017, https://lambda.gsfc.nasa.gov/product/cobe/firas_exsupv4.cfm

"*FIRAS was designed to function as a differential radiometer, wherein the sky signal could be nulled by the reference horn Ical.*" [39]

The CMB monopole temperature was reported by FIRAS as 2.725±0.001 K [37] over a blackbody spectrum. The signal to noise for the monopole was so great that the error bars on the graph of the spectrum are some 400 times smaller than the width of the line used to draw the graph, shown in figure 8.

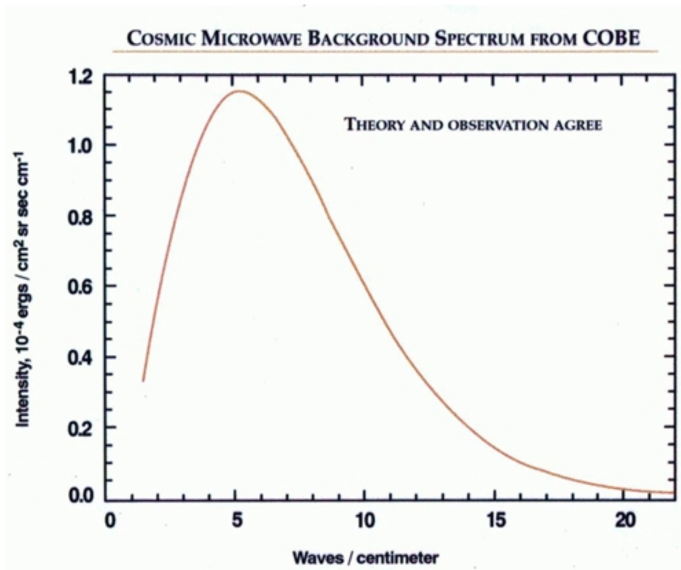


Fig. 8: The planckian spectrum of the CMB monopole signal reported by COBE-FIRAS. FIRAS was sensitive not directly to the sky but to the difference between the sky and the FIRAS external calibrator, *xcal*. Hence, this spectrum is that of the external calibrator, matched to the sky. Although data was initially reported by the FIRAS Team for < 2cm$^{-1}$, this data was subsequently dropped from the plot, without explanation, and the frequency axis was offset to the left. Figure courtesy of NASA and the COBE Science Working Group. Accessed online 11$^{\text{th}}$ August 2017, https://lambda.gsfc.nasa.gov/product/cobe/cobe_image_table.cfm

The COBE Team reported that the satellite's shield covered the frequency range 30 GHz to 3,000 GHz, although FIRAS sampled principally in the 30-600 GHz range. This is a 100-fold shield frequency range. But no such broadband shield exists. Moreover, a shield to intercept extraneous microwaves must be specially designed. Examination of the COBE shield design [45] reveals that no measures were specially taken for microwaves. COBE's shield was not able to prevent microwave diffraction over its shield. Indeed, the COBE-FIRAS Team reported that they detected unexpectedly higher intensity at the lower frequencies and unexpectedly lower intensity at the higher frequencies [37]. This is precisely the effect expected however due to microwave diffraction over the shield.

The COBE Team did not report any microwave interference from Earth. This attests to the Earth being the actual source of the signal [39, 40].

Since the COBE shield was helpless before microwave diffraction over its perimeter, microwave emission originating from the oceans below it, scattered to isotropy by Earth's atmosphere, were able to freely diffract over the shield and into the FIRAS horn. Bearing in mind that the signal to noise for FIRAS was enormous, the source of the signal must be proximal. Since the ≈2.725 K monopole signal is so powerful, any satellite located anywhere should, with a suitable detector, find no less signal to noise power. Yet no cosmological satellite far beyond the confines of Earth reported detection of the ≈2.725 K CMB monopole signal. Without the CMB monople signal beyond the confines of Earth, all arguments for its existence and its supposed anisotropies have no scientific merit. There can no doubt that the ≈2.725 K monopole signal has its origin on Earth [39].

The COBE-FIRAS Team reported a set of three interferograms, obtained in-flight, in a single image (figure 9). The top trace had the Internal Calibrator (ICAL) set at 2.759 K and compared to the sky. The trace seems to contain only small deviations from the horizontal and is reported as "*near null*". The second trace has ICAL set at 2.771 K and compared to the sky. It contains significant vertical displacement and is reported as "*off null*". The third and final trace has ICAL set at 2.759 K and the External Calibrator (XCAL) set at 2.750 K and contains a significant vertical displacement. Despite reporting a "*near null*" at 2.759 K the FIRAS team ultimately reported a 'CMB' temperature of 2.725 K. However, Robitaille [39] has pointed out that the top and bottom traces are not drawn to the same scale. This is evident from the noise power in the traces. The noise power should be the same for all three traces. It is most clearly evident in the middle trace as it is the jitter in the baseline of the trace. For the top and bottom traces to appear on the same scale as the middle trace, so that the jitter is of the same amplitude, they must be amplified by a factor between 3 and 5. The result is that the "*near null*" report is far from near null. The top and bottom traces have had their amplitudes suppressed, apparently to give the false impression that a 'near

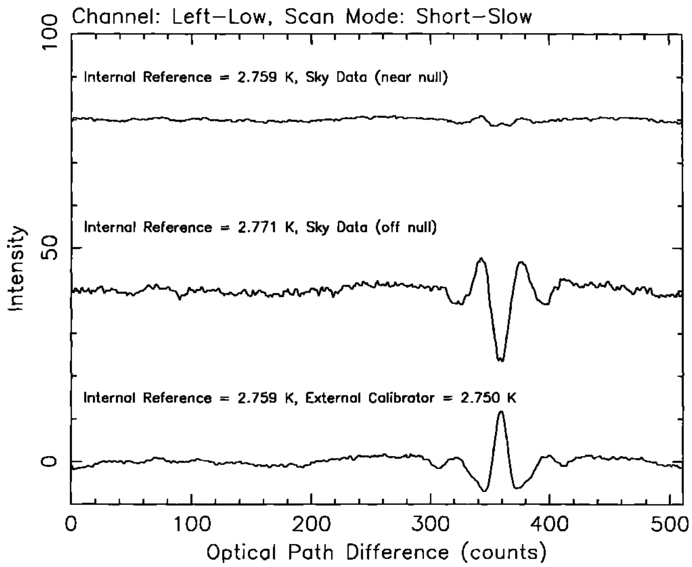


Fig. 9: Interferograms obtained in flight with FIRAS. The top and bottom traces are not on the same scale as the middle trace. The traces are deceptive. From Mather et al. (1990) [44], courtesy of NASA and the COBE Science Working Group. Accessed online $16^{\text{th}}$ August 2017, https://lambda.gsfc.nasa.gov/product/cobe/firas_exsupv4.cfm

null' was obtained. These traces are deceptive [42]. Moreover, the spectral precision reported by the FIRAS Team is well beyond the capacity of the instrumentation that was on COBE:

> "*Finally, in 2002, Fixsen and Mather advance that 'the measured deviation from this spectrum are 50 parts per million (PPM, rms) of the peak brightness of the CMBR spectrum, within the uncertainty of the measurement'. Using technology established in the 1970's, the FIRAS team reported a spectral precision well beyond that commonly achievable today in the best radiometry laboratories of the world.*" [39]

The reported a null at 2.759 K is 34 mK above the reported sky temperature, 2.725 ± 0.001 K. Null should ideally occur at the sky temperature. Owing to 18 mK error in the thermometers, ≈3 mK temperature drift, 5 mK error in the sky horn Xcal, and 4 mK error in *Ical*, Robitaille determines an overall error bar of ≈64 mK in the microwave background. Yet the FIRAS team reported only ≈1 mK. Errors were evidently dumped into the calibration files. And as Robitaille [39]observes, "*a 1 mK error does not properly reflect the experimental state of the spectrometer*". Moreover, the FIRAS team's calibration procedures produced calculated *Ical* emissivities great than 1.3 at the higher frequencies; but the theoretical maximum for emissivity is exactly 1 by definition.

FIRAS was unable to obtain proper nulls, despite the FIRAS team's reports that they obtained "*the most perfect blackbody spectrum ever measured*" [46]:

> "*It is sometimes stated that this is the most perfect blackbody spectrum ever measured, but the measurement is actually the difference between the sky and the calibrator.*" [46]

Robitaille [39] expresses the relationship thus:

$$(\text{Sky - Ical}) - (\text{Xcal - Ical}) = (\text{Sky - Xcal}).$$

It is clear from this relation that the effects of *Ical* and instrumental factors should be negligible: but that is not what the FIRAS team found. It is also clear that if *Xcal* matches the sky a null will result. *Xcal* is assumed an ideal blackbody spectrum and so the sky would also be an ideal blackbody spectrum in the event of a null. The FIRAS team assumed from the outset that the sky is as an ideal blackbody. Note that if the calibration obtained with *Xcal* in place is dominated by leakage of sky signal into the horn then a perfect blackbody spectrum would result because the sky would then be compared with itself. Robitaille [39] has shown that there was significant sky leakage into the horn during calibration with *Xcal*.

Unable to obtain a proper null, the FIRAS team blamed instrument problems and the calibrations, but never entertained the possibility that the sky, owing to emissions originating from the Earth diffracting over the RF shield, was not behaving as a blackbody, as they assumed. Fixen et al [38] remarked: "*However, the measured emission is higher than predicted, particularly at the lowest frequencies*; at the very frequencies at which diffraction of photons from Earth would be a maximum over the RF shield. In addition, all data when the Earth illuminated the instrument were rejected outright, thereby removing any effect of earthshine that might well assign the microwave background to the oceans.

> "*In the end, the FIRAS team transfers the error from the spectrum of interest into the calibration file . . . Using this approach it would be possible, in principle, to attain no deviations whatever from the perfect theoretical blackbody. Given enough degrees of freedom and computing power, errors begin to lose physical meaning. The calibration file became a repository for everything that did not work for FIRAS*" [39]

To extract the cosmic microwave anisotropies thought by cosmology to be lurking beneath the CMB monopole signal, COBE-DMR had to contend with the presence of the microwave monopole, the dipole, and the galactic foreground which is $\approx$1000 times stronger than the signal sought (the galactic contaminaiton is in mK). This is a dynamic range problem, similar to water suppression in biological proton Nuclear Magnetic Resonance (NMR). For instance, a biochemical compound of interest is often dissolved in water, in the aqueous cytosol of a cell. Water is $\approx$110 molar in protons. A compound of interest might be $\approx$1 - 100 millimolar. A best case scenario is then an $\approx$1,000 fold required water signal removal. In biological proton NMR, water suppression can be 100,000 or more. To achieve suppression of water resonances that swamp the resonance of the dissolved compound of interest, various techniques have been developed, either physically, as in specialised spin excitation, or biochemically through substitution. One example of how this is achieved is sufficient to make the point: Biochemical substitution involves removal of most of the water protons by substituting deuterium oxide ($D_2O$) using a process called lyopholisation, where the sample is repeatedly frozen then sublimated under vacuum. The water solvent is then replaced by $D_2O$, which has a nuclear magnetic resonance far from water, thereby revealing the resonance of the compound of interest at the relevant frequency. This is an example of modification of the sample in order to secure the signal of a compound that has a resonance that lies below that of the aqueous solvent. An example of this process is depicted in figure 10.

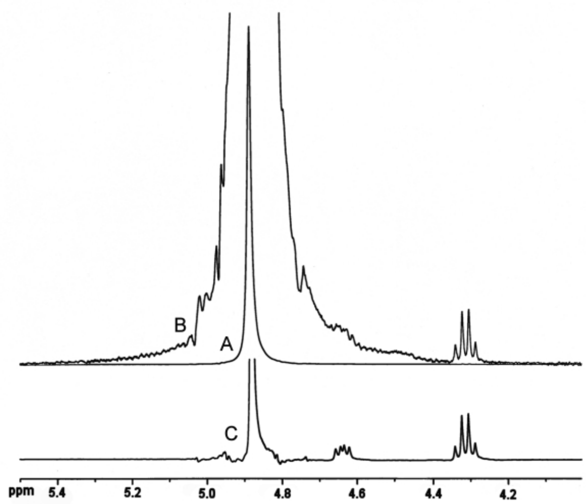


Fig. 10: Proton nuclear magnetic resonance (NMR) spectra acquired from a 0.1 M solution of 0.1 M N-benzoyl-L-arginine ethyl ester hydrochloride in water (A, B). The spectrum is shown in full scale (A). In (B) the vertical axis has been expanded by a factor of 100, such that the resonance lines from the N-benzoyl-L-arginine ethyl ester can be visualized. A 1H-NMR spectrum acquired from 0.1 M N-benzoyl-L-arginine ethyl ester hydrochloride in deuterium oxide ($D_2O$) is also displayed (C). Spectra display only the central region of interest (4.0-5.5 ppm). Acquisition parameters are as follows: frequency of observation 400.1324008 MHz, sweep width 32,768 Hz, receiver gain 20, and repetition time 5 seconds. The sample dissolved in $D_2O$ (C) was acquired first using a single acquisition and a 90 degree nutation. A field lock was obtained on the solvent. This was used in adjusting the feld homogeneity for both samples. For (A) and (B), 20 acquisitions were utilized to enable phase cycling of the transmitter and receiver. In this case, the nutation angle had to be much less than 90 degrees in order not to destroy the preamplifer. A field lock could not be achieved since $D_2O$ was not present in the sample. These slight differences in acquisition parameters and experimental conditions make no difference to the discussion in the text relative to problems of dynamic range. Figure and caption reproduced from [47] with permission.

The cosmological satellites attempting to extract anisotropies from the CMB are even worse off than the example of figure 9, because the hypothesised anisotropies are, analogously, located directly beneath the water resonance. Thus, as Robitaille [47] has emphasised, laboratory experience attests that it is impossible to extract a signal ≈1000 times weaker than the enveloping noise without being able to manipulate the source of the signal or without *a priori* knowledge of the nature of the signal source; neither of which were available to COBE-DMR. George Smoot, the principal investigator for COBE-DMR, related that to extract the weak multipoles, which he called "*wrinkles in the fabric of time*" [21], by computer data-processing, required first the removal of the 2.725 K monopole, the dipole, the galactic foreground, and then the quadrupole. He puzzled over why the multipoles did not appear until the quadrupole was finally removed by computer data-processing methods, since the raw data contained no systematic signal variations:

> "*We were confident that the quadrupole was a real cosmic signal. ... By late January and early February, the results were beginning to gel, but they still did not quite make sense. I tried all kinds of different approaches, plotting data in every format I could think of, including upside down and backwards, just to try a new perspective and hoping for a breakthrough. Then I thought, why not throw out the quadrupole - the thing I'd been searching for all those years - and see if nature had put anything else there. ... Why, I puzzled, did I have to remove the quadrupole to see the wrinkles?*" [21].

Robitaille's [39] answer is simple:

> "*However, when Smoot and his colleagues imposed a systematic removal of signal, they produced a systematic remnant. In essence, the act of removing the quadrupole created the multipoles and the associated systematic anisotropies. ... these findings have no relevance to cosmology and are purely an artifact of signal processing.*"

Smoot's "*wrinkles in the fabric of time*" are nothing more than consistent residual ghost signals produced by his computer data-processing. The appearance of such systematic ghost signals throughout an image when computer data-processing large contaminating signals is very well known in medical imaging, an example of which is figure 11.

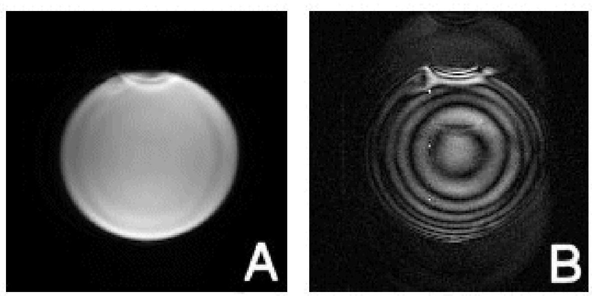


Fig. 11: Ultra High Field 8 Tesla MRI image of an 18 cm ball of mineral oil acquired using a 3-dimentional acquisition. A) Axial slice representing a region contained within the physical space occupied by the 18 cm mineral oil ball. (B) Axial slice through a region located outside the physical space occupied by the ball. Note that the image displayed in (B) should be entirely devoid of signal. The severe image processing artifacts contained in (B) are a manifestation that the processing of powerful signals can result in the generation of weak spurious ghost signals. Figure and caption reproduced from [47] with permission.

"*Apparent anisotropy must not be generated by processing*" [39, 47]. This is not to say that the sky is not anisotropic, since the microwave contamination is anisotropic, but that the anisotropies reported by COBE-DMR are not present in the sky, rather only as self-induced artifacts of computer data-processing, mistaken for signal.

# 5 The Wilkinson Microwave Anisotropy Probe satellite

The Wilkinson Microwave Anisotropy Probe (WMAP) sampled the sky from the 2$^{nd}$ Lagrange Point (L2), 1.5 million kilometres from Earth, depicted in figure 12.

WMAP did not measure absolute intensity of any microwave signal because it was strictly a differential instrument: It operated by measuring the signal difference between input antennae. All data was therefore 'difference data'. Signal from the sky was sampled by two receivers and the difference continually monitored. The pseudo-correlation radiometers of WMAP

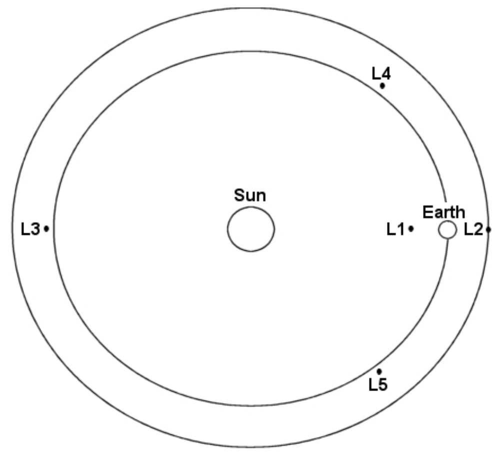


Fig. 12: The Lagrange points and the location of WMAP at L2. Reproduced from [41] with permission.

are shown schematically in figure 13. Signal from different parts of the sky enter the two sky horns. These signals are subtracted by the instrument so that any signal that is common to each sky horn vanishes in the output data. What is left is difference data. Any differences that persist represent anisotropies. Thus, if the CMB monopole signal is present at L2, it is subtracted out immediately by the instrument. WMAP, by its differential operation, was totally blind at L2 to the presence or absence of the strong monopole signal detected by COBE-FIRAS near Earth. In the case of the dipole signal, since it is anisotropic, it appears in the difference data of WMAP. The WMAP Team reported detection of the dipole signal at L2. Because the dipole signal is noise in relation to the sought after anisotropies of the assumed CMB, it had to be removed. Removal of the dipole signal was done by computer data-processing because it cannot be subtracted out instrumentally. In addition to the dipole, anisotropic signals from the galactic foreground, and numerous points sources of microwaves, both galactic and extragalactic, also had to be removed by computer data-processing. Thus, everything depended on computer data-processing after differencing of the sky horns, whether or not the CMB monopole signal even existed at L2.

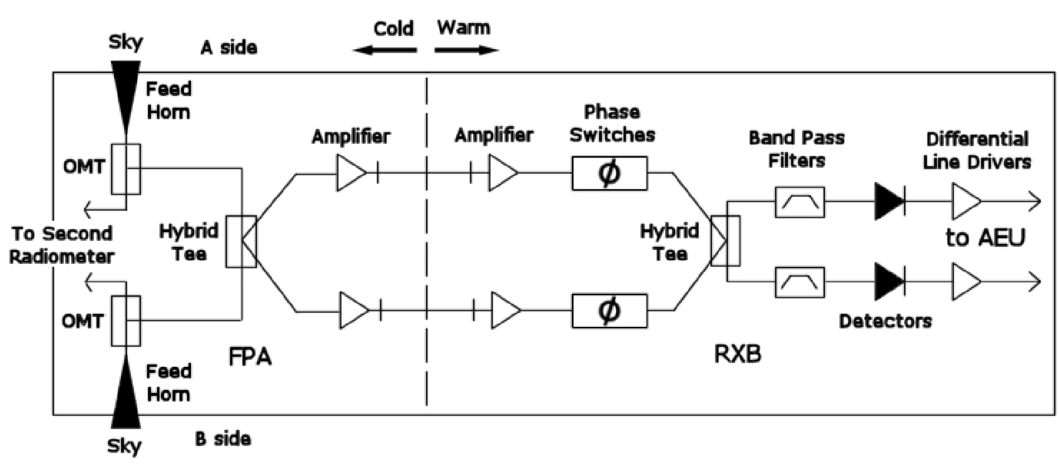


Fig. 13: Partial schematic representation of the WMAP pseudo-correlation differential radiometers [48]. The signal from each horn first travels to an orthomode transducer (OMT) wherein two orthogonal outputs are produced, one for each radiometer. One output from the OMT travels to the $180^{o}$ hybrid tee before entering the phase-matched leg of the radiometer. The signal from each horn was compared directly to its paired counterpart. The satellite did not make use of internal reference loads and could not operate in absolute mode. (Reproduced from [41] with permission.)

WMAP sampled at five frequencies: K ≡ 23GHz, Ka ≡ 33GHz, Q ≡ 41GHz, V ≡ 61GHz, W ≡ 94GHz, shown in figure 14. The red-coloured irregular horizontal band dominating each of the images is due to the galactic foreground, which constitutes noise that must be removed, by computer data-processing.

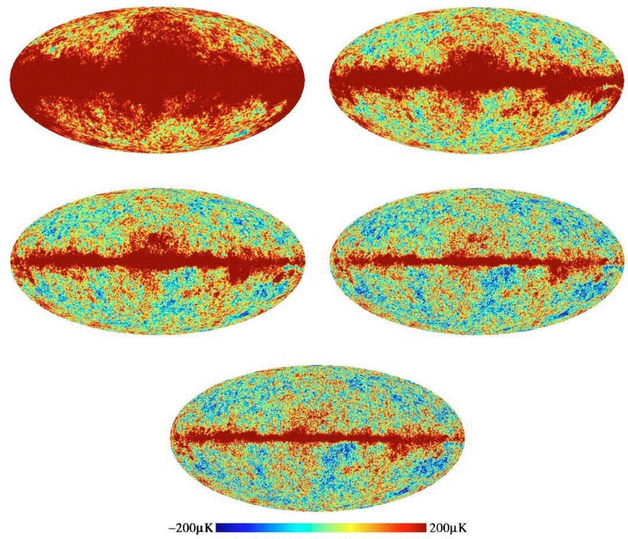


Fig. 14: The five frequency bands observed by the WMAP satellite. Images correspond to 23 GHz (K band, upper left), 33 GHz (Ka band, upper right), 41 GHz (Q band, middle left), 61 GHz (V band, middle right), and 94 GHz (W band, bottom). Reprinted portion of Figure 2 from [49] with permission from Tegmark, M., de Oliveira-Costa, A., Hamilton, A.J.S. Copyright (2003) by the American Physical Society.

WMAP essentially had to look through the galactic noise (peer through the galaxy), which is all over the sky, with the highest intensity in the galactic plane as revealed in figure 13. This is the very same dynamic range problem that COBE-DMR had to contend with. Like Smoot's DMR Team, the WMAP Team had no means to physically or chemically manipulate any microwave anisotropy source and no *a priori* knowledge of the nature of such sources it sought to identify. Consequently, the WMAP Team also could not zero the galactic foreground.

Notwithstanding the impossibility to do so, the WMAP Team, just as the COBE-DMR Team, claimed to have successfully removed the galactic foreground noise from its all-sky anisotropy map. In its attempt to do so the WMAP Team took each all-sky image it had obtained for each of the five frequencies sampled (Fig. 14) and divided them into the same twelve sections, shown in figure 15.


Fig. 15: The 12 regions used to generate the ILC maps for year 3 average data; from Hinshaw et. al. [53]. Reproduced with permission of D. Spergel.

Each region was then processed by a linear combination of each frequency image obtained for that same region. For instance, region 0 was fully constructed by a linear combination of region 0 from each frequency image, by means of assigning a weighting to region 0 in each frequency image; and so on for all regions. The Integrated Linear Combination (ILC) coefficients and weightings are listed in table 1.

Note that the V-band in table 1 was given a favoured weighting. There is no scientific basis for this. Weighting of the V-band was entirely arbitrary. Any band can be favoured *ad arbitrium*. Moreover, claiming that the large galactic foreground

| Region | K-band | Ka-band | Q-band | V-band | W-band |
|---|---|---|---|---|---|
| 0 | 0.1559 | -0.8880 | 0.0297 | 2.0446 | -0.3423 |
| 1 | -0.0862 | -0.4737 | 0.7809 | 0.7631 | 0.0159 |
| 2 | 0.0385 | -0.4543 | -0.1173 | 1.7245 | -0.1887 |
| 3 | -0.0807 | 0.0230 | -0.3483 | 1.3943 | 0.0118 |
| 4 | -0.0781 | 0.0816 | -0.3991 | 0.9667 | 0.4289 |
| 5 | 0.1839 | -0.7466 | -0.3923 | 2.4184 | -0.4635 |
| 6 | -0.0910 | 0.1644 | -0.4983 | 0.9821 | 0.4428 |
| 7 | 0.0718 | -0.4792 | -0.2503 | 1.9406 | -0.2829 |
| 8 | 0.1829 | -0.5618 | -0.8002 | 2.8462 | -0.6674 |
| 9 | -0.0250 | -0.3195 | -0.0728 | 1.4570 | -0.0397 |
| 10 | 0.1740 | -0.9532 | 0.0073 | 2.7037 | -0.9318 |
| 11 | 0.2412 | -1.0328 | -0.2142 | 2.5579 | -0.5521 |

Table 1: ILC weights by regions. ILC coefficients used in the analysis of 3-year data by the WMAP team. This table corresponds to Table 5 in Hinshaw et. al. [53].

signal can be removed, despite absence of access to signal source or *a priori* knowledge of it, the WMAP Team produced Integrated Linear Combination (ILC) images, effectively assuming, without any scientific basis, that the galactic foreground signal is frequency dependent and the sought after underlying anisotropies frequency independent.

Numerical coefficients used by the WMAP team to process each section of their final image, vary by more than 100%.

> "*The WMAP team invokes completely different linear combinations of data to process adjacent regions of the galactic plane. . . . The coefficients for section 4, correspond to* −0.0781*,* 0.0816*,* −0.3991*,* 0.9667*, and* 0.4289 *for K, Ka, Q, V, and W bands, respectively. In sharp contrast, the coefficients for section 5 correspond to* 0.1839*,* −0.7466*,* −0.3923*,* 2.4184*, and* −0.4635*, for these bands. The WMAP team alters the ILC weights by regions, used in galactic signal removal, by more than 100% for the fourth coefficient, despite the adjacent locations of these sections.*" [41]

The ILC coefficients were nothing more than a means to add and subtract data in order to obtain a desired result. "*The sole driving force for altering the weight of these coefficients lies in the need to zero the foreground. The selection of individual coefficients is without scientific basis, with the only apparent goal being the attainment of a null point*" [41]. To any favoured frequency band there corresponds a particular set of ILC maps, and so different sets of cosmological constants would result depending upon the band emphasised; as products of data processing. Clearly, "*The requirement that the signals of interest are frequency independent cannot be met, and has certainly never been proven*" [41], and "*There is no single map of the anisotropy, since all maps are equally valid, provided coefficients sum to 1*" [41], which is precisely the condition set by the WMAP Team. Consequently: "*There is no unique solution and therefore each map is indistinguishable from noise. There are no findings relative to anisotropy, since there are no features in the maps which could guide astrophysics relative to the true solution*" [41]. Since there is no unique map, none of the maps have any real meaning. Any number of different anisotropy maps can be generated by simply altering the ILC coefficients *ad libitum*. WMAP has no unique all-sky anisotropy map. Indeed, Tegmark et. al. [49] generated a different all-sky anisotropy map from the WMAP database by allowing the coefficient weightings to depend upon angular scale and on distance to the galactic plane. Consequently, the all-sky anisotropy maps presented by the WMAP Team and Tegmark et. al. have no scientific merit.

The galactic foreground is of the order of mK, whereas the desired anisotropies are of the order of $\mu$K. Note in table 1 that many of the ILC coefficients were assigned negative values. Physically this corresponds to negative temperatures for the galactic foreground, thereby making the sought after CMB anisotropies hotter than the galactic foreground, when the supposed anisotropies are colder than the galactic foreground, requiring therefore that the galactic foreground contamination be removed in the first place.

The most important determinant of image quality is signal to noise. High signal to noise can permit some signal sacrifice to enhance contrast and resolution. Without high signal to noise, contrast and resolution will always be poor. Medicine is the most exacting field of imaging science and technology. An example from medicine illustrates the utmost importance of signal to noise for image quality. Figure 15 is an image of a sagittal section of a human brain using a 1.5 Tesla MRI scanner, operating at the uppermost limit of its capacity. "*The resolution is high (matrix size = 512 × 512) and the slice thickness is thin (2 mm). At the same time, the nutation angle, echo times, and repetition times are all suboptimal. As a result, this image* *is of extremely poor clinical quality. The contrast between grey and white matter has disappeared and the signal to noise is ≈5*" [41].

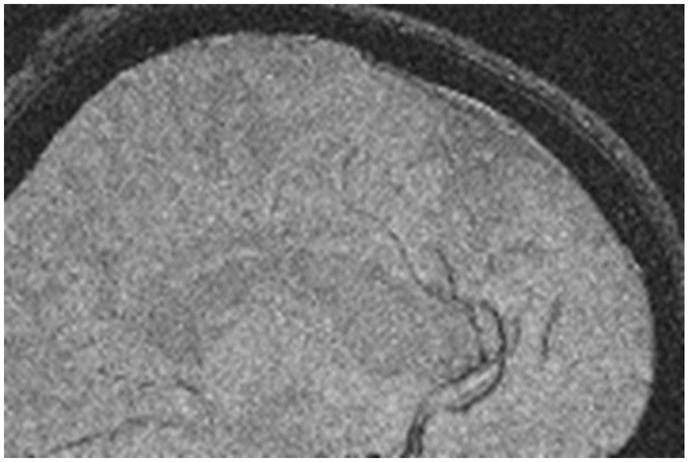

Fig. 16: Section (490 × 327) of a high resolution sagittal image of the human head acquired at 1.5 Tesla. Acquisition parameters are as follows: acquisition sequence = gradient recalled echo, matrix size = 512 × 512, slice thickness = 2 mm, feld of view 20 cm × 20 cm, repetition time = 750 msec, echo time = 17 msec, and nutation angle = 45 degrees. Figure and caption reproduced from [50] with permission.

Compare figure 16 with figure 17. Figure 17 was acquired with the first Ultra-High Field MRI scanner [50–52], operating at a field strength of 8 Tesla. The image in figure 16 has phenomenal contrast; the delineation of grey and white matter and the appearance of vasculature is spectacular. This image was acquired with a much larger image resolution (matrix size = 2,000 × 2,000) while maintaining nearly the same parameters as for Figure 16. Despite its higher resolution, the image in figure 16 has a signal to noise of ≈20. Although it took longer to acquire, due to increased phase encoding steps, the time per pixel is less than that for Figure 16. "*Clearly, signal to noise can purchase both contrast and resolution*" [41].

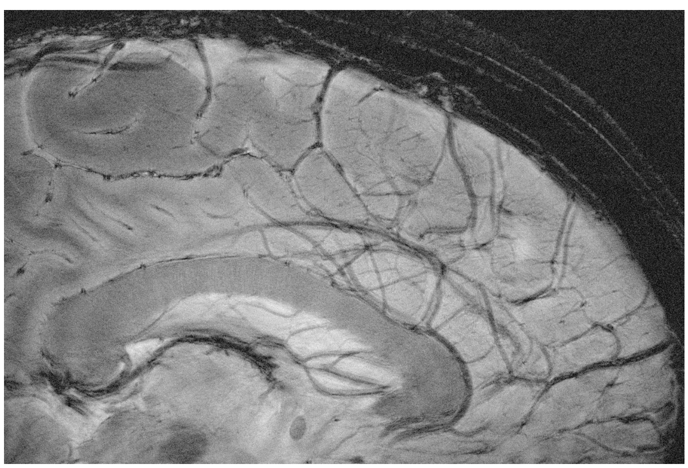

Fig. 17: Section (1139 × 758) of a high resolution sagittal image of the human head acquired at 8 Tesla. Acquisition parameters are as follows: acquisition sequence = gradient recalled echo, matrix size = 2,000 × 2,000, slice thickness = 2 mm, feld of view 20 cm 4 × 4 20 cm, repetition time = 750 msec, echo time = 17 msec, and nutation angle = 17 degrees. This image corresponds to Figure 3A in Robitaille P.M.L., Abduljalil A.M., Kangarlu A., Ultra high resolution imaging of the human head at 8 Tesla: 2K×2K for Y2K. *J Comp. Assist. Tomogr.*, 2000, v. 24, 2-7. Caption reproduced from [41], with permissions. Pressaging danger to science, Wolters Kluwer, the publisher of *J Comp. Assist. Tomogr.*, charged $130.40 AUD for permission to reproduce this image.

WMAP images however have a maximum signal to noise that barely exceeds 1. Consequently, "*WMAP is unable to confirm that the 'anisotropic signal' observed at any given point is not noise. The act of attributing signal characteristics to noise does not in itself create signal. . . . WMAP images do not meet accepted standards in medical imaging research*" [41].

In the absence of high signal to noise, the only indicative feature of images is reproducibility. However, WMAP images cannot evidently be reproduced, since the WMAP team not only selectively weighted the V-band, but varied all ILC coefficients from year to year, for the central region of its images, and also averaged images for a 3-year data image which differs significantly from the first year image. There was no stability on a year-to-year basis let alone on cosmological time scales (which can never be realised). Moreover, the WMAP team's difference images are between year 1 and the averaged 3 year, the latter containing the year 1 image itself, not between images year to year. Figure 18 depicts comparative images; "*the difference images are shown with reduced resolution contrary to established practices in imaging science*" [41].

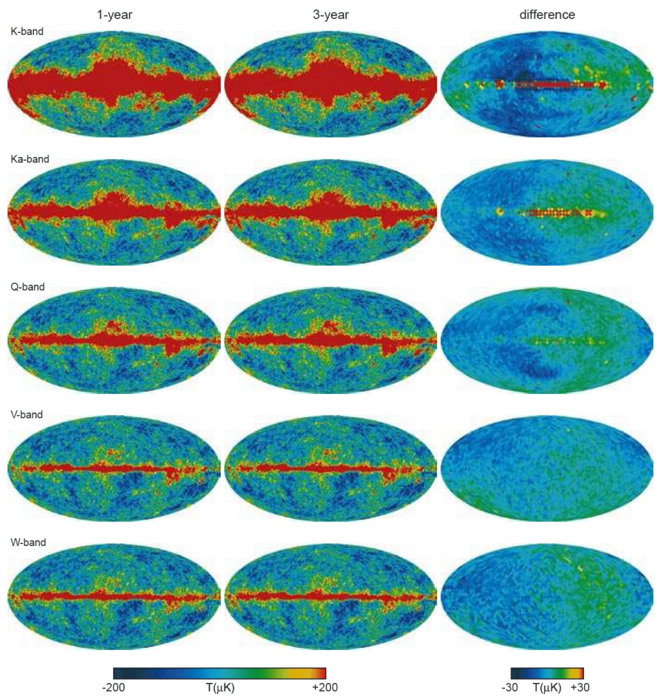


Fig. 18: Comparison of 3-year average data with year-1 data through difference for the K, Ka, Q, V, and W bands of the WMAP satellite. The WMAP Team presents the difference images with reduced resolution contrary to established practices in imaging science. From [53] (figure 3) with permission from D. Spergel.

WMAP has no unique map. The final all-sky map presented by the WMAP Team is entirely arbitrary. Merely by adjusting the ILC coefficients entirely different WMAP maps can be produced. Any number of such different maps can be produced in this way. That Tegmark et al. [49] produced a different map from WMAP 'data', reinforces the fact that none of these anisotropy maps are distinguishable from noise.

Attempts to establish stablity in the all-sky anisotropy maps are futile because they must be stable on cosmological time scales, not merely on an *averaged* 3-year basis. Cosmological time scales are not available to cosmologists, and so claims of image stability are meaningless. Even so, WMAP images are not even stable on a yearly basis. The galactic foreground and the point sources are inherently unstable. This is clearly demonstrated in the year 1 and year 3 WMAP all-sky images [40,47]. The 3-year average constitutes an inappropriate attempt to smooth the image. The 'cleaning' of the maps is *ad hoc* because the WMAP team cannot know the extent to which galactic signals must be removed from each channel. It is simply impossible for the active and unstable galactic foreground to be zeroed. As stated above, the 3-year average ILC image differs significantly from the first-year ILC image, shown in figure 19.

Note that the difference images in figures 18 and 19 are presented by the WMAP Team at lower resolution than the 1-year map and the 3-year average map, contrary to standards and practice in imaging science. The lower resolution of the difference maps hides differences in the two maps that were differenced. Moreover, the WMAP Team varied the ILC coefficients from year to year. For example, in the 1-year map the region 0 was given the ILC coefficients K = 0.109, Ka = -0.684, Q = -0.096, V = 1.921, W = -0.250, whilst the 3-year average map was assigned the corresponding values (0.1559, -0.8880, 0.0297, 2.0446, -0.3423), as shown in table 1, also bearing in mind that the 1-year map is itself a component of the 3-year average

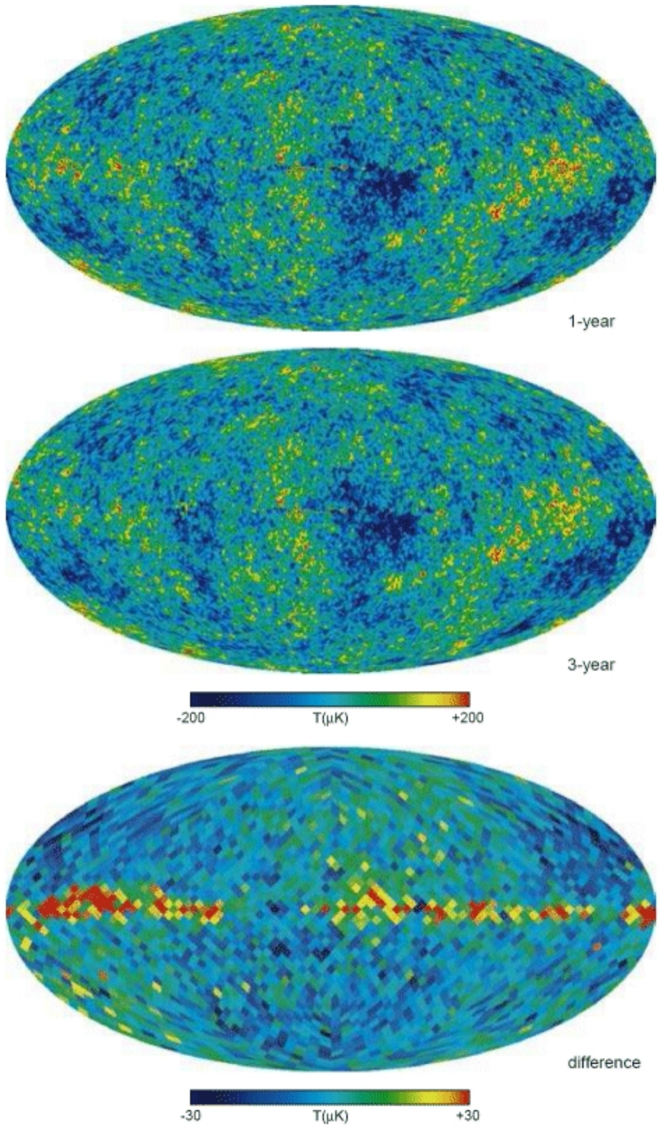


Fig. 19: Comparison of the 3-year average ILC map with the year-1 ILC map. Note that the difference images are shown at reduced resolution contrary to established practices in imaging science. This figure corresponds to Figure 9 in Hinshaw et. al. [53]. Reproduced with permission of D. Spergel.

map. Note that the K-band was changed by nearly 50% and that the Q-band changed sign and decreased in magnitude by a factor of 3.

The vagarious methods employed by the WMAP Team to produce all-sky* anisotropy maps attest that there are in fact no CMB anisotropies anywhere. The notion that the ≈2.725 K monopole pervades the Universe as a thermal remnant of a big bang creation *ex nihilo*, is due to theory that violates of the physics of thermal emission and thermodynamics. Kirchhoff's Law of Thermal Emission is false and Planck's equation for thermal spectra is not universal. One cannot assign an absolute temperature to the microwave signals detected from the ground by Penzias and Wilson and by COBE-FIRAS in Earth orbit. In any event the ≈2.725 K monopole signal has its source in the oceans of Earth and does not reach to L2.

*'All-sky' means that the entire galactic plane is included.

## 6 The *Planck* Satellite

The European Space Agency's *Planck* satellite, as with NASA's WMAP, was located at L2. It carried two instuments for determination of CMB anisotropies; the Low Frequency Instrument (LFI) and the High Frequency Instrument (HFI). The HFI was limited to anisotropy survey as it was not capable of detection of a CMB monopole:

> "*Planck cannot measure accurately the monopole (uniform part of the emission) because many sources contribute (telescope, horns, filters, . . .*" [54]

Since COBE-FIRAS reported an enormous signal to noise, *Planck* HFI would have experienced the same, so the impact of spurious signals from telescope, horns, filters, etc. on *Planck* would be of little concern.

The LFI however was able to operate in both differential and absolute mode because it carried two onboard 4 K blackbody reference loads. In this regard it was similar to COBE-FIRAS which carried a blackbody calibrator. In differential mode the LFI functioned like WMAP and COBE-DMR, in order to survey anisotropies. Figure 20 is a schematic of the *Planck* LFI differential radiometers.

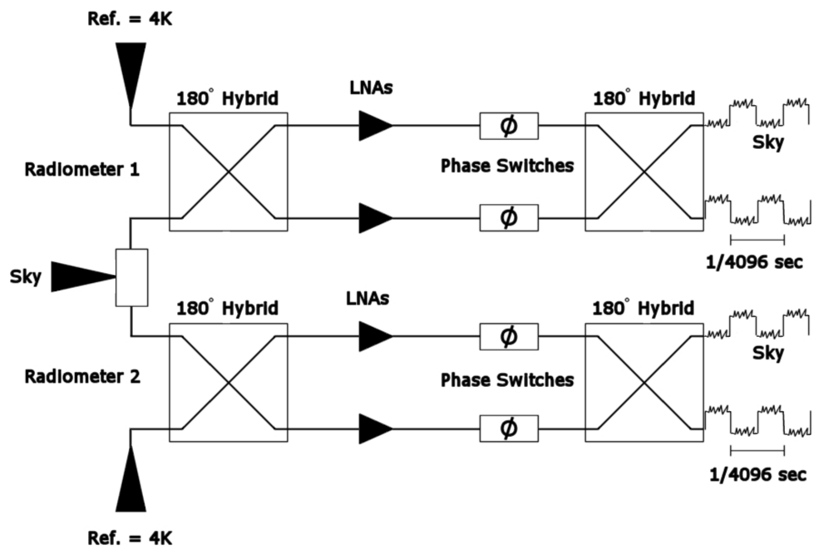


Fig. 20: Partial schematic representation of the PLANCK LFI pseudo-correlation differential radiometers. Prior to entering each radiometer, the signal from each sky horn travels to an orthomode transducer (OMT) where two orthogonal linearly polarized signals are produced. Each of these signals is then 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. Figure and caption reproduced from [41] with permission.

In absolute mode the LFI could compare the sky directly with its reference loads and thereby ascertain the presence of an ≈2.725 K monople signal L2. But the *Planck* Team has never reported detection of the CMB monopole signal at L2. In fact, the *Planck* Team utilised the COBE-FIRAS strong monopole signal as its reference base:

> "*The CMB is given by a perfect blackbody with only a single spectral parameter, namely the CMB temperature. We adopt a mean value of $T_{cmb}$ = 2:7255 ±0:0006K (Fixsen 2009), and note that the uncertainty in this value is sufficiently small to justify its use as a delta function prior.*"

The temperature reported in this passage from the *Planck* Team is that detected by COBE-FIRAS ≈900 km from Earth. It is a scientific fact that the ≈2.725 K monopole signal has never been detected beyond ≈900 km of Earth. Without this monopole signal beyond Earth, all claims for the 'CMB' and its anisotropies have no scientific merit: just wishful thinking.

The reference loads of the LFI had to be kept at the temperature 4 K. There was no direct means on the LFI to do so. The shield of the HFI however was cooled cryogenically to 4 K. To ensure operational temperature of the reference loads of the LFI, the *Planck* Team attached the them directly to the HFI shield by means of steel screws and washers:

"*stainless steel (AISI304) thermal washers, ... interposed between the loads and the interface points to the HFI. ... These are small cylinders (typically 5 mm long, 1 mm wall thickness) whose dimensions are optimized to dump temperature fluctuations in order to meet requirements, ... screws (mounted on the HFI), ... The optimization of the thermal washers allowed to increase the damping factor, ... Cases, supported by an Al structure, are mounted on the HFI using Stainless Steel thermal decouplers (washers), which allows to carefully control the thermal behavior,... Thermal interface is dominated by conduction through thermal washers,... Metal parts are assembled using Stainless Steel screws at high torque, to make thermal contact as close as possible to an ideal value.*" [55, 56]

Although this method ensured that the reference loads maintained a temperature of ≈4 K, they did so by conduction, not by thermal emission and absorption. The conduction paths introduced by the steel attachments between the reference loads and the HFI shield ensured that the reference loads could never be blackbodies. The error permitted heat to be shunted directly from the reference loads to the HFI shield by conduction so that the reference loads emitted few or no photons to the reference horns, making the reference loads appear to the reference horns to have a temperature of ≈ 0 K. In attaching the reference loads to the HFI shield by steel screws and washers the *Planck* Team overlooked the basic physics of thermal emission and heat transfer relating to blackbodies. It thereby became impossible for the LFI to work even before it left the launching pad. Figure 21 is a schematic of the 4 K reference loads and their attachment to the HFI shield.

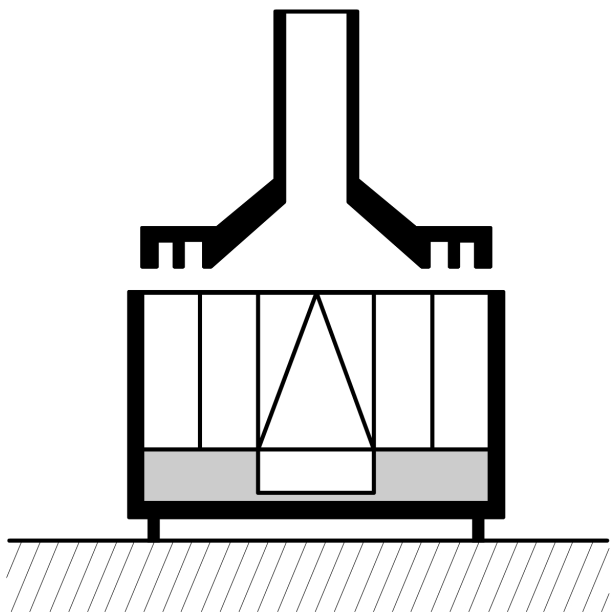

Fig. 21: Schematic representation of a *Planck* LFI reference load. Each load is comprised of a reference horn (upper section) and a target (middle section) separated by a 1.5 mm gap. The targets are constructed from molded Eccosorb (CR-110 or 117) absorber, surrounded by an aluminum casing which acts to preserve thermodynamic steady state within each unit, using conduction. Heat is allowed to flow out of the target casing through a conductive path directly into the 4 K shield of the HFI (represented by the hatched area in the lower section). This path is provided by stainless steel cylindrical washers and screws. By providing a conductive path out of the target, the Planck LFI team created a situation wherein a Type-8 error is introduced [57]. By itself, the design ensured that the targets could not operate as ≈4 K blackbody reference loads. Figure reproduced from [56] with permission.

The *Planck* Team reported testing of the 4 K reference loads before launch. The reference loads produced internal standing waves, as the *Planck* LFI return-loss traces prove (figure 21). In other words the reference loads responded as resonant cavities, not as blackbodies. Standing waves are not thermal processes. Thus, once again, the 4 K loads were never blackbodies. Blackbodies do not produce standing waves. Consequently, a blackbody reference load must not produce standing waves. The presence of standing waves is proof sufficient that the *Planck* LFI reference loads were never able to function as blackbodies even if they were not attached by conduction paths to the HFI shield. Note the significant resonances in figure 22, as low as -50dB at some frequencies. If the target was black, these resonances would not have appeared.

The *Planck* Team's own computational analyses of the 4 K reference loads revealed that microwave radiation could not be contained within the reference load casing. Microwave radiation leaked out everywhere. The computational analysis reported

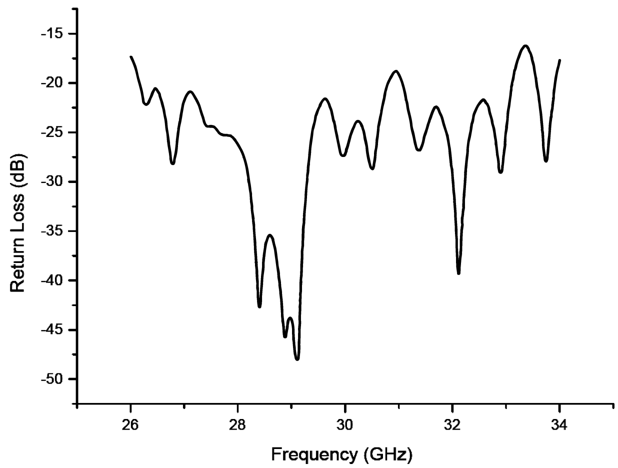


Fig. 22: A network analyzer tracing for a 30 GHz reference target system, as provided by the *Planck* LFI team [55]. This particular tracing was extracted from Figure 26 in [55] in order to better visualize its features. Note the presence of significant resonances on this tracing, indicating the existence of standing waves within the horn-target system. It is well known, based on elementary considerations in electromagnetics [31], that cavities, waveguides, and enclosures, at microwave frequencies, can sustain standing waves in a manner depending on their size and geometry (see [31] and references therein). This problem is particularly important when the dimensions of the target approach the wavelengths of interest. In this case, 30 GHz corresponds to a wavelength of ≈1 cm in vacuum. The target casings are 3:3 × 3:3 × (≈ 2) cm (see Table 1 and Figure 12 in [55]). The presence of such resonances in the ≈4 K reference loads, demonstrates unambiguously that the targets are not black. In fact, the targets are still acting as resonant devices [31]. For a blackbody to exist, all such resonances must be suppressed (i.e. as ideally seen by a constant -50 dB tracing across the spectral range). In this case however, and when combined with the data in Figure 22, it appears that approximately -15 to -20 dB of return loss can be accounted for by leakage from the 1.5 mm gap. Then, between -20 to -25 dB of return loss can be attributed, at certain frequencies, to the existence of resonance features. Note that 29 GHz gives a wavelength of ≈1.03 cm in vacuum, and perhaps a little more in Eccosorb (see [57] and references therein). As such, the resonances at 28.5-29.2 GHz correspond almost exactly to 3 wavelengths in a square 3.3 cm enclosure. Figure reproduced from [55] with permission of the IOP and L. Valenziano on behalf of the authors and the *Planck* LFI consortium. Caption reproduced from [56] with permission.

by the *Planck* Team, of field distributions both inside and around the targets, during testing with microwave radiation, clearly reveals microwave flowing freely throughout the space in front and around the target. This is particularly evident in the left frame of figure 23. The computational analyses provide unambiguous evidence that the return-loss measurements far overstate the performance of the reference loads when attempting to evaluate emissivity. The LFI Team did not correctly evaluate the emissivity of the 4 K reference loads.

> "*Indeed, Valenziano et al. [55] do not even provide the estimated emissivity of their targets. By itself, this constitutes an implicit indication that these values cannot be properly determined, with such methods, as I previously stated.*" [56]

Nothwithstanding, the *Planck* Team assumed that in making their return-loss measurements, no leakage into the gap could take place, even though such leakage is evident in their own calculations, as shown in figure 23. They further assumed, contrary to their own return-loss measurements, as shown in figure 22, that the reference load casings could not support any standing waves.

The LFI consortium has demonstrated a major deficiency in knowledge of, and violation of, even the fundamental principles of thermodynamics by permitting the 4 K reference loads to be perfect conductors:

> "*the 70 GHz loads are assumed to be perfect thermal conductors, due to their small thickness and mass.*" [55]

This issue has been examined in fine detail in [57].

It is curious that the *Planck* Team maintains that one can take the 70 GHz map from the LFI and compare it to the 100 GHz map from the HFI, two completely different instruments, and see at high galactic latitude the same anisotropies, bearing in mind that the LFI did not even work. It is also interesting to note that the *Planck* Team reported better than expected performance from the LFI. The reason for this unexpected better performance is that the 4 K reference loads appeared as ≈

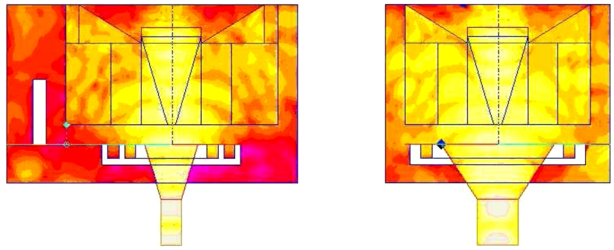

Fig. 23: Computational determination of the E-field distribution at 70 GHz for a horn-target assembly as reproduced from Figure 10 in [55]. White areas represent perfect conductors, whereas regions of increased brightness depict more intense fields [55]. The left panel corresponds to PHI = 90 while the right panel to PHI = 0. Further details are available in [55]. Note how the target is unable to localize microwave energy. Leakage of radiation beyond the 1.5 mm gap separating the horn and the target is evident, especially in the right panel. If leakage appears to be less intense in the left panel (examine the left edge of the casing), it is because the horn dimension in this cut is substantially smaller than the target. Nonetheless, some restriction of radiation is visible on the left edge of the casing in the left panel. This acts to confirm that none of the other edges are able to confine the radiation. Note also that the section of CR-117 absorber below the pyramid is actually acting to reflect rather than absorb the radiation. This is especially evident in the left panel (note red area beneath the central pyramid (see [55] for more detail). From these calculations, it is apparent that the Planck LFI targets at 70 GHz are not black, enabling dissipation of energy well beyond the horn-target assembly. Unfortunately, the Planck team does not display corresponding results at 30 and 44 GHz. Reproduced from [55] with permission of the IOP and L.Valenziano on behalf of the authors and the Planck LFI consortium. Caption reproduced from [56] with permission.

O K reference loads because their emission profiles were drastically compromised by conduction to the HFI shield. Table 2 summarises the logical possibilities.

| **Expected performance of the *Planck* LFI receivers** | | |
|---|---|---|
| | Sky Temperature ≈3 K | Sky Temperature ≈0 K |
| Reference ≈4 K | As expected | Poor |
| Reference ≈0 K | Poor | Better than expected |

Table 2: All logical possibilities for performance of the LFI. Adapted from [56].

In any event, the fatal flaws in the design of the *Planck* instruments do not circumvent the fact that the strong monopole signal detected by COBE-FIRAS does not exist at L2. The evidence that the strong monopole signal detected by COBE-FIRAS is overwhelming [32, 33, 39, 40, 47]. Ironically, the failure of the LFI produced certain evidence that the strong monopole detected by COBE-FIRAS does not exist at L2.

Planck is but one of three satellites that have allegedly detected 'CMB' anisotropies. All these satellites must agree, if their anisotropies are real. They do not agree. The alleged anisotropies are not stable. This has been proven by WMAP. WMAP has no unique map. The final all-sky map presented by the WMAP Team is entirely arbitrary. Tegmark produced a different map from the WMAP 'data', reinforcing the fact that none of these maps are anything but noise. WMAP ILC coefficients vary from year to year, by as much as 100%, and in adjacent sections of the images. Since there is no unique anisotropy map, and no means to assign meaning to any particular such map, the maps are indistinguishable from noise. Consequently the alleged 'CMB' anisotropies have no meaning. COBE-DMR did not detect 'CMB' anisotropies either. Arbitrarily removing the quadrupole from nothing but noise certainly produces data-processing artifacts. Changing instrument from COBE to WMAP to *Planck* does not make the galactic foreground, point sources, or the alleged 'CMB' anisotropies, become stable. It is the galactic foreground and the point sources that are inherently unstable. This is clearly demonstrated in the year 1 and year 3 WMAP all-sky images, and another reason why there is no unique map. Moreover, COBE, WMAP and *Planck* suffer from the same insurmountable problem - they must peer through the galactic foreground in order to find their alleged anisotropies. However, galactic foreground is noise as far as the 'anisotropies' are concerned, and must be removed, by data-processing. Similarly, the dipole signal must be removed, again by data-processing. The best radiometric laboratories on Earth today cannot achieve what the 'CMB' anisotropy satellites claim to have achieved in space, because it is known to be impossible under the conditions experienced by the CMB satellites. Moreover, stability must be determined on a cosmological time scale. None of the CMB satellites have any possibility of determining anisotropy on a cosmological time scale.

Ultimately, the assignment of an absolute temperature to the strong monopole signal from Earth is a violation of the laws of thermal emission, even if Kirchhoff's Law of Thermal Emission was true. The strong monopole signal from Earth is not the temperature of anything: it is an apparent temperature, due to the oceans on Earth. There can be no CMB without Kirchhoff's Law of Thermal Emission and universality of Planck's equation for thermal spectra. However, Kirchhoff's Law is certainly false; hence Planck's equation for thermal spectra is not universal. Consequently, big bang cosmology and its firey CMB have no scientific basis.

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