A Short History of Radiation Theories- What Do They Reveal About "Anthropogenic Global Warming"?

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Note: A German version of this article can be found here.

Introduction

The official, or consensus AGW (Anthropogenic Global Warming), movement has two sides or faces: one, supported by celebrities, governments and the mass media aims to convince the public that AGW is "real" and threatening; the other, in support of the first, serving as an indispensable base in the attempt to "prove" that AGW is "real" on a scientific basis.

The fundamental framework of the basis of AGW is a certain radiation theory claiming that the atmosphere, and in particular certain gases like water vapor, carbon dioxide and methane, absorb the infrared rays emitted from the earth's surface and then re-emit a fraction of this absorbed radiative energy back to the surface which in turn leads to an increased temperature on the earth.

This supposed radiative behavior of the atmosphere is referred to as either "back radiation" or "downwelling longwave radiation". Both are said to constitute the "natural greenhouse effect" which is presented to the public as being the essential factor in warming the earth above an otherwise hostile "planetary blackbody temperature" of only -18° C. Since carbon dioxide is regarded as a major contributor of "back" or "downwelling longwave" radiation, it is said that we will inevitably face a climate catastrophe if we do not drastically lower our carbon dioxide emissions.

However, something is amiss with the scientific part of AGW and in particular with its radiation hypothesis, in that unexpectedly the earth temperature does not comply with its laws – a trendline analysis of satellite data clearly shows a maximum of global temperatures in 2010/2011 although worldwide carbon dioxide emissions increased by 45% between 1990 and 2010.
Simply put, it can not be said that increasing carbon dioxide emissions between 1990 and 2010 are *causing* the increase of earth's temperature climaxing in 2010/2011. *AGW* claims that increasing

CO_2 leads to an almost proportional increase of average global temperatures. The facts just do not correlate or add up.
It is therefore worthwhile to take a closer look at the history of radiation science so as to provide a better understanding of the development of the currently applied radiation theory to illustrate how, based on historic evidence, the AGW does not hold.

Pictet, Rumford, Prevost

According to ancient Greek and Roman historians, Archimedes already knew about the radiative power of the sun: During the siege of Syracuse in 212 BC he reportedly set the Roman warships afire with the aid of mirrors.

Later, according to Evans and Popp (1984), "References to experiments with radiant heat appear in Italian, English, French, and German publications scattered over a period of 200 years, from 1570, say, to 1770."

Unless otherwise stated or cited, the following information was taken from the aforementioned source as well.

Until the end of the 18th century experiments were mainly carried out with two objects being placed in the respective foci of two opposite concave mirrors at a distance of several feet apart. In one very popular and dramatic demonstration, a combustible object was ignited at a distance of 20 to 24 feet by the reflection and concentration of the heat of a single coal, the coal being placed at the focus of one mirror and the combustible object at the focus of the other.

It was not until the beginning of the 19th century, or more exactly the summer and fall of 1800, that experiments and research on radiative heat became more focused and structured. Sir Benjamin Thompson, also known as "Count Rumford", in the company of Professors Hope, Playfair, and Stewart of the University of Edinburgh, undertook to repeat an experiment that had been performed originally by Marc-Auguste Pictet of the Academy of Geneva.

In this experiment Pictet investigated what appeared to be the "reflection of cold": using two concave mirrors, he placed a flask filled with cold water and snow or ice at the focus of one mirror

and a sensitive air thermometer at the other mirror's focus. When thus placed the thermometer's displayed temperature immediately dropped (AGW claims that an atmosphere colder than the planet's surface does warm the planet). In fact, when the flask was placed *in close proximity to* the mirror's focus, the temperature reading did not change at all.

This apparently intrigued Rumford because following this experiment he presented his first publicly announced opinion on the subject of heat.
In the following years he performed many experiments on this matter, invented new apparatus for use in these experiments, and proffered theoretical explanations for his results. This is covered further on.

One of his most important findings was that a metallic vessel covered with a thin layer of soot cooled more quickly and heated more rapidly than a vessel of the same size and form with a highly polished surface. He thus discovered what is common knowledge today: black coatings are very good emitters (and also absorbers) of heat.

However, it seems he did not draw or come to the above conclusion as he believed in the existence of "calorific" (heat) and "frigorific" (cold) rays, the latter having, to his belief, been clearly demonstrated by the "reflection of cold" in Pictet´s experiment.

In another ingenious experiment – with respect to what was known then – he investigated the effect of a heat source applied to one of the hollow balls of his "thermoscope", an instrument of his own devising (please refer to the source mentioned above for clarification of its construction), and a source of "cold" applied to the opposite side of this ball at exactly the same distance as the heat source. Both radiation sources were metallic tubes; one filled with water at a fixed temperature *above* room temperature and the other with a fixed temperature of the same amount *below* room temperature.

The thermoscope was constructed in such a way that any volume change of air, expansion or compression, inside the hollow ball would be directly visualized. The results of his experiment were unambiguous: the ball's volume did not change and therefore, Rumford concluded, "calorific" rays were of exactly equal strength as "frigorific" rays. He thus thought he had proven what he believed to be the right explanation for Pictet´s "reflection of cold" experiment: the existence of "frigorific" rays.

This assumed misconception of Rumford's, if it is so, is a clear cut example of how a **preconceived opinion or concept blocks other rational explanations** of the observed facts and we need to keep this in mind when considering why "back" or "downwelling" radiation is defended at all cost by its proponents.

Radiation Theories Offered By The Scientists Of The Time

There is an ongoing scientific debate – it is in fact still ongoing as will be shown at the end of this article – about the nature of light and/or radiation (at the time scientists thought heat differed from light because ordinary transparent glass was able to block heat for a certain length of time until it was itself heated and thus, in turn, began radiating heat). Two explanations are possible: light is a form of particles (Newton) or waves (Maxwell).

At the time of Pictet, Rumford and Prevost both theories had their scientific followers. We should remember, however, that these scientists regarded what we now call "empty space" as an invisible **fluid**, sometimes referred to as the "aether". Because waves, according to the received wisdom of the time, required some kind of fluid to move forward and heat, in particular, was seen as a special "igneous fluid".
Equally the "emissionists" thought that "caloric", and therefore also "frigorific", was a form of invisible *particles* emitted by heat or radiation sources.

Pictet´s "reflection of cold" experiment had greatly influenced other researchers and in particular Rumford, thus to begin with Pictet´s attempts of explanation:
He had been undecided which of two possible fundamental explanations should be favored and claimed it was not possible to choose between the caloric and wave theory of heat on the basis of experimental evidence. However, he inclined through personal preference to the caloric (particle) theory, championed by the French physicists and chemists, and notably by Lavoisier.

Pictet had initially been astounded by the results of his own experiment. On reflection though he had been able to explain it. He believed the air around the thermometer created a certain *tension* as every warm body does – he also firmly believed that cold did not exist in itself but was a "privation of heat". However, this heated air around a thermometer would develop exactly the same tension as the thermometer and would therefore *resist* any further radiation from the thermometer the

surrounding air. In this – equilibrium – situation, *tension* and *resistance* were equal and thus no transfer of heat from either body to the other would occur.

Pictet regarded the equilibrium situation as a static balance of tension and resistance.

Therefore, if a cold object was placed at the focus of one mirror, it would, according to Pictet, absorb the heat of the surrounding room including the heat emanating from the thermometer whereby the thermometer itself was cooled. In this regard his experiment would not differ from one in which a heat source would be placed at the focus of the mirror opposite to the mirror holding the thermometer at its focus.

Finally, Pictet remarked that the same explanation would apply if we regard the caloric effect as resulting, not from emanation, but from a vibration in the **elastic fluid** (emphasis by the author) **of fire** that fills the space in which the experiment was performed. “It is known that these vibrations are susceptible of being reflected according to the same laws as emanations, of which the reflection of sounds affords us daily examples.”

Rumford’s explanation: It was already mentioned above that "Rumford regarded radiant heat as an undulation analogous to sound, and seems to have viewed Pictet’s experiment more or less as a case of a driven oscillator: "The cold body in one focus compels the warm body (the thermometer) in the other focus to change its note."... "This was the explanation he ventured to offer his companions at Edinburgh in 1800." A few years later he gave a much more detailed explanation to further stress and substantiate his undulation theory.

However, Evans and Popp, the authors of the detailed historic outline I am using as a reference, point out that the "essential difficulty with Rumford’s version of the undulationist theory was that he wished to associate the change in temperature experienced by an object solely with the radiation absorbed by it, and denied the temperature-changing effect of the emitted radiation. As a result, Rumford’s system suffered from internal inconsistencies that did not trouble Prevost’s."

According to *Prevost’s* notion of 1818, physicists dealing with the nature of light were divided into three different classes: “les émissionaires, les undulateurs, et les indifférens” - the "emissionists, undalationists, and the undetermined". Evans and Popp remark, "A similar division applies very well to physical doctrines on the nature of heat during the 30-year period that concerns us here

(1775-1805). If anything, opinion on heat during this period was even more fragmented. Reduced to its most basic terms, the question was this: were the phenomena of heat produced by emissions of a material substance, or were they due to undulations?"

And they conclude: "In Saussure and Pictet, we shall see a cautious undulationist and a cautious emissionist, respectively. But in Rumford and Prevost, we shall see two of the most confident and assertive proponents that the two schools of thought ever produced." Note: Saussure is not treated here.

This conclusion may be one of the most important facts in understanding how the present notion of "back" or "downwelling" radiation could develop: *Prevost was a "most confident and assertive" emissionist* ***already before*** *he developed his most influential theory of heat transfer described in the following paragraphs*.
Evans and Popp even state: "Prevost introduced a mode of reasoning that has since become habitual in thermodynamics."

Prevost asserted that fire was a "discrete fluid", a fluid believed to consist of particles. Taking this for granted, he came to the following conclusions again quoted directly from Evans and Popp. This neatly shows why and how proponents of "back" and "downwelling" radiation believed this process would occur and why they claimed the science was "settled" – because Prevost had prepared the basics of this notion already back in 1791, more than 200 years ago.

"According to Prevost, such equilibrium between two bodies consists in the equal, simultaneous exchanges of fire particles between them. Imagine two cubical portions of space which share a common face, thus forming a rectangular parallelepiped. Let the walls of this rectangular box be of a material perfectly solid and poreless. Into this box, Prevost imagines placing a quantity of free fire. The fire moves freely through the whole of this space. And there is no reason why it should pass with less facility through the empty square that is the boundary between the two cubes than through any other part of this space. There are continual exchanges of particles between the two portions but the quantity of fire in each remains constant. Different particles are ceaselessly found in the same place, but their number and their average separation remain constant. Such is the state of thermometric equilibrium."

Please note that Prevost believed in the **exchange** of "fire **particles**" between the two bodies. So, the theory of "heat exchange" as the basis of any "back" or "downwelling" radiation was born here! In our "modern" science we believe these particles were instead photons. But still the whole topic of "back radiation" is about *particle exchange* between two radiating bodies.

Let us now briefly look at how the scientific debate was led.
Evans and Popp write: "Prevost, it should be noted, treats Pictet with the greatest politeness." … "And Pictet, for his part, seems to have immediately accepted Prevost's explanation of the experiment."
Rumford, however, whom we see as someone mostly believing only in his own explanations, "does not mention Prevost by name, but he lists Prevost's assumptions so clearly that there can be no doubt whose theory he had in mind." He then "objects that it is impossible to explain how the same body could receive and retain, and reject and drive away, the same substance at one and the same time."

So, it remained unclear whether the observed phenomena could be best explained by undulation or particles.

Application Of Radiation Theories To Climate – Tyndall and Arrhenius

The Internet provides a ready source of historical scientific literature sites. One such a site is Timothy Casey´s and the following information is taken from this site unless otherwise stated.

Casey has studied (and published) Tyndall´s and Arrhenius´ original work relating to the "greenhouse effect". He also gives a translation of Fourier by Burgess (1837). As Arrhenius, the "father of the greenhouse effect", defers his work at least in part to Tyndall, we will start with his observations and experimental work.

In 1861, *Tyndall* wrote a paper titled "On the Absorption and Radiation of Heat by Gases and Vapours, and on the Physical Connexion of Radiation, Absorption, Conduction. - The Bakerian Lecture." In his preface, or § 1, he writes: "§ 1. The researches on glaciers which I have had the honour of submitting from time to time to the notice of the Royal Society, directed my attention in a

special manner to the observations and speculations of De Saussure, Fourier, M. Pouillet, and Mr. Hopkins, on the transmission of solar and terrestrial heat through the earth's atmosphere.
This gave practical effect to a desire which I previously entertained to make the mutual action of radiant heat and gases of all kinds the subject of an experimental inquiry."

It may therefore not be surprising that his "desire" led to false conclusions about the "absorption" of gases he meant to measure. Casey writes: "It is clear that Tyndall measured opacity and relative opacity, not absorptivity and absorption as he seems to claim. In fact, Tyndall uses the terms "opacity" and "absorbing power" interchangeably throughout his work. This is indicative of a fundamental misunderstanding, which is nonetheless studiously avoided by nearly all authors who claim that Tyndall's work proved the "Greenhouse Effect".

"Although historical authors such as Arrhenius generally acknowledge that Tyndall regarded "absorbing" gases as thermal buffers rather than warming agents, contemporary and historical authors alike (Arrhenius, 1896; Weart, 2003, p. 3) fail to acknowledge the fact that Tyndall made absolutely no measurement of actual absorption, he confused absorption and opacity, and if anything, his differential radiation idea rests heavily on the idea of luminiferous aether - later refuted by Michelson & Morley (1887)."

Arrhenius, according to this Wikipedia article, "developed a theory to explain the ice ages, and in 1896 he was the first scientist to speculate that changes in the levels of carbon dioxide in the atmosphere could substantially alter the surface temperature through the greenhouse effect.[4] He was influenced by the work of others, including Joseph Fourier. Arrhenius used the infrared observations of the moon by Frank Washington Very and Samuel Pierpont Langley at the Allegheny Observatory in Pittsburgh to calculate the absorption of infrared radiation by atmospheric CO_2 and water vapour. Using 'Stefan's law' (better known as the Stefan Boltzmann law), he formulated his greenhouse law. In its original form, Arrhenius' greenhouse law reads as follows:
if the quantity of carbonic acid increases in geometric progression, the augmentation of the temperature will increase nearly in arithmetic progression."

In "Worlds in the Making", he "suggested that the human emission of CO_2 would be strong enough to prevent the world from entering a new ice age, and that a warmer earth would be needed to feed the rapidly increasing population:

"To a certain extent the temperature of the earth's surface, as we shall presently see, is conditioned by the properties of the atmosphere surrounding it, and particularly by the permeability of the latter for the rays of heat. (p46)"
"That the atmospheric envelopes limit the heat losses from the planets had been suggested about 1800 by the great French physicist Fourier. His ideas were further developed afterwards by Pouillet and Tyndall. Their theory has been styled the hot-house theory, because they thought that the atmosphere acted after the manner of the glass panes of hot-houses."

Here we may see an example of sloppy research by Arrhenius (please also see below) because he cites Fourier "about 1800". However, according to Casey, Fourier published his ideas related to the atmosphere in 1824 at the earliest.

On the other hand, Arrhenius´ ideas are most interesting. He believed CO_2 would be BENEFICIAL and NECESSARY to "feed the rapidly increasing population". What do the UN IPCC, and many of the scientists referring to Arrhenius, make of that?

But the more important question is: Was Arrhenius´ theory based on indisputable facts? Or is it merely theory?

Once again Casey: "Contrary to what Arrhenius (1896, 1906b) and many popular authors may claim (Weart, 2003; Flannery, 2005; Archer, 2009), Fourier did not consider the atmosphere to be anything like glass. In fact, Fourier (1827, p. 587) rejected the comparison by stipulating the impossible condition that in order for the atmosphere to even remotely resemble the workings of a hotbox or greenhouse, layers of the air would have to solidify without affecting the air's optical properties. What Fourier (1824, translated by Burgess, 1837, p. 12) actually wrote stands in stark contrast to Arrhenius' claims about Fourier's ideas:

In short, if all the strata of air of which the atmosphere is formed, preserved their density with their transparency, and lost only the mobility which is peculiar to them, this mass of air, thus become solid, on being exposed to the rays of the sun, would produce an effect the same in kind with that we have just described. The heat, coming in the state of light to the solid earth, would lose all at once, and almost entirely, its power of passing through transparent solids: it would accumulate in the lower strata of the atmosphere, which would thus acquire very high temperatures. We should

observe at the same time a diminution of the degree of acquired heat, as we go from the surface of the earth."

Even worse, "Arrhenius (1906b, pp. 154 and 225) still clung to the aether hypothesis, which refers to the unspecified material medium of space. Arrhenius' adherence to this hypothesis remained firm in spite of its sound refutation by Michelson & Morley (1887). This leaves the conceptual underpinning of radiation in Arrhenius' "Greenhouse Effect" to Tyndall (1864, pp. 264-265; 1867, p. 416), who ascribes communication of molecular vibration into the aether and communication of aethereal vibration to molecular motion."

Moreover, Erren (2003) points out: "The key paper on global warming written by Svante Arrhenius [1] in 1896 relies on the infrared observations of the moon as published by Langley in 1890 [2]. The paper of Langley contains errors that were corrected in 1900 by Langley and Abbot[3] but this was after Arrhenius published his theory."

It is therefore realistic to conclude that Arrhenius´ theory is based on misconceptions – aether theory and misunderstanding of Fourier´s greenhouse experiments – and flaws in Langley´s data upon which his theory is built. So, Arrhenius´ "greenhouse effect" theory is questionable, to say the least. But nevertheless, modern "greenhouse effect theories" still largely claim that:
a) The atmosphere acts like a greenhouse made of glass
b) CO_2 is a major contributor to this greenhouse effect

Robert W. Wood's Refutation Of Arrhenius

According to Casey, Arrhenius had misquoted Fourier, "who maintained that closed spaces such as hotboxes (and by extension greenhouses) retained their heat by cutting off circulation with the cooler atmosphere." Perhaps it is thus that it took almost 100 years for another scientist to "rediscover" Fourier's findings and interpretations.

In 1909, Robert W. Wood performed a very simple yet clear-cut experiment to determine why a real greenhouse made of glass is warmer than its surroundings. Wood asked himself: "Is it therefore necessary to pay attention to trapped radiation in deducing the temperature of a planet as affected by its atmosphere?"

And he answered this question in the following way: "The solar rays penetrate the atmosphere, warm the ground which in turn warms the atmosphere by contact and by convection currents. The heat received is thus stored up in the atmosphere, remaining there on account of the very low radiating power of a gas. It seems to me very doubtful if the atmosphere is warmed to any great extent by absorbing the radiation from the ground, even under the most favourable conditions."

Here is Wood's elegant experiment: "To test the matter I constructed two enclosures of dead black cardboard, one covered with a glass plate, the other with a plate of rock-salt of equal thickness. The bulb of a thermometer was inserted in each enclosure and the whole packed in cotton, with the exception of the transparent plates which were exposed. When exposed to sunlight the temperature rose gradually to 65° C., the enclosure covered with the salt plate keeping a little ahead of the other, owing to the fact that it transmitted the longer waves from the sun, which were stopped by the glass. In order to eliminate this action the sunlight was first passed through a glass plate.

There was now scarcely a difference of one degree between the temperatures of the two enclosures. The maximum temperature reached was about 55° C. From what we know about the distribution of energy in the spectrum of the radiation emitted by a body at 55° C, it is clear that the rock-salt plate is capable of transmitting practically all of it, while the glass plate stops it entirely. This shows us that the loss of temperature of the ground by radiation is very small in comparison to the loss by convection, in other words that we gain very little from the circumstance that the radiation is trapped."

Wood's experiment of course does only show that greenhouses *made of glass* do not "trap" any radiation. But shouldn't we ask ourselves: if a very solid material like glass does not trap any radiation is it then logical to assume that the turbulent, chaotic mixture of gases comprising our atmosphere, would? After all, already Fourier refuted such a possibility.
And we should at least stop arguing that the atmospheric "greenhouse effect" is named in such a way because it resembles the physical mechanisms by which actual greenhouses are warmed. This is definitely wrong.

Wood's experiment was confirmed in great detail by Professor Nasif Nahle in this experiment in 2011.

Kirchhoff's Law

The history of radiation theories of course wouldn't be complete without Kirchhoff's law. Moreover, this law is often stated to "prove" that "back" or "downwelling" radiation "is real".

Perhaps we should recall the two mechanisms discussed and allegedly proclaimed to "warm the earth" by the action of the atmosphere:

1.) "Back radiation", as suggested by Kiehl and Trenberth 1997, allegedly adds some extra radiation wattage to the sun's insolation, thereby warming the earth more than the sun´s radiation alone would do.

2.) "Back" or "downwelling" longwave radiation acts to slow down cooling of the earth by acting like a *somewhat* cooler body – cooler with regard to the earth's surface - which is still *warmer* than outer space and therefore, seemingly, delays cooling of the earth which in effect leads to a "warmer earth".

Whereas 1.) can easily be seen to contradict the 2nd law of thermodynamics, formulated between 1850 (Clausius) and 1851 (Kelvin), as heat, even radiative heat, cannot flow from the cooler atmosphere (due to convection it is *always* cooler than the earth's surface) to the warmer surface, 2.) is much more tricky.

The proponents of 2.) say something like: "Quantum physics tells us that *statistically* there are more photons flowing from the warmer body to the cooler body than the other way around but that does not mean that there are NO photons – statistically – moving from the cooler to the warmer body. Only the NET FLOW is decisive. And the net flow, according to the 2nd law of thermodynamics, of course is only from hot to cold. BUT, because – statistically – there are some photons moving from cold to warm, i. e., from the atmosphere to the earth's surface, the rate of cooling of the earth is smaller than it would be WITHOUT the *somewhat* colder body, i.e., the atmosphere."

It should be easy to see how much this kind of argument is based on nothing more than Prevost's ideas. However, in modern times, Prevost's "igneous fluid particles" has been replaced by "quantum physics" or "quantitized photons". We will see shortly if "quantum physics" is something we can really trust, i. e., if it is scientifically undisputed and proven beyond doubt.

Kirchhoff's law states that: At thermal equilibrium, the emissivity of a body (or surface) equals its absorptivity. This at first seems logical, a simple matter of energy balance.

However, Claes Johnson argues: "But Kirchhoff's Law concerns emissivity and absorptivity as emission and absorption per unit time and in this setting it is not at all trivial. The question is why a body capable of absorbing radiation and emitting radiation, must absorb and emit at the same rate? Is it because emission and absorption are simply the reverse of each other with emission simply absorption backwards in time? No, it is not so trivial, because emission and absorption are different physical processes both with an arrow of time which cannot be reversed. Emission and absorption are not the reverse of each other."

What might be worse is yet another fact: Arne Schirrmacher reveals that "David Hilbert told the German physicists at one of their main professional meetings in the morning of September 18, 1912 that they had failed for more than fifty years to provide a proof for one of their most precious laws: Kirchhoff's law on heat radiation that turned involved experimental results into a relation as simple and persuasive like Ohm's law 33 years before, had not even in the simplest special cases been made plausible."

At a later passage in Schirrmacher´s text it turns out that Kirchhoff's law is merely based on *thought experiments*.

Let us be totally clear about that: a law which was never **really**, EXPERIMENTALLY, i. e., *based on FACTS*, **proven** is used to "prove" that "back" or "downwelling" radiation must be real because:

1.) according to Kirchhoff's law any body emits the amount of radiation it absorbed [in all directions]

2.) Prevost´s argumentation, disguised as quantum physics in our modern times, says that **particles**, photons (Planck), emitted by the absorber will travel to another, should the situation arise also warmer, emitter and slow down its emission and thus cooling process

Of course Prevost´s and even Planck´s considerations (see below) are also only theoretical EVEN THOUGH at least Planck´s radiation theorem is accepted by the majority of modern physicists.

It may therefore seem justified to state that:

Already the theory of "back" or "downwelling" radiation is based on nothing more than other unproven albeit commonly accepted theories.

And, as "theory" is another word for "supposition", in contrast to "facts", we may, in keeping with Prevost, Kirchhoff, and Planck, according to the stringent inherent logic of the argument conclude that:

"BACK" OR "DOWNWELLING" RADIATION IS SUPPOSITION. And therefore, the "atmospheric greenhouse theory" based on "downwelling" or "back" radiation of absorbed surface emission by carbon dioxide and other gases, is SUPPOSITION or FICTION.

Pure and simple!

Maxwell

One of the questions discussed in this paper in the light of scientific history is whether light, or heat, is a form of particles (photons) or waves.

Wikipedia neatly summarizes the situation prior to Planck:

"In most theories up to the eighteenth century, light was pictured as being made up of particles. Since particle models cannot easily account for the refraction, diffraction and birefringence of light, wave theories of light were proposed by René Descartes (1637),[28] Robert Hooke (1665),[29] and Christian Huygens (1678);[30] however, particle models remained dominant, chiefly due to the influence of Isaac Newton.[31] In the early nineteenth century, Thomas Young and August Fresnel clearly demonstrated the interference and diffraction of light and by 1850 wave models were generally accepted.[32] In 1865, James Clerk Maxwell's prediction[33] that light was an electromagnetic wave—which was confirmed experimentally in 1888 by Heinrich Hertz's detection of radio waves[34]—seemed to be the final blow to particle models of light."

"In 1900, Maxwell's theoretical model of light as oscillating electric and magnetic fields seemed complete. However, several observations could not be explained by any wave model of electromagnetic radiation, leading to the idea that light-energy was packaged into quanta described by $E = h\nu$. Later experiments showed that these light-quanta also carry momentum and, thus, can be considered particles: the photon concept was born, leading to a deeper understanding of the electric and magnetic fields themselves."

"The Maxwell wave theory, however, does not account for all properties of light. The Maxwell theory predicts that the energy of a light wave depends only on its intensity, not on its frequency; nevertheless, several independent types of experiments show that the energy imparted by light to atoms depends only on the light's frequency, not on its intensity. For example, some chemical reactions are provoked only by light of frequency higher than a certain threshold; light of frequency lower than the threshold, no matter how intense, does not initiate the reaction. Similarly, electrons can be ejected from a metal plate by shining light of sufficiently high frequency on it (the photoelectric effect); the energy of the ejected electron is related only to the light's frequency, not to its intensity.[35][Note 3]"

We can learn the following from the above quote:

- Before 1850, "particle models remained dominant, chiefly due to the influence of Isaac Newton"
- By "1850 wave models were generally accepted" and in "1865, James Clerk Maxwell's prediction that light was an electromagnetic wave ... seemed to be the final blow to particle models of light."
- "The Maxwell wave theory, however, does not account for all properties of light. The Maxwell theory predicts that the energy of a light wave depends only on its intensity, not on its frequency..." Furthermore, "electrons can be ejected from a metal plate by shining light of sufficiently high frequency on it (the photoelectric effect); the energy of the ejected electron is related only to the light's frequency, not to its intensity."

Please keep this in mind when we now turn to Planck´s radiation law and a new approach to solve the mystery of radiation.

Planck

Another Wikipedia article describes the emergence of Planck´s (radiation) law:

"In 1894 Planck turned his attention to the problem of black-body radiation."
"Planck's first proposed solution to the problem in 1899 followed from what Planck called the "principle of elementary disorder", which allowed him to derive Wien's law from a number of assumptions about the entropy of an ideal oscillator, creating what was referred-to as the Wien–Planck law. Soon it was found that experimental evidence did not confirm the new law at all, to Planck's frustration. Planck revised his approach, deriving the first version of the famous Planck black-body radiation law, which described the experimentally observed black-body spectrum well. It was first proposed in a meeting of the DPG on October 19, 1900 and published in 1901. This first derivation did not include energy quantization and did not use statistical mechanics, to which he held an aversion. In November 1900, Planck revised this first approach, relying on Boltzmann's statistical interpretation of the second law of thermodynamics as a way of gaining a more fundamental understanding of the principles behind his radiation law. As Planck was deeply suspicious of the philosophical and physical implications of such an interpretation of Boltzmann's approach, his recourse to them was, as he later put it, "an act of despair ... I was ready to sacrifice any of my previous convictions about physics.[9]

The central assumption behind his new derivation, presented to the DPG on 14 December 1900, was the supposition, now known as the Planck postulate, that electromagnetic energy could be emitted only in quantized form, in other words, the energy could only be a multiple of an elementary unit $E = h\nu$, where h is Planck's constant, also known as Planck's action quantum (introduced already in 1899), and ν (the Greek letter nu, not the Roman letter v) is the frequency of the radiation. Note that the elementary units of energy discussed here are represented by hν and not simply by h. Physicists now call these quanta photons and a photon of frequency ν will have its own specific and unique energy."

Again I would like to point out what seems most important from the above quote:

- Planck was *deeply suspicious* of Boltzmann's statistical interpretation of the second law of thermodynamics. Therefore, his "recourse to them was, as he later put it, "an act of despair …" An *act of despair...*
- "Physicists now call these quanta photons,..."

As an outcome of Planck´s theorem, modern radiation physics now has to live with the wave-particle duality of light. But does it really have to? We will see shortly.

Summary Of Historical Approaches To Explain The Nature Of Light Or Radiation

You might ask yourselves: 'Why is it important to contemplate the nature of light with respect to radiation? What's the difference for any radiative effect to be exerted as photon (particle) or wave?'

We will solve this puzzle soon.

The different historical views of the nature of radiation or light can be summarized as follows:

- Pictet was uncertain and thought both a wave or particle model might explain his observed "reflection of cold". However, he preferred the particulate approach.
- Rumford was a strict "undulationist" – a proponent of the claim that only waves could explain what was observed.
- Prevost again was just as strictly adhering to his particle model.
- Due to Newton's influence, particle models dominated until 1850.
- By 1850 wave models were generally accepted and after Hertz's experimental confirmation of Maxwell, his wave model again dominated.
- After 1900 photons, the wave-particle duality and quantum physics are dominating physics and radiation theories.

If this summary can show us one thing then it is that the "wave-particle duality" played a wicked game throughout the history of modern science. Like a huge pendulum the attempts to explain the nature of radiation and light were deflected from one side to the other until the concept of wave-particle duality seemingly stopped the pendulum at a resting point and finally harmonized two fundamentally different concepts in a third and hitherto unknown theoretical approach.

But did this harmonization bring peace of mind?

At least Albert Einstein, whom some call the greatest physicist and genius of all time, was never truly satisfied with Planck´s findings, as some of his quotes may show – respective emphasis, if any, are by the author of this text: "In the year nineteen hundred, in the course of purely theoretical (mathematical) investigation, Max Planck made a very remarkable discovery: the law of radiation of bodies as a function of temperature could not be derived solely from the Laws of Maxwellian electrodynamics."

Please note what is most important in the above quote: "… in the course of purely THEORETICAL investigation". ONLY a theory. NO evidence based on experiments.

"This discovery became the basis of all twentieth-century research in physics and has almost entirely conditioned its development ever since. Without this discovery it would not have been possible to establish a workable theory of molecules and atoms and the energy processes that govern their transformations. Moreover, it has *shattered the whole framework of classical mechanics and electrodynamics* and set science a fresh task: that of finding a new conceptual basis for all physics. **Despite remarkable partial gains, the problem is still far from a satisfactory solution**. (Albert Einstein, 1950)".

And finally: "All these fifty years of conscious brooding have brought me no nearer to the answer to the question, 'What are light quanta?' Nowadays every Tom, Dick and Harry thinks he knows it, but he is mistaken. (Albert Einstein, 1954)."

Can we therefore really trust Planck´s law?

Claes Johnson

In 2010, Professor Claes Johnson from Sweden, developed and published a completely new mathematical approach to solve the problem of blackbody radiation and the photoelectric effect, both of which "required" quantum physics by Planck and Einstein, respectively, before, on the basis of a unified set of equations which now again rely on *waves* only.
Johnson calls his approach "deterministic finite precision computational wave mechanics" which is described in more detail also here.

According to Johnson, "A blackbody acts like a transformer of radiation which absorbs high-frequency radiation and emits low-frequency radiation. The temperature of the blackbody determines a cut-off frequency for the emission, which increases linearly with the temperature: The warmer the blackbody is, the higher frequencies it can and will emit. Thus only frequencies below cut-off are emitted, while all frequencies are being absorbed.

A blackbody thus can be seen as a system of resonators with different eigen-frequencies which are excited by incoming radiation and then emit radiation. An ideal blackbody absorbs all incoming radiation and re-emits all absorbed radiation below cut-off.
Conservation of energy requires absorbed frequencies above cut-off to be stored in some form, more precisely as heat energy thus increasing the temperature of the blackbody."

While already this view of a blackbody is theoretically interesting and new, Johnson's conclusions from his model are even more interesting: "Radiative heat can be transmitted by electromagnetic waves from a warm blackbody to a colder blackbody, but not from a cold to a warmer, thus with a one-way direction of heat energy, while the electromagnetic waves propagate in both directions. We thus distinguish between two-way propagation of waves and one-way propagation of heat energy by waves. A cold body can heat up by eating/absorbing high-frequency, high temperature, coherent waves in a catabolic process of destruction of coherent waves into incoherent heat energy. A warm body cannot heat up by eating/absorbing low-frequency low-temperature waves, because catabolism involves destruction of structure. Anabolism builds structure, but a black- body is only capable of destructive catabolism (the metabolism of a living cell consists of destructive catabolism and constructive anabolism)."

Again, I would like to stress Johnson's most important point of argumentation: "We thus distinguish between two-way propagation of waves and one-way propagation of heat energy by waves."

What does this mean? If you read at least the shorter of Johnson´s articles you will understand that electromagnetic waves can flow from both the warmer to the colder body and vice versa but HEAT can ONLY be transferred from the ***warmer*** to the *colder* body as required by the 2nd law of thermodynamics.

Proponents of AGW choose to argue that "downwelling longwave radiation (DLR)" is real because it can be *measured* and there are many government funded programs to measure DLR. However, with respect to AGW the question is not if one can measure the temperature of the atmosphere by means of radiation – which is basically what is done when DLR is measured from earth´s surface. The one and only important question is whether DLR **transports heat** from the *colder* atmosphere to the ***warmer*** ground.

Particle based radiation models, like Planck´s, inevitably must suggest (to someone ready to believe such a suggestion) that heat bound to the "particles" (quantitized photons) is transported at least statistically from cold to warm, thereby violating the 2nd law of thermodynamics, when these quanta "statistically" also move from cold to warm.

Johnson avoids this violation of the 2nd law.
With Johnson´s proposed mechanism it is OF COURSE possible to *measure* the temperature of the – colder – atmosphere standing on the earth´s surface with appropriate devices like e. g. a pyrgeometer (two-way propagation of emitted waves) but any "downwelling" radiation cannot transport ANY HEAT from the colder atmosphere to the warmer earth surface and thus can neither warm the surface nor reduce its cooling rate *by means of* ***downwelling*** *radiation*.

Note: Of course the presence of an absorbing/emitting atmosphere can change a planet's temperature and the cooling rate must be the same as the insolation in stationary state, but the temperature gradient and thus surface temperature can change with changing atmospheric properties. The above statement therefore *only* refers to a change of cooling rate by "back" or "downwelling" radiation.

Is Johnson's mathematical and theoretical approach less (or more) credible than Planck's and Einstein's in the first place?
Unlikely! Planck's and Einstein's proofs were as purely mathematical and theoretical as is Claes Johnson's.

From this point of view Johnson's approach has to be regarded as equally valid as Planck´s. However, the implications with regard to "back" or "downwelling" radiation suppositions are HUGE: whereas any particle (photon) statistics implies the delusion of "added heat" or "reduced planetary cooling" imposed by the atmosphere, Johnson clearly rejects this supposition as fiction.

Conclusions

The history of radiation theories reflects the history of science: concepts, or theories, are born and discarded as further research and further observation failed to cohere with old concepts. What was initially a valid concept accepted by all or the majority of scientists for a time can cease to hold with the emergence of new knowledge and eventually become recognized as a "misconception".
A telling example of this is Rumford's "frigorific" waves.

Tyndall thought he had measured absorption when he experimented with different gases (among them carbon dioxide and air freed from carbon dioxide) but had apparently only measured opacity which, in contrast to absorption, still includes a measure of reflected radiation.

Other scientists, like Arrhenius, appear to have misunderstood Tyndall and also Fourier and additionally relied on inappropriate data sets to develop their theory.

Arrhenius´ theory of carbon dioxide as major "warming agent" of the atmosphere due to absorption and back radiation of heat is thus not very credible.
Additionally, his belief of a greenhouse being heated by "trapped radiation" has been clearly refuted by Wood only some years after Arrhenius´ proposal.

According to the Wikipedia article mentioned before Arrhenius emerges as seemingly not as noble as his involvement in setting up the Nobel committee had implied: "About 1900, Arrhenius became involved in setting up the Nobel Institutes and the Nobel Prizes. He was elected a member of the Royal Swedish Academy of Sciences in 1901. For the rest of his life, he would be a member of the Nobel Committee on Physics and a *de facto* member of the Nobel Committee on Chemistry. He used his positions to arrange prizes for his friends (Jacobus van't Hoff, Wilhelm Ostwald, Theodore Richards) and to attempt to deny them to his enemies (Paul Ehrlich, Walther Nernst, Dmitri Mendeleev).[1]"

Thus, for over a quarter century (he died in 1927) Arrhenius exerted his enormous bias in all Nobel Prize winners of that time.

All in all, it is most remarkable that Arrhenius´ flawed theory could have survived for as long as it did and be the very – historical – basis of today's AGW beliefs. This may be because Arrhenius was awarded the Nobel prize and Wood not. However, Arrhenius did not receive a Nobel prize for his climate theory but for his discovery of ions dissolved in aqueous solutions, the fundamental difference being that Arrhenius´ discovery of ions was based on EXPERIMENTS unlike his climate theory which was only a theory based on someone else's – flawed – data set.

The historical development of radiation theories has clearly shown that heat transported from the atmosphere to the earth's surface by "back" or "downwelling" radiation is incorrect for a very simple and indisputable reason: Both Prevost's and Planck's **particle based** theories are just that: theories. There is and has been NO factual evidence for their validity. Just as there is NOT A SINGLE shred of factual proof for "downwelling" radiation warming the earth or retarding its cooling.

Thus the basis of AGW remains unproven and highly suspect.

To capitalize on the above: There are two possibilities for a scientific proof. The "hard" proof involves experimental results reproducible and reproduced by other scientists. Ohm's law is a classic example of such a law proven by experiments. Even a non-scientist, can verify Ohm´s law with simple experiments and measurements.

The other, weaker, proof is one which arises from conviction and *common acceptance* or *scientific consensus*: a theory is most convincing for other scientists to explain certain observations which cannot be easily measured or not measured at all with the instrumentation available at a given time. Prevost could not MEASURE "particles" flowing from one body to the other inside his "igneous fluid" just as Kirchhoff could not MEASURE that in- and outgoing radiation of a blackbody were equal (and therefore had to rely on thought experiments only). Equally Planck could not MEASURE his proposed quantified photons.

These latter, weaker, proofs tend to have a limited "half-life" depending on the duration in which they remain unchallenged. The Ptolemaic model of the sun and stars revolving around the earth was accepted by almost everyone for some 14 centuries. Initially Copernicus, then Bruno and eventually Galileo *challenged* this "proven theory" and the rest is now history.

111 years ago Planck formulated his radiation law which led to the birth of quantum mechanics or quantum physics. This, in turn, led to completely new branches of physics and what is called "modern" theoretical physics.

It is illogical to accept that the theoretical development of physics ended 111 years ago, fundamental discoveries had already been made by then and that there would be no further developments.

Initially as earth's temperature was increasing along with increasing emissions of carbon dioxide there had been a *certain* justification for the AGW stance in assuming that this simple proportional correlation could prove correct even though correlations do not in itself constitute proof.

But now that the very little increase of earth's average atmosphere temperature by less than 0.4° C measured by 11 different NOAA satellites between 1984 and 2010/2011 has come to its preliminary maximum even this correlation and thus AGW has failed.

This should be the time to reconsider the theoretical basis of AGW and the theoretical explanations given for "back" or "downwelling" radiation by many scientists all over the world.

Measuring DLR does *not prove anything* except that any temperature – and thus also the temperature of the atmosphere – can be measured by means of radiation which is nothing new. All the rest derived from these measurements is only theory or **supposition**. While it is the right of any scientist to believe in his theory, this alone is not scientific. The spirit of science requires sustained reconsideration of one's own theoretical beliefs and convictions in conjunction with reality and other emerging and eventually more convincing theories.

Now that Planck's and Einstein's theories have been challenged by Claes Johnson, the consensus has been broken, they are no longer undisputed and thus not entirely credible. Therefore a new and probing scientific discussion about the nature of radiation and the photoelectric effect needs to take place and with the credibility of AGW under the spotlight, such a discussion could lead to a deeper understanding of radiation and the photoelectric effect and thus the true nature of the world we live in. It could serve to offset the billions of government funds spent on dubious science worldwide over the past 20 years plus and ultimately lead to a more positive outcome.

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ADDENDUM

A similar article focusing on the interesting subject of "The Greenhouse And Its Effects" as well as the history of "greenhouse science" can be found here:
http://nzclimatescience.net/images/PDFs/the%20greenhousexxx.pdf