Theoretical Basis for a Non-Expensive Experiment for Proving or not Green-House Effect

Slavoljub Mijovic
University of Montenegro; Faculty of Natural Sciences and Mathematics; Dzordza Vashington bb 20000 Podgorica Montenegro e-mail: slavom@rc.pmf.ac.me

Abstract
The simplest theoretical basis is proposed for direct proving or not green-house effect. It is hypothesized that a colder object cannot increase temperature of a warmer, by only radiation. A chip experimental set up is described.

Introduction

A lack of the direct proof of existing or not of the green-house effect is linked to complexity of the processes in the Earth atmosphere and dependence of many parameters. In a basic approach green-house effect is easy to understand, even for non-scientists. To balance the absorbed incoming energy from the Sun, the Earth radiates the same amount energy back to space. Due to existing so-called green house gases in the atmosphere, a part of this radiation from the Earth is captured and reradiate back to the Earth, thus increasing the temperature of the Earth[1,2].
Basically, there are two fundamental questions: Does green-house effect actually exist? And, if the answer is yes, in what magnitude?
This work is dealing only with the first question.

The theoretical model and the hypothesis

To avoid any geometrical problem, let us have a flat plate object which behaves as a perfect black-body from one side, and as a perfect reflector from the other side (imitates the Earth). Further, let suppose that object has enough size that ends effects are negligible. If this object is somehow heated internally with $q[W/m^2]$ (imitates the Sun), mass m of the unit of surface is heated in according to the equation [3]:

$$mc\frac{dT}{dt} = q - \sigma T^4 \quad , \tag{1}$$

where t, T, c, σ, are temperature, time, specific heat and Stefan-Boltzmann constant respectively.

Now, it is easy to calculate the equilibrium temperature $\left(\frac{dT}{dt} = 0\right)$:

$$q = \sigma T^4 \text{ and } T = \sqrt[4]{q/\sigma}. \tag{2}$$

If we now bring another black body near (see fig.1) (the atmosphere), that basic question is, what are their temperatures after approaching the equilibrium? We now have a system of equations for both plates:

$$mc\frac{dT_1}{dt} = q - \sigma T_1^4 + \sigma T_2^4,$$

$$mc\frac{dT_2}{dt} = \sigma T_1^4 - 2\sigma T_2^4 \quad . \tag{3}$$

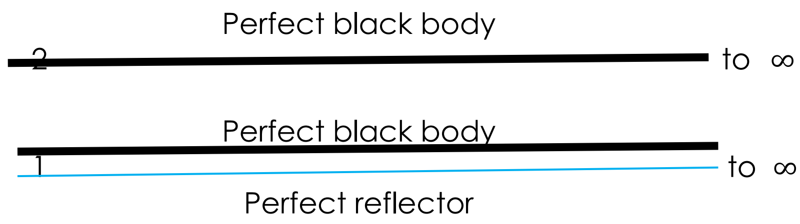

Figure 1. The simplest model of green house effect.

Again, it is easy to calculate that these temperatures are, independently from initial conditions:

$$T_1 = \sqrt[4]{2q/\sigma} \text{ and } T_2 = \sqrt[4]{q/\sigma}. \tag{4}$$

Thus, due to present of another black body, the temperature of the first body was increased about 19% $(\sqrt[4]{2})$ (see Fig.2). For the sake of simulation of the green-house effect at the Earth, the constants m, c and q were chosen to obtain similar temperatures as at the Earth.

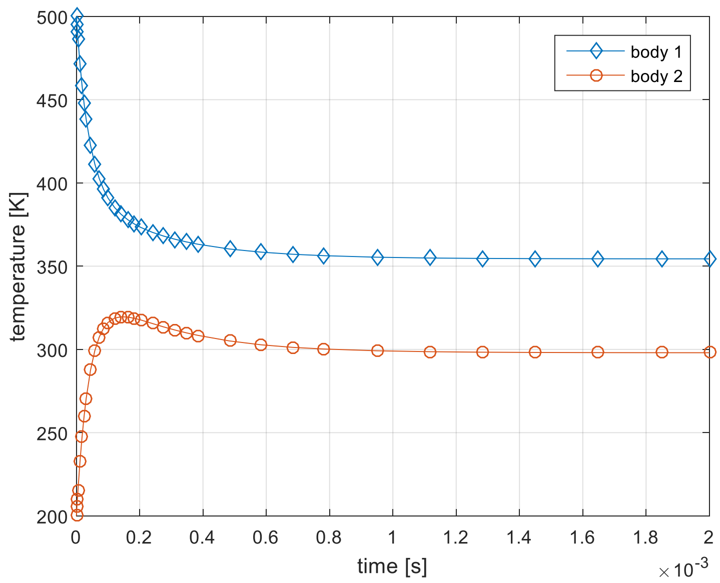

Figure 2. The solution of the system equation (3).

The reason for that is re-radiation of the second body to the first body. If we put as "screens" more black bodies, similar calculation would show that the temperature of the first body would increase dramatically, by factor $(\sqrt[4]{n})$ with n "screens".

Is this really true?

The problem arises from the next reason:

The body 2 is heated by the body 1 and is at lower temperature. Can really the colder object, heated only by the warmer object, increases the temperature of warmer object, just by radiation [3]? Or, stated in another words: Does necessarily a black body changes own characteristic at different own temperatures, i.e., can it really exist in reality?

The hypothesis is that warmer object is saturated in lower energy microstates and cannot absorb more photons from the colder object.

This fundamental question can be solved in a non-expensive experiment.

Proposal for the experimental set-up

To avoid other mechanisms of heat exchanges vacuum is needed. A bigger vacuum chamber, thermally isolated, is needed with an indirectly current heated metal-oxide big flat plane cathode (Fig. 3.) Other side of the electrode could be white painted metal. By controlling current through the cathode, set the cathode temperature to be about 300K, and measure it with a thermocouple. Under the same conditions bring an object to front of the cathode, to simulate black body 2 from the theoretical model, and measure its temperature with another thermocouple. The result of these simple measurements will be the direct proof.

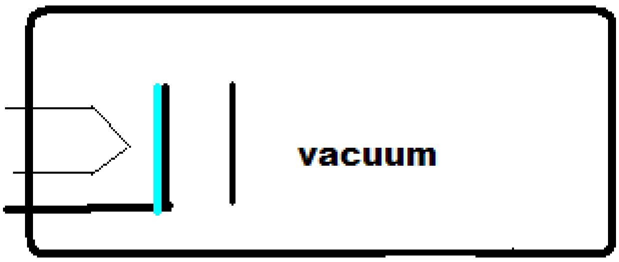

Figure 3. The simplest experimental set-up for proving or not the green-house effect.

References

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[3] J. H. Lienhard IV, J.H. Lienhard V. "A Heat Transfer Textbook", Third Edition, Phlogiston Press, Cambridge 2004.

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