The inclusion of environmental issues as an important component of science education

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Moduly jako prostředek inovace v integraci výuky moderní fyziky a chemie

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Contents

Starting points

- Observations and design of experiments are essential parts of physics and science education.
- Environmental physics is a suitable interdisciplinary topic for inquiring students to scientific process.
- Several experiments can be designed as outdoor activities to promote interest of students in natural environment.
- Today teachers have some sensors like thermometers, luxmeters, hygrometers at their disposal as well as measuring tools with data loggers and respective software.

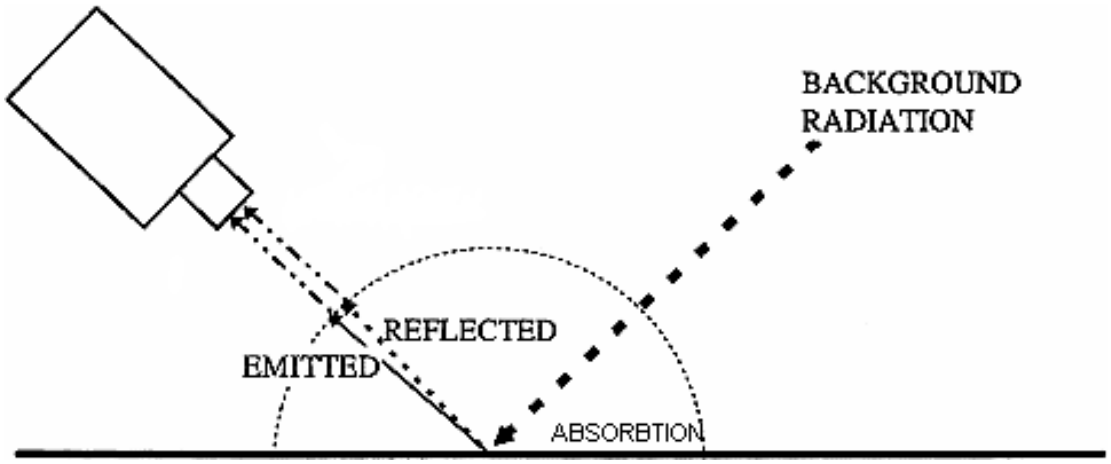
The goal of the project

We are developing a course for future science teachers with aspiration to improve the knowledge on climate by experimental activities.

The goal of the project is to develop several modules helping to implement the abilities used by scientists in their work.

- The ability to design experiments for investigation of new phenomena
- The ability to collect and analyze experimental data
- The ability to devise and test relationships between phenomena and their explanation
- The ability to apply the knowledge in multiple contexts

Modul: Visible & Nonvisible Radiation

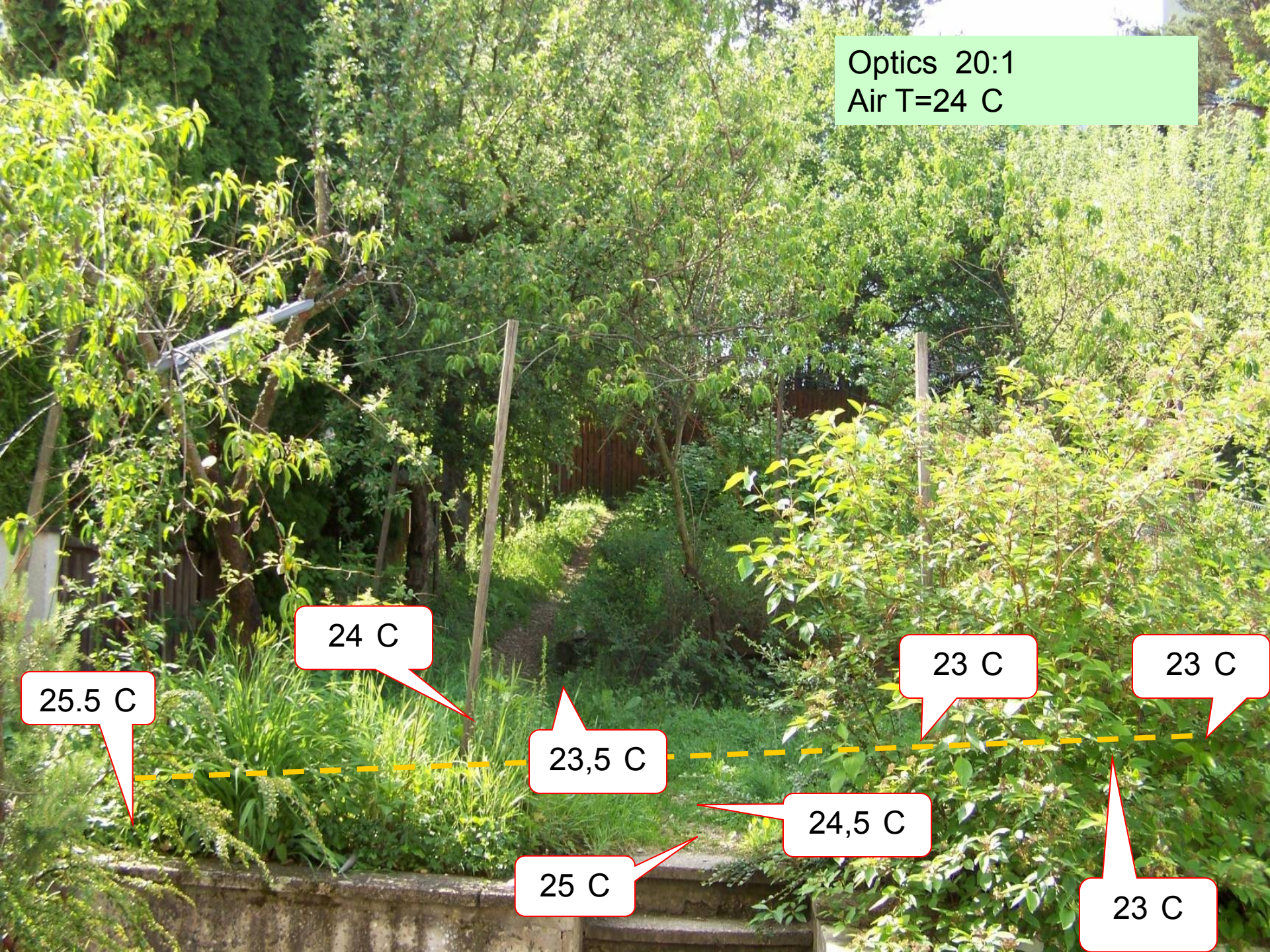


- Infrared temperature measurement of objects
- Measurement of reflectivity of different surfaces
- Visual vs. solar albedo
- Photosynthesis measurement
- Radiation cooling and heating
- Wavelength distibution of sunshine

Infrared temperature measurement of objects

What we need to consider when using an IR thermometer?
Have all objects the same temperature as the surrounding air?

Equipment:
Camera, IR thermometer


Optics 20:1
Air T=24 C
24 C
25.5 C
23,5 C
23 C
23 C
24,5 C
25 C
23 C

Measurement of reflectivity of different surfaces

How dark? How bright? How hot the objects get?

Equipments:

Luxmeter, solar wattmeter, spectrophotometer, Physical Reference Data

Students measure illumination values from the source (sun - UP) and reflected radiation (DOWN) from various surfaces by devices.

Students calculate the reflectivity of various surfaces as the ratio of the illumination and reflected flux values.

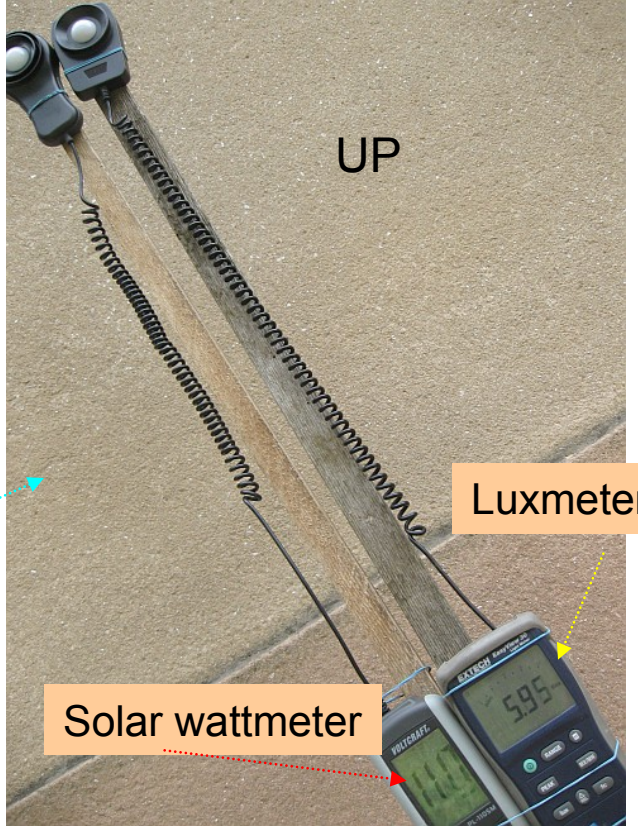
Albedo A - ratio of incident radiative energy flux and non absorbed radiative energy flux.

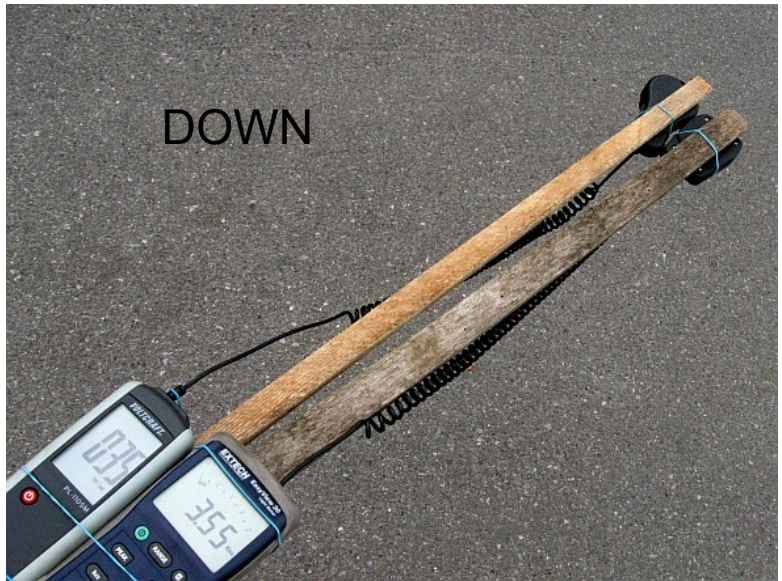
Reflectivity can be considered as an estimate of albedo A. Good enough?

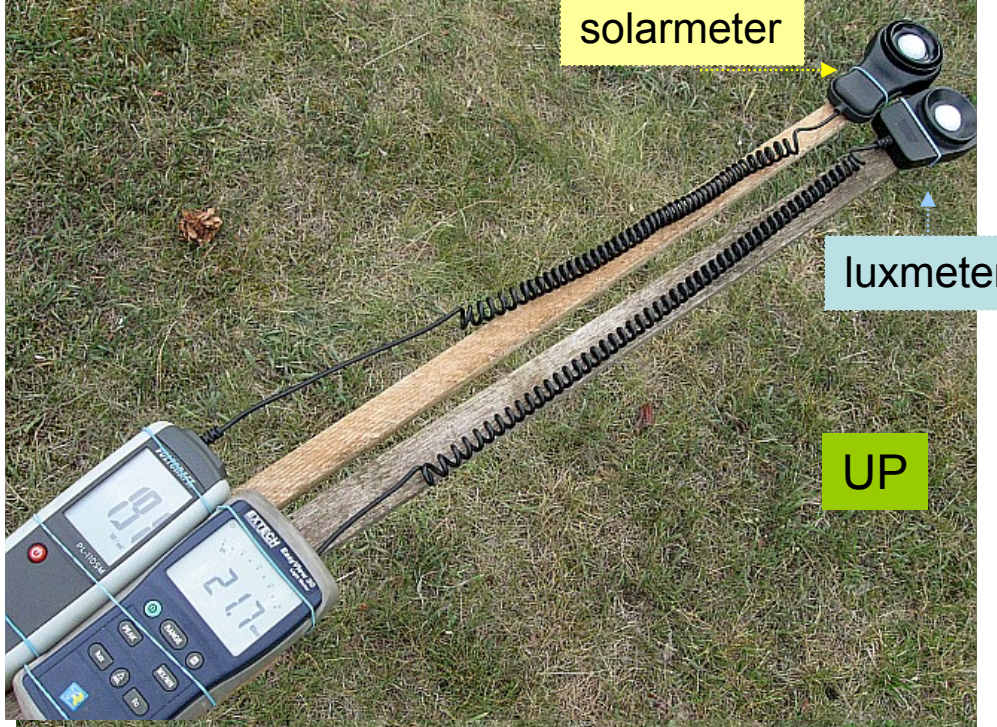
Solar wattmeter
Luxmeter (visual)

Measured reflectivities

Solar Wattmeter A_{solar}	Luxmeter (visual) A_{visual}	
0.24	0.23	Pavement tiles
0.15	0.14	Black asfalt







A_{visual}=0.07 ?

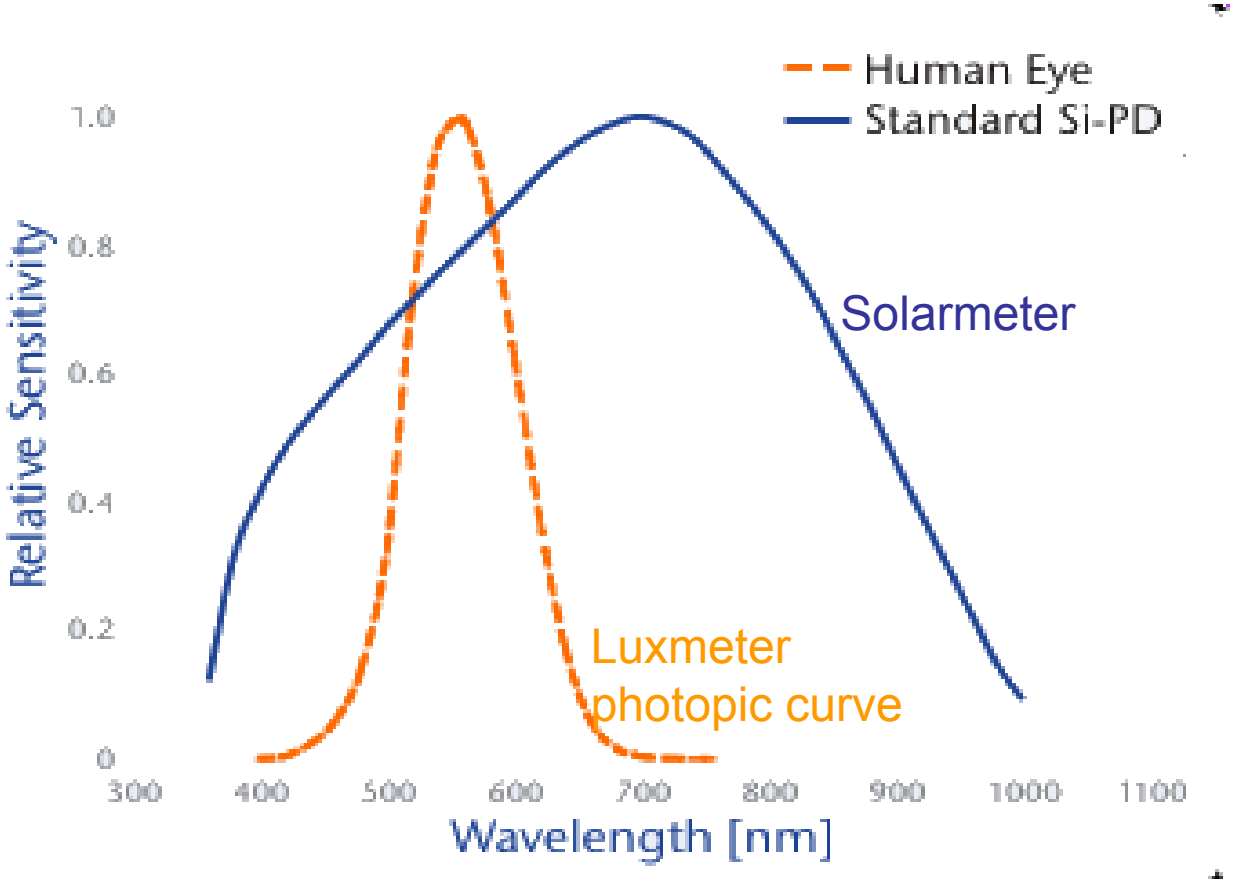
In references:
A=0.4 for vegetation cover

A_{solar}=0.39

Is there an explanation for it?

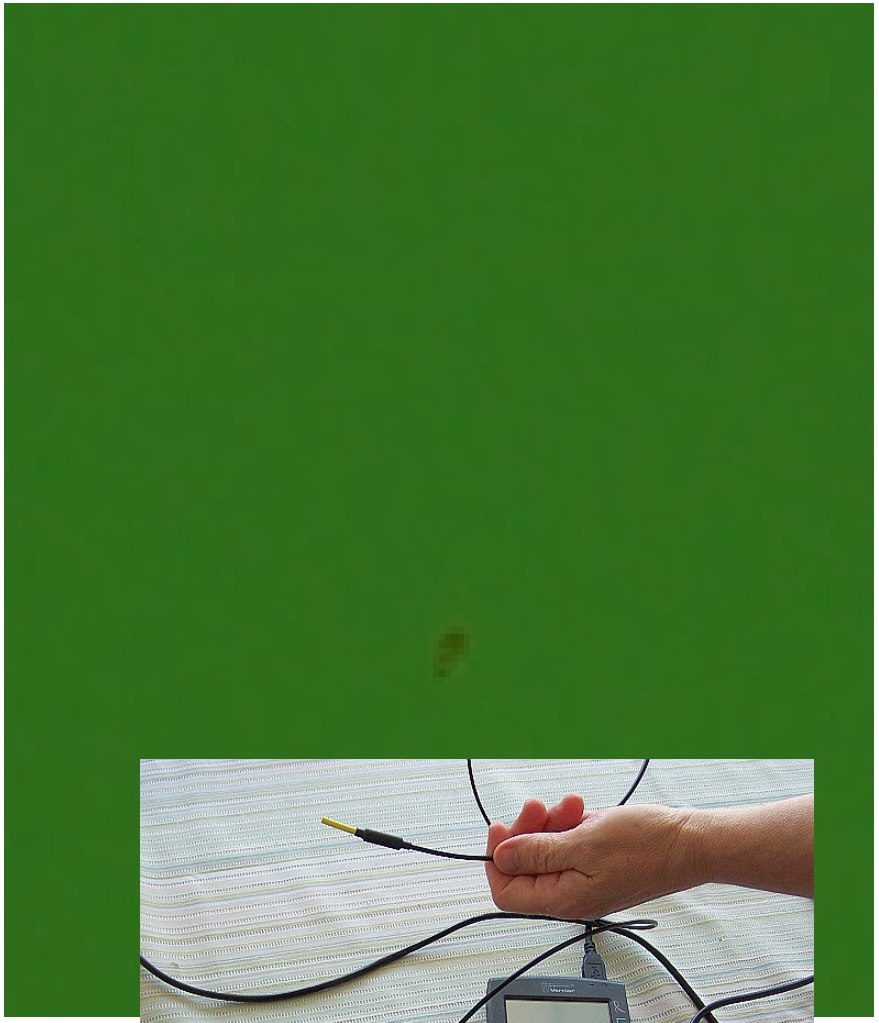
There is a difference between both instruments.

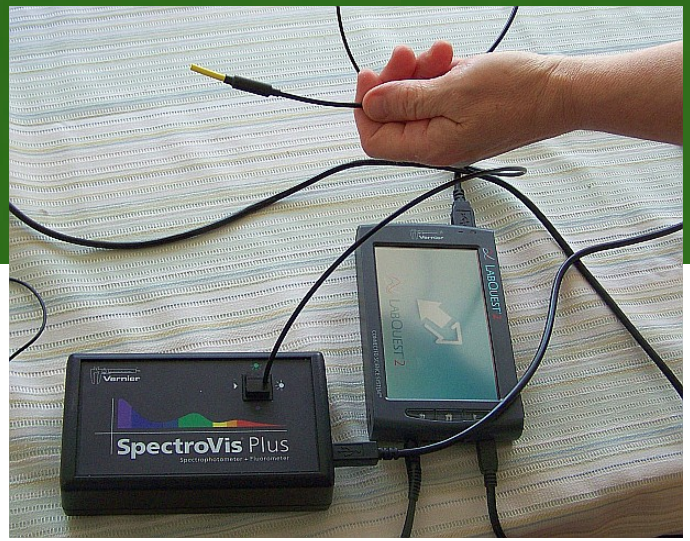
Spectral sensitivity of Luxmeter and Solarmeter



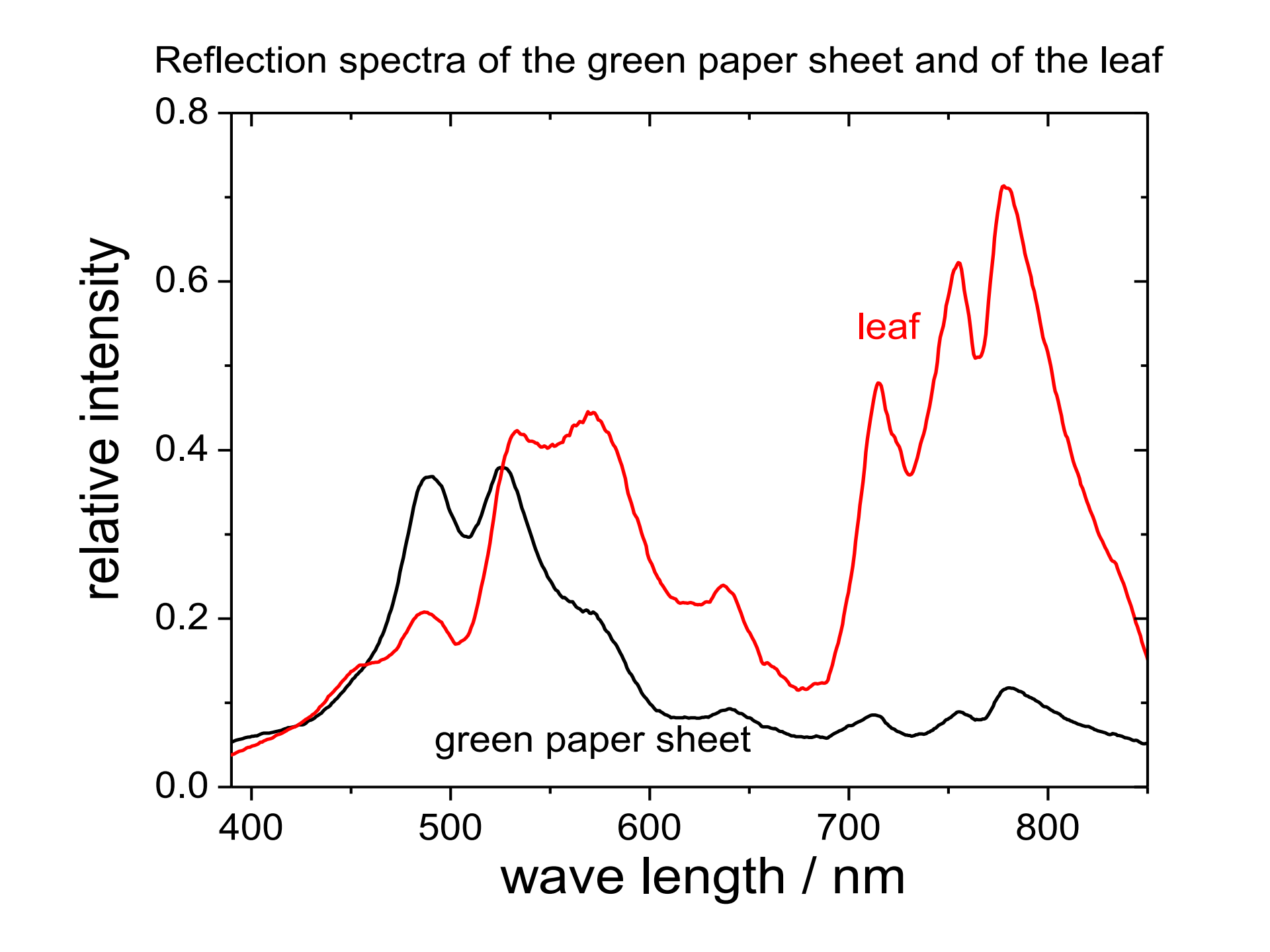
If vegetation reflects significantly in IR range, then the puzzle is explained …

Spectra measurements of leafs and green paper sheet



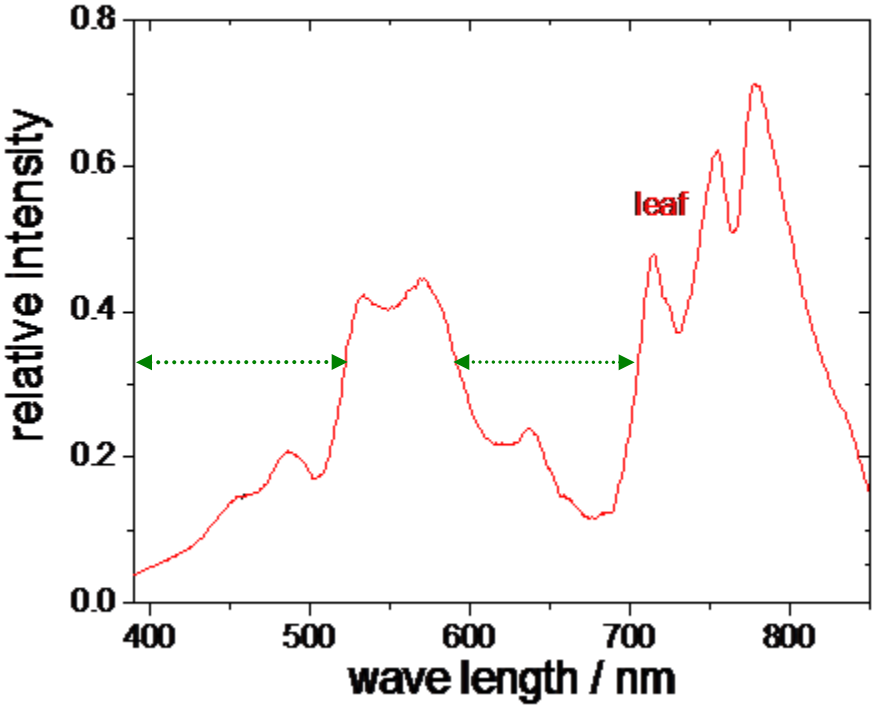


SpectroVis Plus – 380 nm až 950 nm, resolution 1 nm

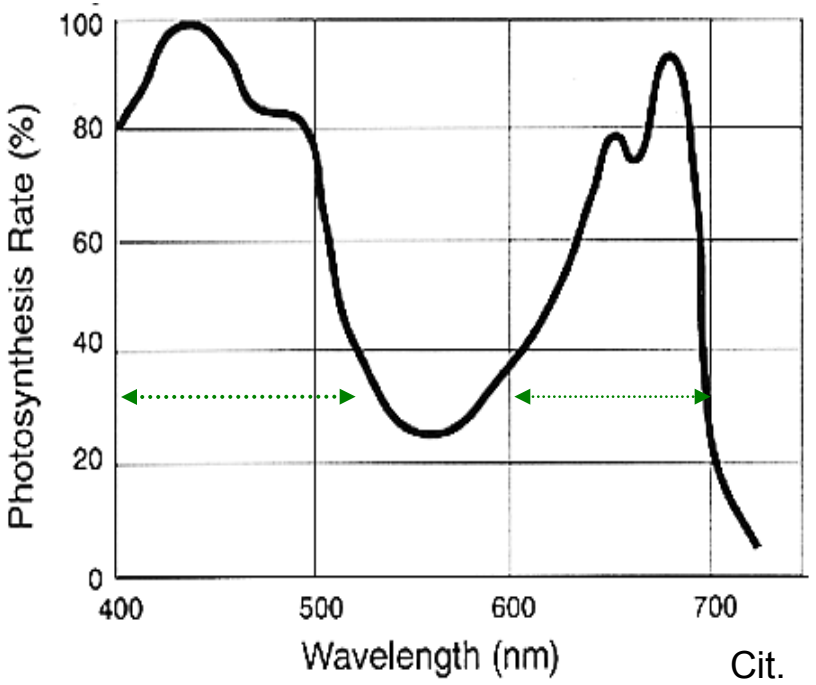

Reflection spectra of the green paper sheet and of the leaf
relative intensity
0.0
0.2
0.4
0.6
0.8
400
500
600
700
800
wave length / nm
leaf
green paper sheet

Comparison of measured reflectivity and photosynthesis rate

reflection spectrum



„consumption“ spectrum



Cit. Wikipedia

Spectra are nearly coplementary.

Green plants have high albedo in the near infrared range due to avoiding of overheating and water loosing.

Green plants are clever!

Photosynthesis measurement petroselinum

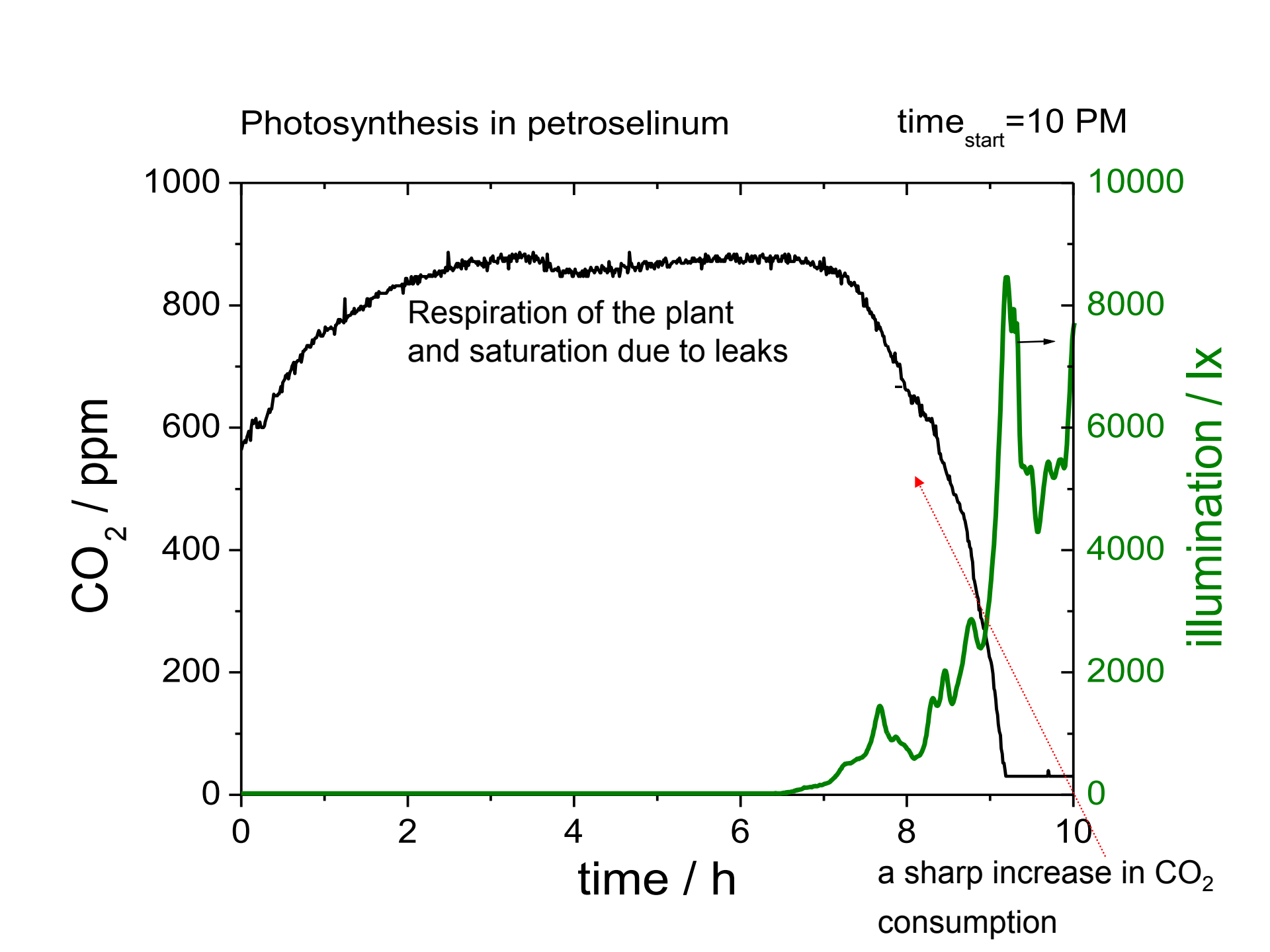
parsley (petroselinum)
plant spices

luxmeter

CO_2 meter

almost hermetically sealed transparent bag

datalogger


Photosynthesis in petroselinum
time start =10 PM
Respiration of the plant
and saturation due to leaks
a sharp increase in CO2
consumption
CO2 / ppm
illumination / lx
time / h
0
200
400
600
800
1000
0
2000
4000
6000
8000
10000
0
2
4
6
8
10

Radiation cooling and heating

Many scientists recommend to paint roofs white to reduce global warming.

Why?

Are the white roofs better than the shiny metallic ones?

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Obama's climate guru: Paint your roof white!

BY STEVE CONNOR, SCIENCE EDITOR | WEDNESDAY 27 MAY 2009

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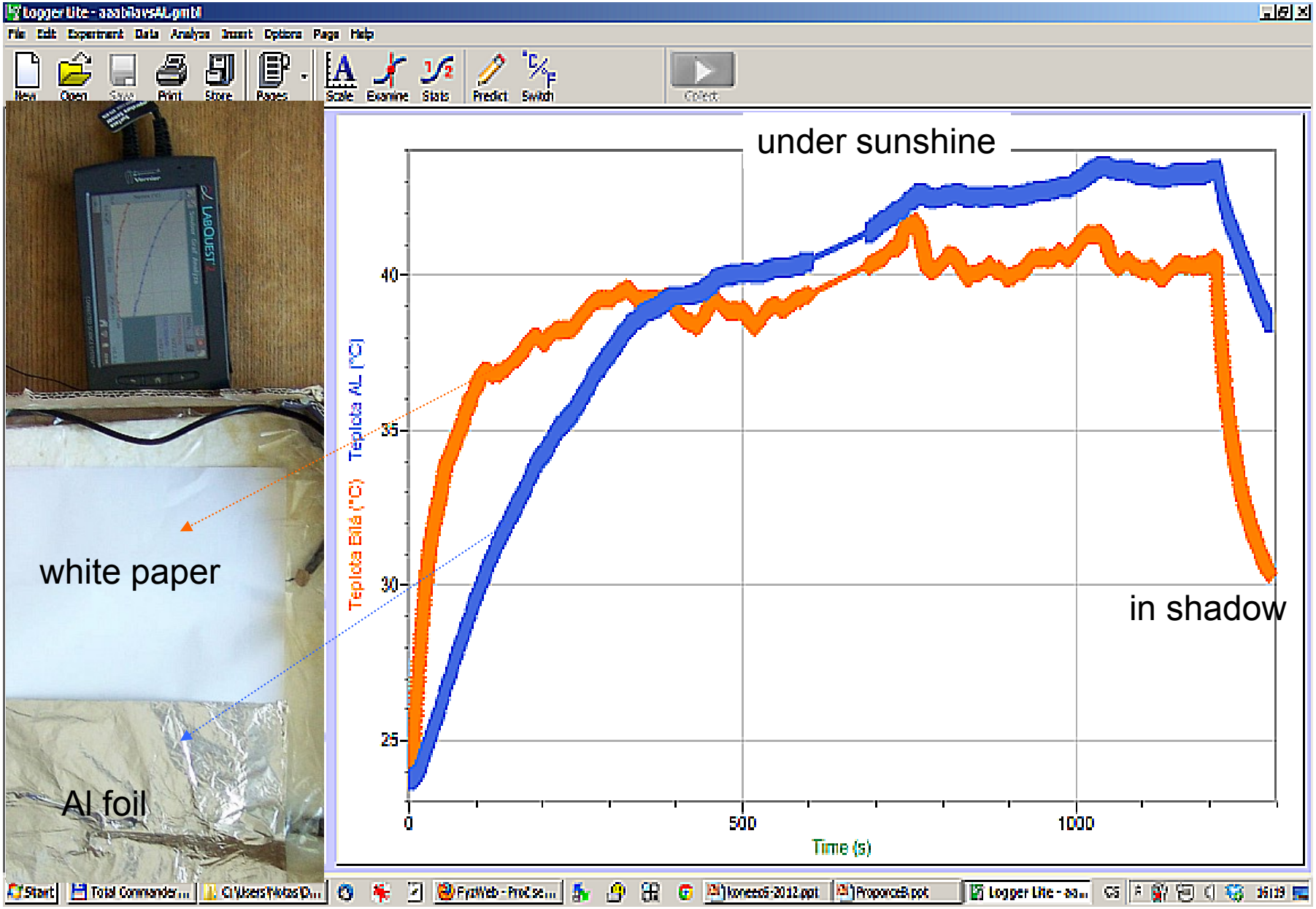
Latest in Climate Change

Picture essay: The terrible legacy of biofuels

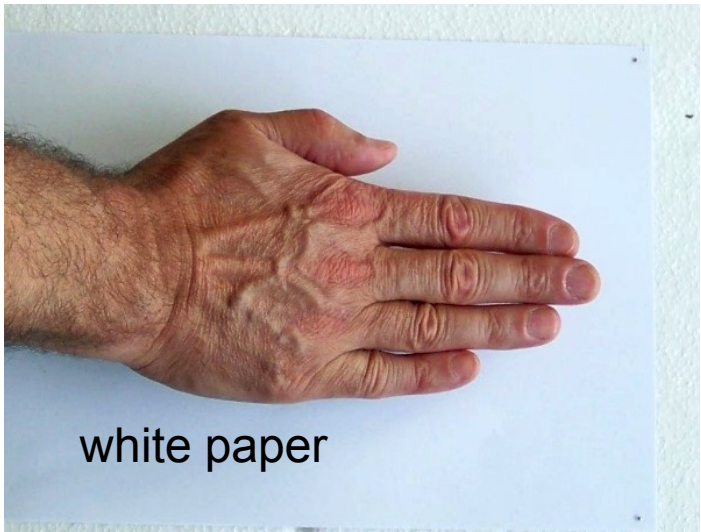
The green movement at 50: Can the world be saved?

Population growth and over-consumption could have 'potentially catastrophic

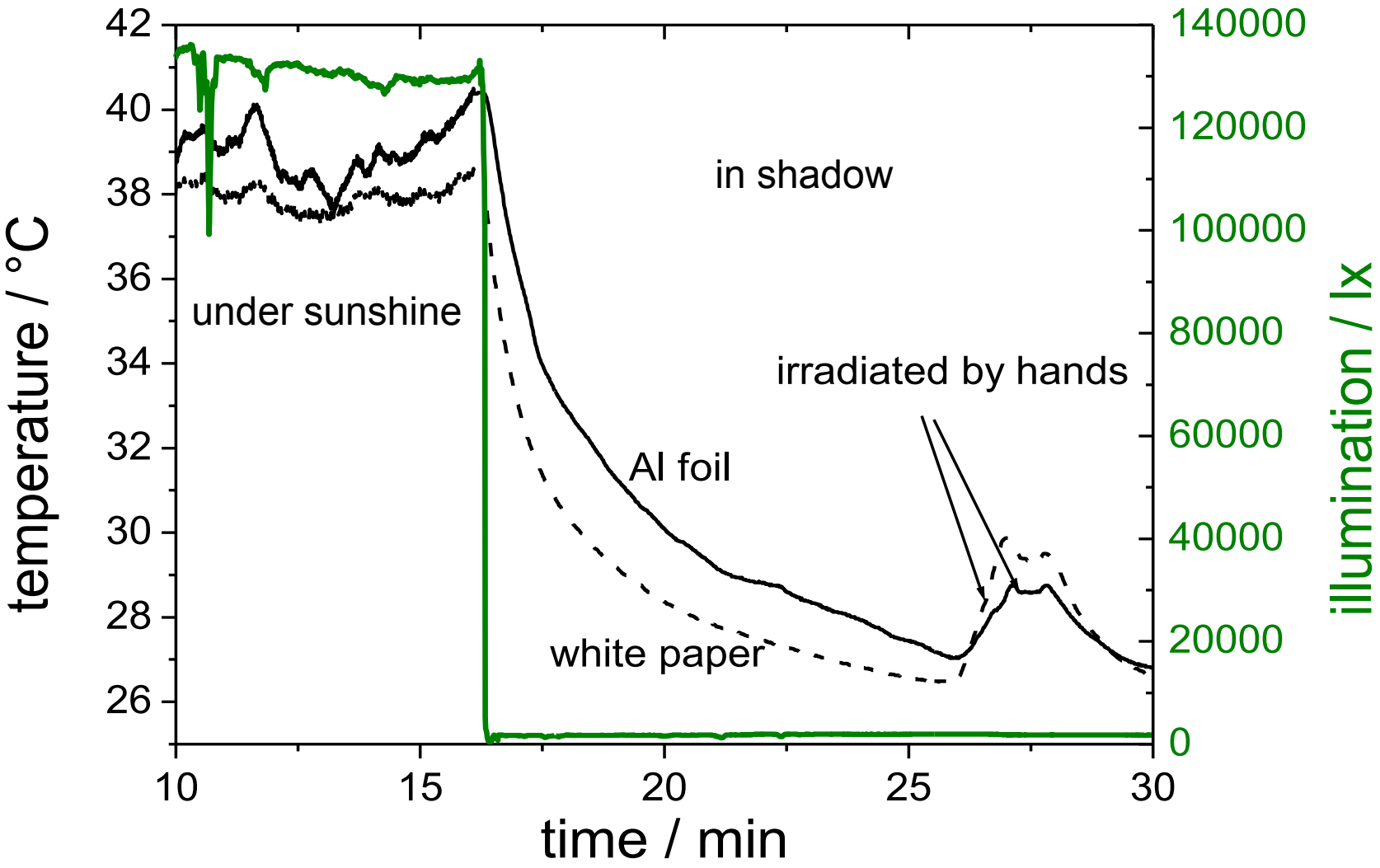

under sunshine
in shadow
white paper
Al foil
Teplota Al (°C)
Teplota Bílá (°C)
40
35
30
25
0
500
1000
Time (s)

23.5C

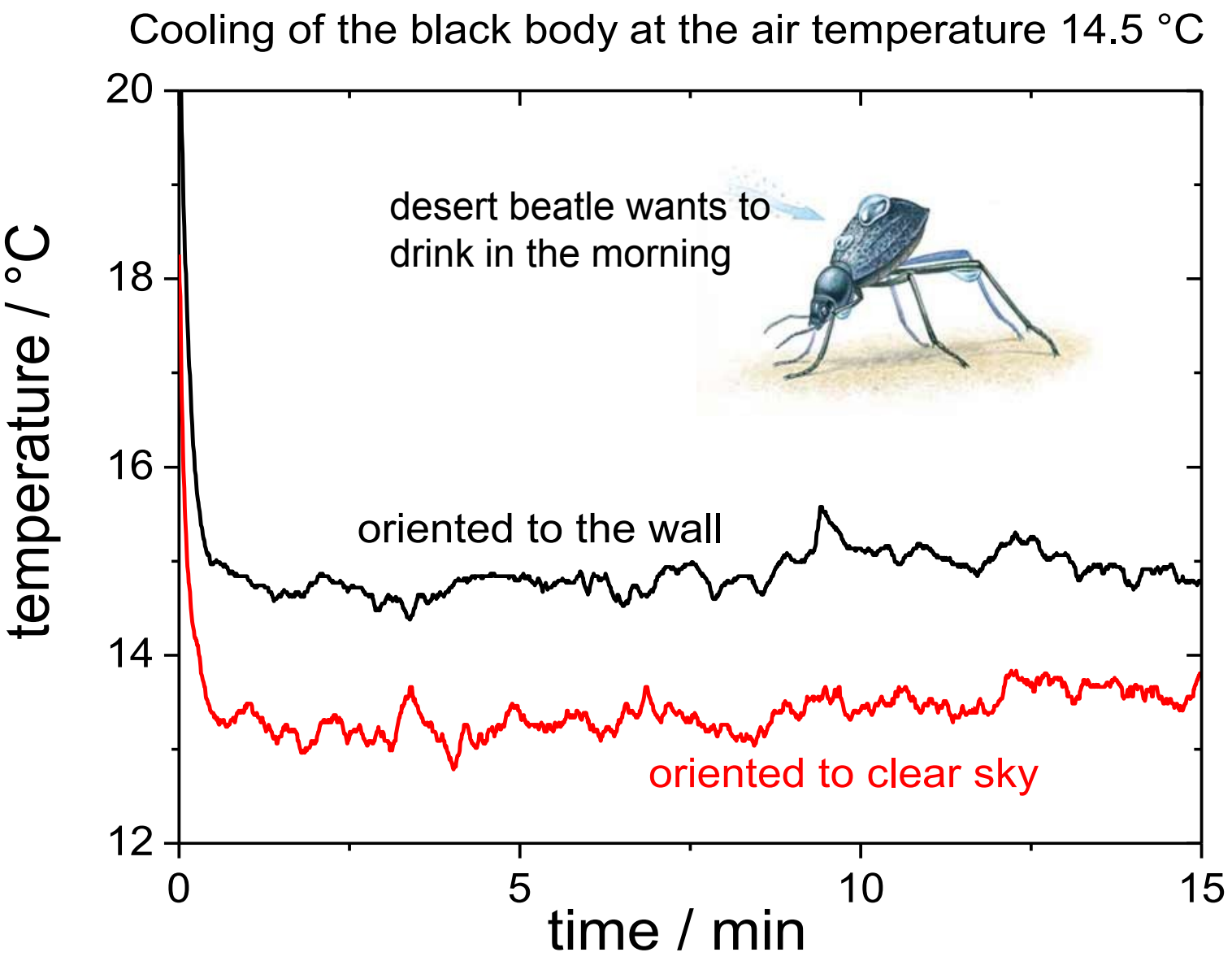
How the surfaces are heated if irradiated by the palm hand?



Interaction of Al and white surface with sunshine and irradiation by hands

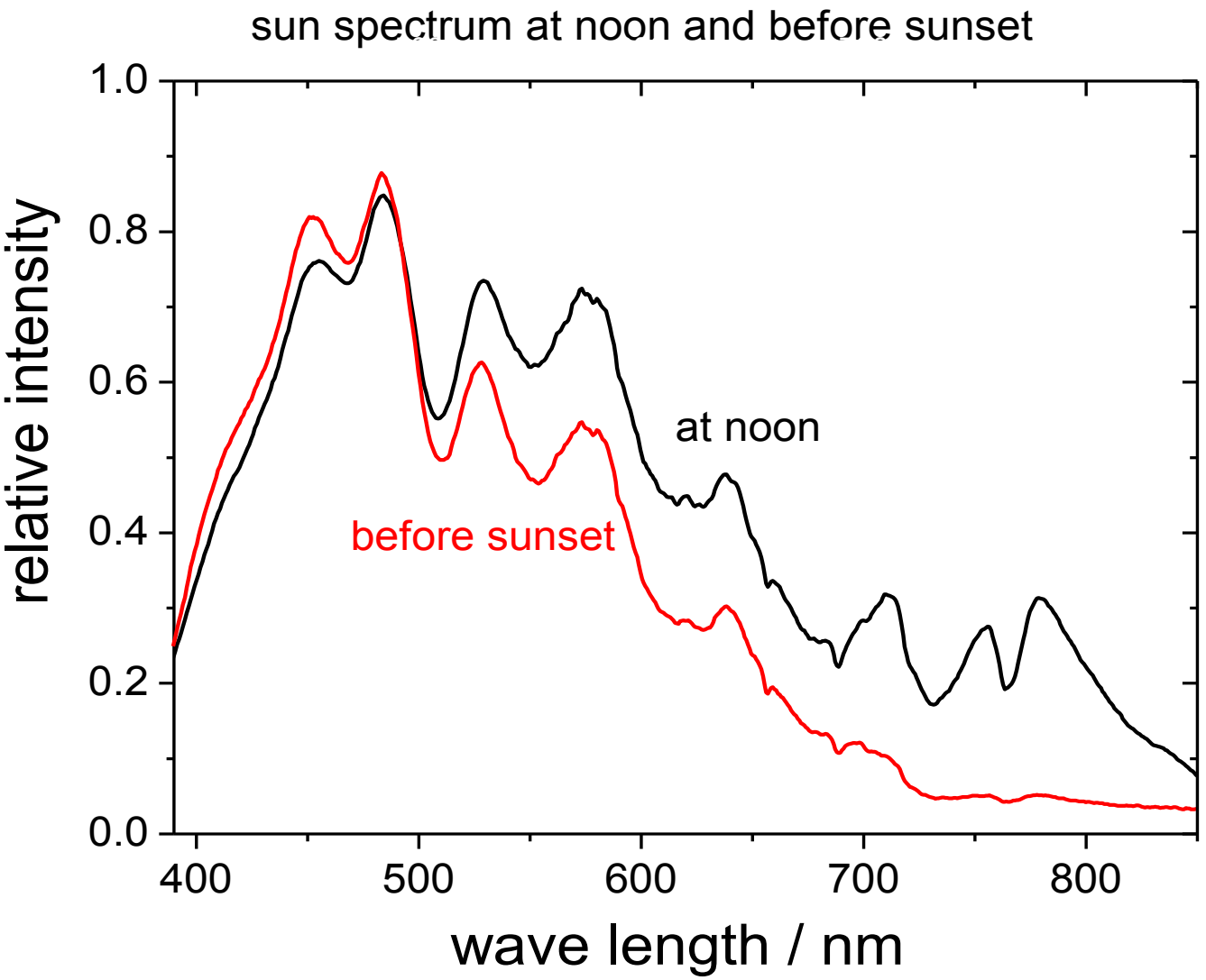


How to cool bodies under the clear sky?



Wavelength distibution of sunshine

Does the sun spectrum depend on the thickness the atmosphere layer?



Conclusion

Combining experimental activities and problem tasks repesents one of the ways which can be chosen to increase knowledge and skills of the future teachers in physics.

Reference

Environmental Encyclopedia, 3rd ed., Thompson Gale, 2003, ISBN 0-7876-5486-8

Thank you for your attention.

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