# Disturbances by light at night: first results from Czechia and some new methods

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A short grant by the **Czech Environment Ministry** (VaV/740/3/03) in autumn 2003 meant a start of scotobiology research by our group based at Masaryk University in Brno. Health-relevant results are mentioned here, more details will be offered next month (at Cancer and Rhythm, Oct 14 - 16, 2004, Graz, Austria). A detailed research report is available in Czech only, at `http://amper.ped.muni.cz/noc`, just some bits are in English too.

*Many people live in streets where windows are more illuminated than the road*

# Blood pressure

has been suggested by **J. Siegelová** as a quantity, which could be influenced by inappropriate light at night. A method of oscillometric measurement of blood pressure by AD monitors has been used to check the existence of the effect.

Nine people were investigated, four men and five women, average age 37 (SD 15 years). They were monitored for 48 hours of their normal life. From 6 to 22, there were 3 measurements per hour; at night, just one per hour. The experimental treatment consisted in letting some light into the bedroom for the second night (**illuminances of faces ranged from units to tens of lux**) .

Within a period from midnight to 3 a.m., **an unusual rise of systolic pressure was observed**, on average by 11 "mmHg" (by 1.5 mmHg for a diastolic one). This rise was significant in both systolic and diastolic pressures at the 0.05 level.

Considering that 10 mmHg rise of systolic pressure corresponds to doubling the mortality on brain vascular accidents, the observed rise of 11 mmHg is by no means negligible.

(J. Siegelová's further co-authors of the poster in Graz will be B. Fišer, Z. Brázdová and B. Fišer)

# Two queries about sleep disturbances etc.

One third of Czech population perceives to be disturbed by full Moon in their bedrooms. Moon produces never more than 0.2 lx illuminance of the window, half of that is typical – **so white light 0.1 lx outdoors is surely a nuisance**. Even much lower values of indoor illuminance are reported as disturbing by some individuals.

The introductory sample had three hundred respondents, the main query included then one thousand people, country-wide. Results:

- **5 % of Czech population perceives unwanted artificial light from outdoors as one of the two main causes of their sleep problems,**
- further 7 % complains about light amounts which are not attenuated to tolerable levels,
- further 20 % attenuates light pollution of their bedrooms to dark levels perceived as sufficient,
- 5 % of Czech population is unhappy to miss the full natural morning light due to barriers against the man-made light they have to use.

However, what are the health consequences of reduced morning light even for the remaining 20 % of population which uses barriers against light at night?

No dependence of imissions to bedrooms on the size of settlement has been found. Stationary outdoor lighting has been reported as the source, street lighting at the first place.

Artificial lighting intruding from outdoors disturbs one third of the population. This makes it a serious health problem regardless of its possible oncogenic consequences, It should be avoided in any case.

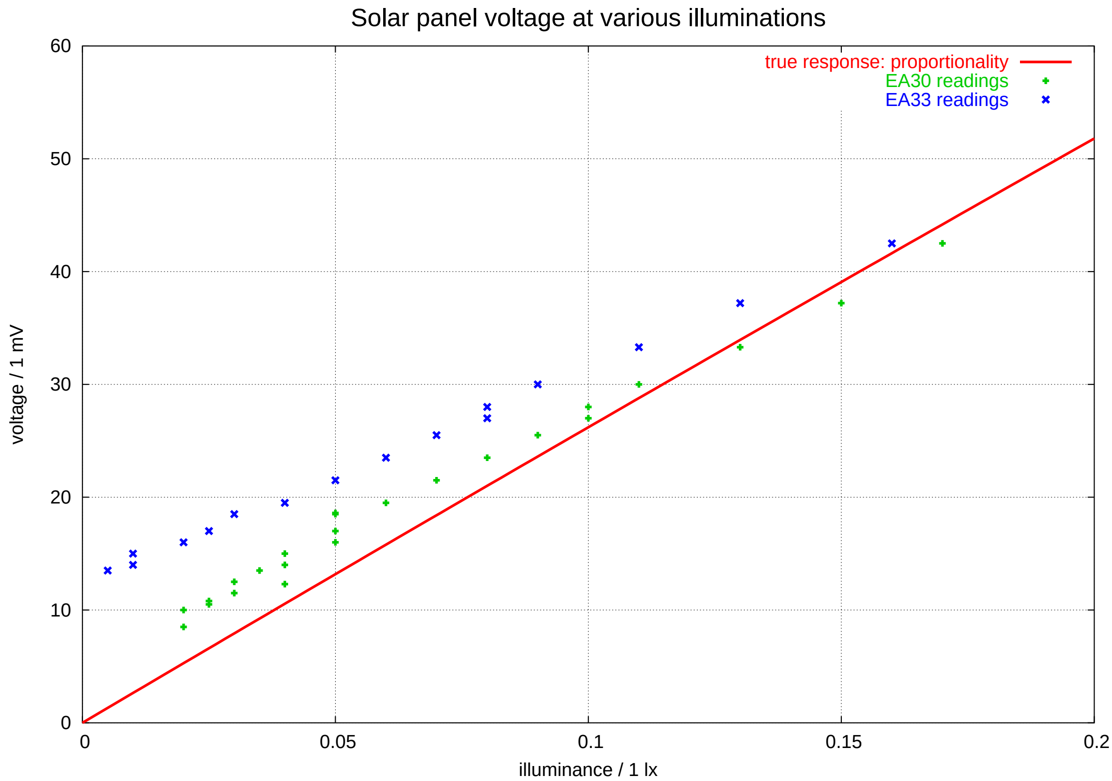
(More detailed results will be presented in Graz with K. Skoččovský and R. Skotnica.)

# Faint light and circadian-efficient radiation measurement

For measuring very low light levels, novel approach is to be used. Solar cells and digital cameras are suitable tools.

Standard light-meters (luxmeters) are meant for rather strong light, over tenths of lux. However, much lower light levels are perceived as disturbing, down to **one millilux of the face illuminance**. This limit seems to be a safe one, if the light does not come from a small source (then it could be still disturbing when the eyes are opened).

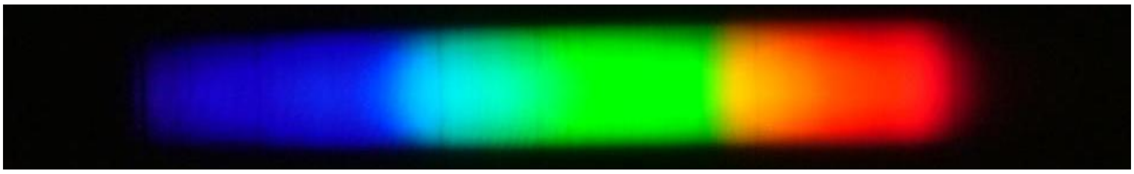
A simple way of measuring illumination down to millilux level is using a **solar cell and a common multimeter**. Just the type of the light sources is to be guessed and appropriate calibration used (in Graz, such methods will be shown together with F. Kerschbaum, T. Posch and M. Bleha from Vienna Uni). Example measurement during twilight demonstrates drawback of two luxmetres against a solar panel for faint light, as the panel behaves proportionally for sure:



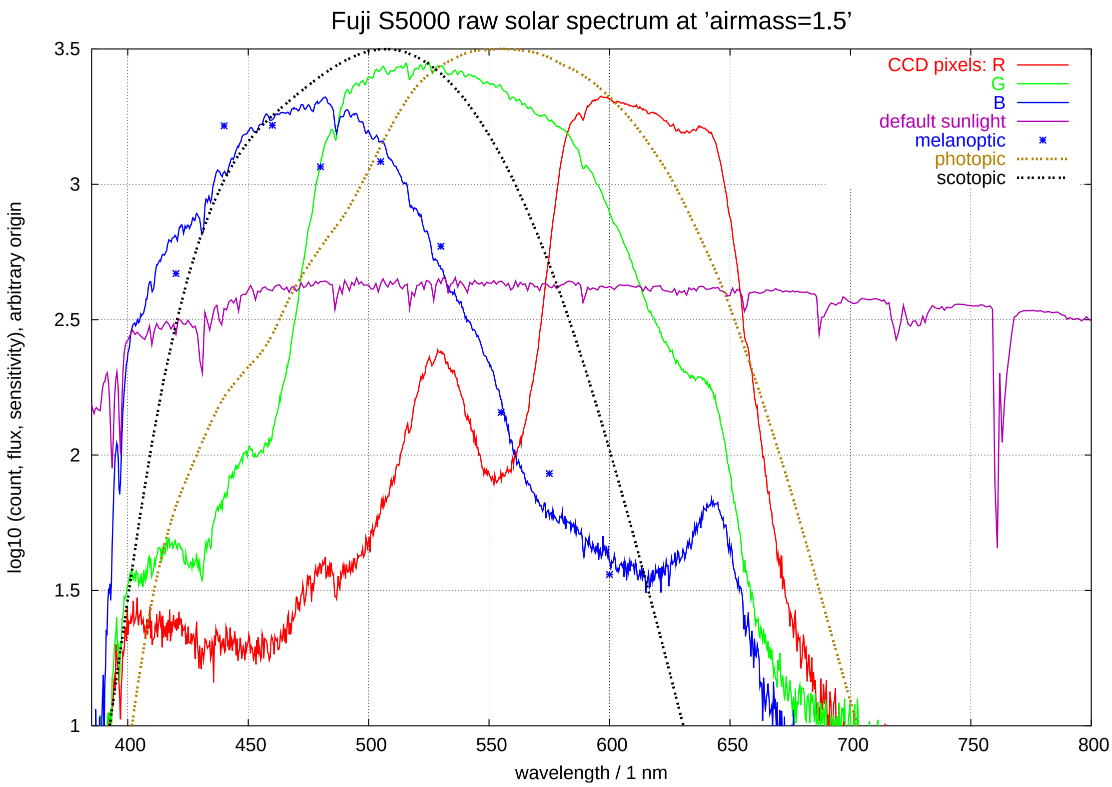

For circadian influences, standard luxmeters would need similar guesses and calibrations, as they are made to match the daytime eye spectral sensitivity. In principle, luxmeters and solar cells may be equipped with an additional or replacement filters to gain spectral sensitivity matching the **"melanoptic curve"** (Brainard *et al.* 2001; Thapan *et al.* 2001; Glickman *et al.* 2002). Nobody offers such filters up to now, as far as we know.

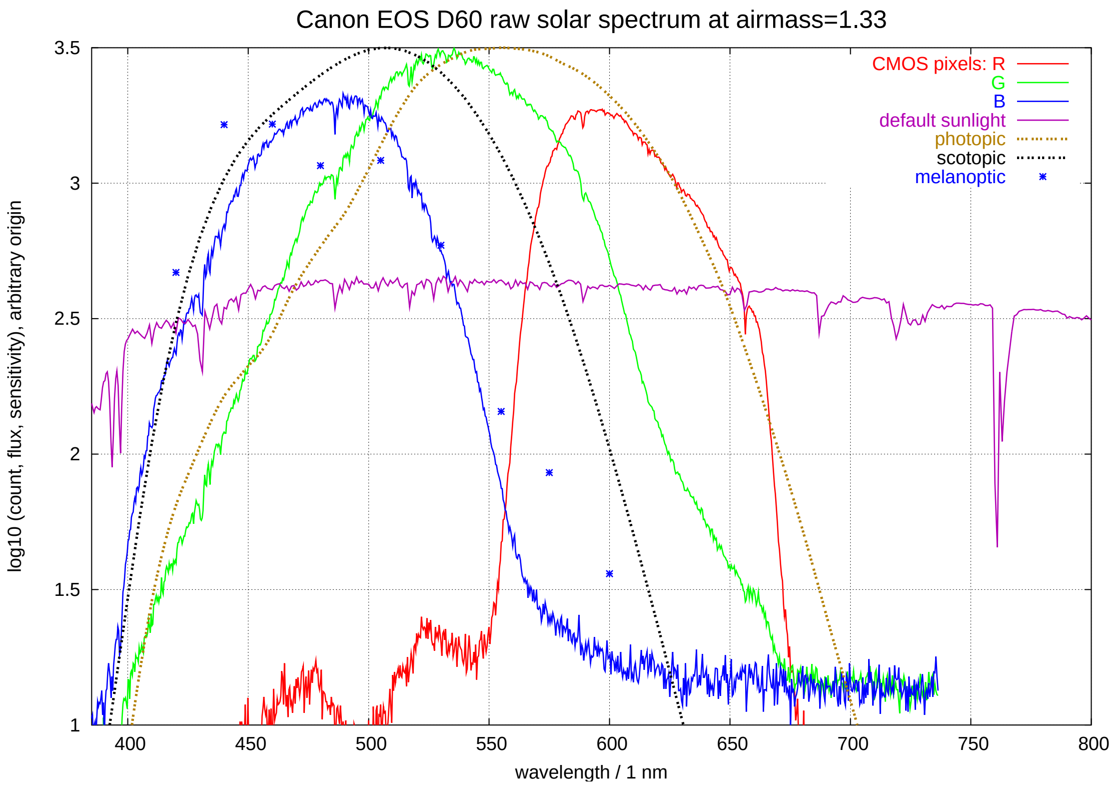
What about blue pixels of modern digital cameras? For two camera types which offer raw data this has been examined using a solar spectrum for calibration. The images have been taken with the appropriate angular height of the Sun in the sky, so that its light went through 1.5 times the thickness of the atmosphere. An author's CD-based cardboard spectroscope (with a slit from two razors) had been used, after a series of attempts.

The spectrum taken with Fuji S5000 camera:



Solar spectrum has a lower intensity at a handful of wavelengths, so-called spectral lines. After processing the images with our software, the solar spectrum graph as recorded by the three types of camera pixels has been obtained:

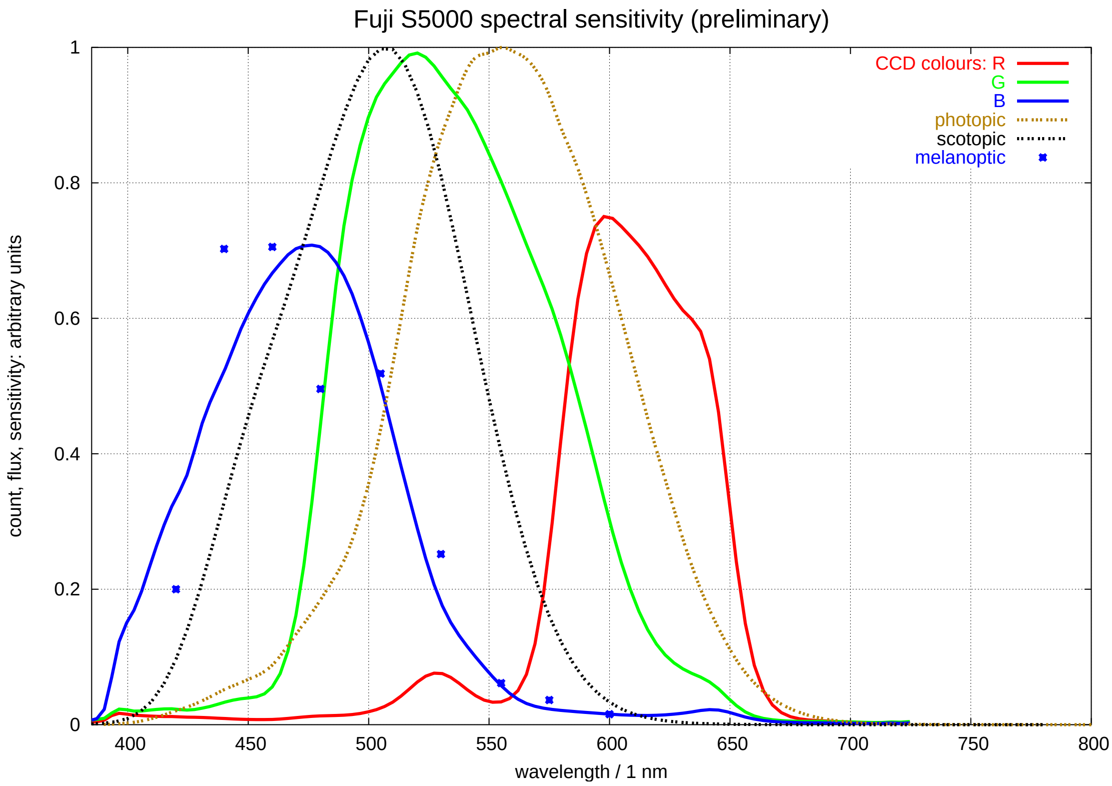


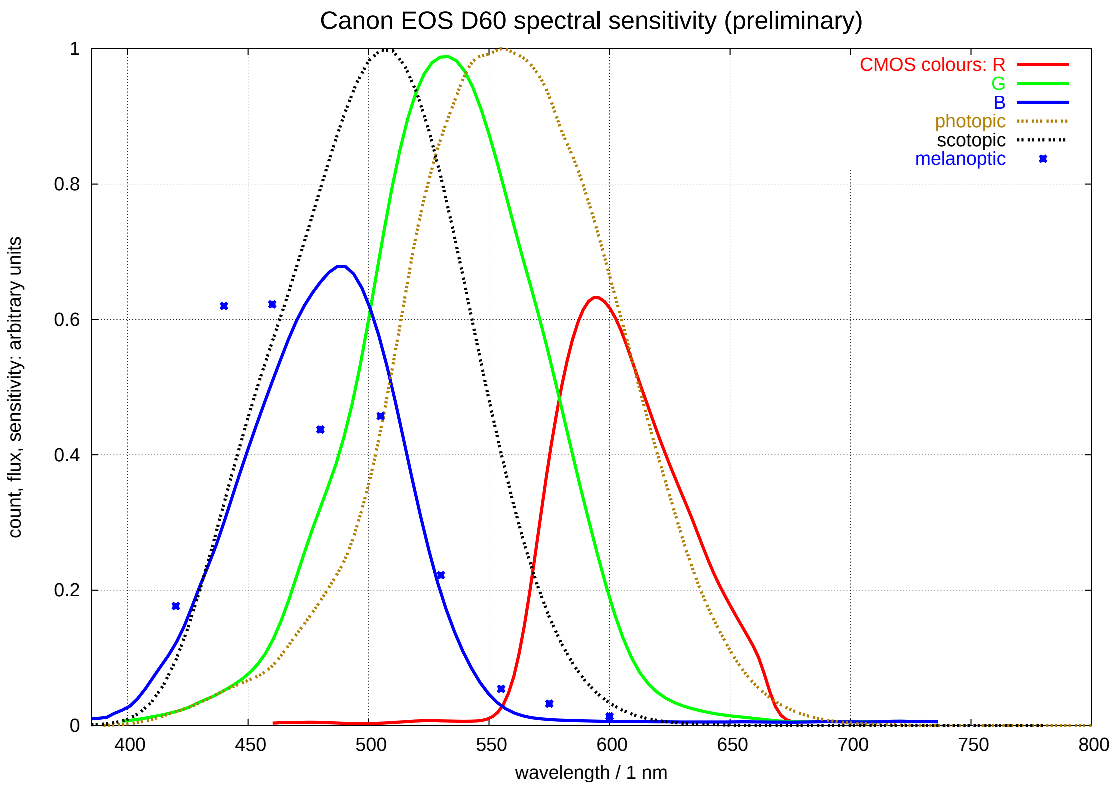




A canonic solar spectrum as arriving through “1.5 airmasses” is shown as well (ASTM, 2003). It helped to match the wavelengths (most prominent absorption features are marked by vertical lines). The three sensitivities of human eye are plotted for comparison: photopic, scotopic, and, just by those several points from one of the pioneer works (Brainard *et al.* 2001), “melanoptic” (including the crude estimate of the 420 nm point; in the other paper (Thapan *et al.* 2001); the sensitivity appeared several times larger at 424 nm).

Apparently Fuji S5000 blue sensitivity matches the assumed melanoptic eye sensitivity rather well. The blue peak of Canon EOS D60 seems to be a bit too narrow in its violet wing.

Curves made by dividing the recorded spectra by the canonic solar spectrum are given in a linear scale in the next graphs. They are to be considered as preliminary (illumination of the diffraction grating by different parts of the Sun has to be excluded and the spectral influence of the aerosols as a difference from the "standard atmosphere" has to be quantified). Present uncertainties down in the left wing of the blue filter reach perhaps 30 per cent.






So, at least some CCD cameras can measure melanopsin-affecting light rather well. But how to express the amount of effective radiation?

This should be an analogy to expressing scotopic-effective radiation. There are "scotopic luxes" (lumens, candelas) for this purpose. The definition is based on the demand that at 555 nm monochromatic radiation there is always 683 lumens per watt. For a flat spectrum this means that scotopic illumination is some 2.5 times the scotopic one, given the sensitivities as shown in the graphs.

For melatonin suppression, the sensitivity at blue-green maximum is probably more than ten times larger than at 555 nm. We can crudely say that **a flat spectrum light would give ten times more melanoptic lumens than photopic lumens**. The number might hold well thanks to the fact, that the violet part of the melanoptic sensitivity is influenced by a shortwave opacity of the lens, and so the curve is probably narrower than the photopic one.

Sunlit white surfaces have not a really flat spectrum, but for the green and blue filters it works almost like that. **By setting their B luminance to ten times the photopic one** (measured by a luxmeter, or computed astronomically), **the camera is simply calibrated.**

All needed software is available at `http://amper.ped.muni.cz/light/luminance`. It's not easy to use, but what's important: by taking several images by a suitable camera, the effective amount of radiation affecting melatonin secretion can be documented for further use.

## Topics for further research

**H. Hrstková** suggested recently some ways of investigating the light and leukaemia link.

Patients might be asked about light in their bedrooms in the past times, when the disease developed. In some cases we can even measure the effective radiation levels. For children, the option of light left on in their bedrooms (on purpose) should be registered. Is there any difference from the healthy population?

National oncologic registers may be used to search for seasonal trends – are there more cancers found in the autumn, after the period of less natural darkness (and possibly lower melatonin levels)? Of course, sunshine-caused ones are to be handled separately, and the natural variation of darkness at night can be much reduced by artificial light for population in rich countries (absence of seasonal change in melatonin levels is a consequence).

## References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