may be substantial (20–50%), and this is a most significant effect to be considered when measuring changes in light pollution!. The variations with solar cycle are of similar size (≈50%) and correlated to the solar 10.7 cm flux.

There are indirect temporal variations caused by the passage of Milky Way and the zodiacal light, which may introduce spurious variations in measurements taken at different hours or days. Some change in scattered light intensity will also occur by the diurnal motion of these extended light sources.

There is a slight annual variation of zodiacal light, by about ± 10% at high ecliptic latitudes, due to the Earth's orbital motion within the interplanetary dust cloud.

4.4. BRIGHTNESS OF THE NIGHT SKY

Measurements of dark night sky brightness at different observatories lead to best values of typically 22 mag/square arcsec in V, 23 mag/square arcsec (≈ 100 S_{10}) in B. The spectrum of the night sky is dominated by strong airglow lines e.g. at 557.7 nm [OI], 589 nm [NaI], 630 nm [OI] and OH emission at longer wavelengths. Comparatively dark spectral bands are from 380 nm to 400 nm, 450 nm to 520 nm, 640 nm to 710 nm, and around 820 nm. If a choice has to be made, try to protect these bands!

4.5. RECOMMENDATIONS FOR LIGHT POLLUTION MEASUREMENTS

Therefore, if one wants to avoid mixing up natural changes with man-made increases in monitoring of light pollution, the following measures are recommended:

- Perform measurements at preselected, known positions on the sky, document all relevant coordinates, avoid stars or correct for them.
- Measurements should cover a sufficiently long interval (several hours per night/ several nights) to be free of "random" airglow variations within a night and from night to night.
- Measurements should cover a substantial fraction of the solar 11-year cycle or, at least, take the effect of solar activity into account when comparing measurements from different years.

5. FIELD SURVEY OF OUTDOOR LIGHTING IN JAPAN

K. Narisada, K. Kawakami

The Illuminating Engineering Institute of Japan conducted a field survey concerning the outdoor lighting in 1995, in various areas of the country. The aim of the survey was to find which types of luminaires in existing lighting installations are wasting the greatest amount of upward flux into the sky. The survey was conducted in six of the seven zones, proposed in an earlier draft of the guide of the CIE, i.e. E1, E2a, E3a, E3b, E4a and E4b. On the basis of the results of the survey, the proportion of the upward flux per 100 hectares was compared separately for eight types of luminaires, such as the luminaires for traffic roads, residential areas, decorative (shopping) streets, projectors, luminous signs, etc. As a result, it was found that the major sources of the upward flux were the luminaires for decorative streets and luminous signs and to be improved their photometric characteristics.

6. BILATERAL AGREEMENTS ON LIMITS TO OUTDOOR LIGHTING; THE NEW CIE RECOMMENDATIONS, THEIR ORIGIN AND IMPLICATIONS

D. A. Schreuder

Summary

Sky glow presents itself as a background luminance over the sky, against which the astronomical objects are to be observed. The interference of astronomical observations is caused by the resulting reduction in luminance contrast. The glow is caused by non-directional scatter of light by particles in space and in the atmosphere. Part of the light, and part of the particles are natural, and part is man-made. The '(natural) background radiation' is defined as the radiation (luminance) resulting from the scatter of natural light by natural particles. For earth-bound observatories, the background luminance is the limit for sky glow. It is customary to express the sky glow (from man-made sources) as a percentage of the natural background luminance.

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The main sources of stray light that may interfere with astronomical observations are:
. lighting of industrial sites, airports and building sites;
. road and street lighting;
. advertising signs
. floodlighting of buildings, discos and monuments
. lighting of billboards
. lighting of greenhouses
. lighting of sports facilities
. area lighting of sales areas, parking lots, farm yards, railroad yards etc.

The Commission Internationale de l'Eclairage CIE set up 'Guidelines for minimizing sky glow; A CIE Technical Report'—presently in print. Most recommendations are expressed in values of the Upward Light Output Ratio—installed (ULORinst). The recommendations are based on three principles:

* the requirements for upward light emission are related to the activities in the 'zone' under consideration ('zoning');

* the requirements for upward light emission are most stringent in the 'night'; they may be relaxed in the 'evening' ('curfew');

* the lighting requirements in nearby zones must be taken into account (distance relations).

The future plans for the CIE Technical Committee CIE TC 4-21—in close collaboration with IAU Commission 50—include:

. preparing Draft ISO-Standards for measuring methods and for limiting values of sky glow

. preparing a draft manual on the theory and practice of road lighting for astronomers and for highway authorities.

. collect routine sky brightness measurements from various observatories

. contribute to the education of astronomy and the role of lighting there-in.

7. U.S PERSPECTIVE FOR INTERFERENCE TO RADIO ASTRONOMY

T. E. Gergely (Division of Astronomical Sciences, National Science Foundation)

During the last decade a number of new radio telescopes were built, and several are currently in various construction, design or planning stages. These instruments represent a substantial scientific investment, and radio astronomy continues to contribute many new ideas and results to astronomy. At the same time, the regulatory environment related to the radio spectrum has undergone considerable liberalization in the USA, as well as internationally. In the USA responsibility for spectrum utilization is shared by the National Telecommunication and Information Administration (NTIA), that oversees Government uses, and the Federal Communication Commission (FCC), that looks out for private sector spectrum needs. US spectrum management principles, as stated by the FCC, include the fostering of competition, flexibility of spectrum use, licensing and spectrum fee policies geared towards supporting the value of the spectrum and looking out for both the global market context and the public interest. Regulatory support of radio astronomy under the last item on this list is certainly not very high among FCC priorities. Similar situation prevails at the International Telecommunication Union (ITU), which regulates the uses of the radio spectrum internationally.

The last decade also has seen an expansion of satellite based radio services. Satellite technologies with substantial spectrum demands include the mobile satellite services, digital audio broadcasting, direct-to-home broadcasting and advanced fixed and fixed satellite services. This last name is a euphemism for satellite systems currently planned for distributing Internet and related material and other high data rate applications. The large expansion of satellite services, simultaneously with the relaxation of regulations, threatens radio astronomy. Considerable spectrum has been reallocated to satellite downlinks, and unavoidably (and sometimes avoidably) these are found next or near enough to radio astronomy bands so that spurious and/or out-of-band emissions spill over, and make astronomical observations difficult or impossible. The increasing spectrum congestion at cm and dm wavelengths, the wide bandwidths needed for Internet applications, and the availability of mm-wave technology are beginning to be felt in the mm and sub-mm regions of the spectrum, which astronomers considered their exclusive domain until recently, regardless of the allocation table.

Solutions to these problems will not be easy. Astronomers will need to educate the general public, as well as the regulatory authorities. In doing so, they must keep in mind that many new