PROPOSAL OF A SPECTROSCOPIC MAP OF ASTRONOMICAL SITES

STEFANO ROSONI
Circolo Astronomico Dorico "Paolo Andrenelli", c.p. 70, Ancona, Italy

ABSTRACT. We propose to both professionals and amateurs to carry out spectroscopical mapping of the sky i.e. the determination of the spectroscopical map $I(\alpha, z, \lambda)$ where I is the sky brightness in the direction of azimuth α and zenith distance z. Its knowledge would allow, among other things, (i) a better study of the propagation of light pollution at the different wavelength; (ii) the determination with a simple integration of the sky brightness in every direction and in every band or filter's bandpass even if non standard; (iii) the determination of the spectral emission function of the sources (cities); (iv) the monitoring of their changes with the time.

In order to obtain usable results this kind of research requires much care, preliminar studies, the preparation of a capable equipment and some work to be applied correctly. Nevertheless we think that it could be within every advanced amateurs reach.

This research note summarizes the main points of the methode we proposed (Rosoni 1997). Details will be discussed in forthcoming papers.

1. Introduction

In order to better control light pollution it is necessary to better know it and its behaviour.

Common measurements pratices consist of a mapping of the sky brightness in one or few photometrical bands. It is also common pratice in some branch of astronomy to obtain spectra of the sky background but the works so far published are restricted to the study of spectra taken only in one or few directions of the sky (Jenkins & Unger 1991; Louistisserand et al. 1987; Massey & Gronwall 1989; Massey et al. 1990; Osterbrock et al. 1976; Osterbrock & Martel 1992; Turnrose 1974).

Here we propose to both professionals and amateurs to carry out a spectroscopical mapping of the sky. The determination of the spectroscopical map $I(\alpha, z, \lambda)$, where I is the specific sky brightness at wavelength λ in the direction of azimuth α and zenith distance z, would allow, among other things, (i) a better study of the propagation of light pollution at the different wavelength; (ii) the determination with a simple integration of the sky brightness in every direction and in every band or filter's bandpass $F(\lambda)$ even if non standard:

$$b(\alpha, z) = \int_{band} F(\lambda) I(\alpha, z, \lambda) d\lambda \tag{1}$$

(iii) the determination of the spectral emission function of the sources (cities) which is not necessarily equal to the integrated spectrum of all its lamps due to the spectral

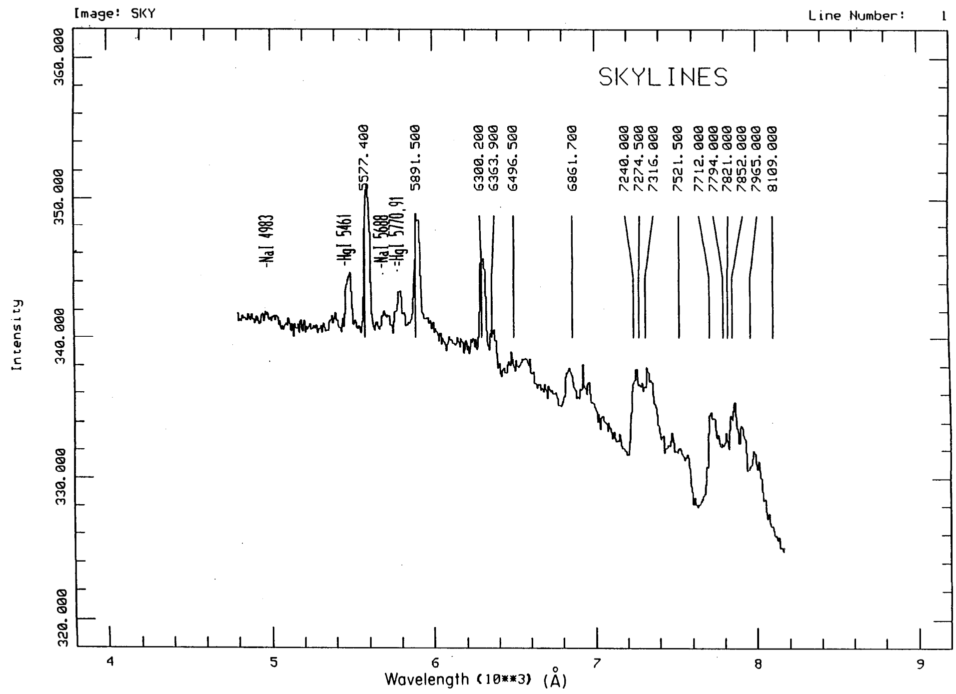

Fig. 1. A spectrum of the night sky at the Mount Ekar Observatory from 4800Å to 8200Å taken in 1990 by Pierantonio Cinzano and kindly provided to us. Natural sky lines and lines from artificial lighting are shown.

response of the reflecting surfaces still unknown; (iv) the monitoring of the changes with the time.

This kind of work is quite difficult because it needs to be done very accurately in order to obtain usable results. This research note summarizes the main points of the methode we proposed (Rosoni 1997). Details will be discussed in forecoming papers.

2. Instruments and procedure.

The spectroscopical map $I(\alpha, z, \lambda)$ can be obtained as a discrete sequence of spectra taken in a set of directions of the sky (es. the sequence proposed by Matsushima (1964)) and can easily be stored electronically as a tridimensional array.

The spectra can be taken as CCD images or photographic images on the focal plane of a spectrograph. In the second case, more difficult, it is necessary a calibration of the plates or the film with a spectrosensitometer which expose sequences of spot of known intensity with light of different wavelenght or a sequence of spectra of a spectrophotometric standard source. This allows to obtain the response curve of the plate or the film at the different wavelength. Moreover, film or plates need to be scanned with a microdensitometer or other adequate devices.

Prisms and diffraction gratings are not difficult to find so that a spectroscope it is nowadays available also to amateurs.

Spectra needs two kind of calibration:

1. A calibration in wavelength allows to associate to each position along the spectrum its wavelenght. It requires one or two comparison spectra, at the sides of the scientific spectrum, obtained with a short exposure of a known spectroscopic standard source and with some optical devices able to send the images in the proper position.
2. A calibration in intensity allows to determinate the absolute value of the incoming flux. A calibration using a comparison spectra of a spectrophotometric standard star would require the knowledge of the estinction at the various wavelength in order to obtain the flux "under the atmosphere" which is of interest in studies of light pollution. The spectral extinction is rapidly variable with atmospheric conditions and not easy to determinate. A calibration for comparison with natural sky lines is uncertain due to their possible variability. The best thing would be to have a spectroscopical standard source at the ground not far from the telescope. This point is under study by the author.

3. Conclusions

Even if spectroscopical mapping require much care, preliminar studies, the preparation of a capable equipment and some work to be applied correctly, we think that it could be within every advanced amateurs reach.

Acknowledgements

My acknowledgments to Salvatore Cristaldi of *University of Catania* for his substancial revision of my research proposal and to Pierantonio Cinzano of *University of Padova* who kindly wrote this research note for me summarizing my research proposal in Italian.

References

Fletcher, J.M. & Crampton, D. 1973, An astronomical view of high-pressure sodium lamps, Publ. Astron. Soc. Pacific, 85, 1-3.

Jenkins, C. & Unger, S. 1991, The night sky spectrum from La Palma, ING-La Palma Technical Note No. 82.

Louistisserand, S., Bucher, A., Koutchmy, S. & Lamy, P. 1987, Night sky optical spectrum from a high altitude observatory, Astron. Astrophys. Suppl. Ser., 68, 539-543.

Massey, P. & Gronwall, C. 1989, Spectrophotometry of the Kitt Peak night sky, Bull. of American Astron. Soc., 21,4,1067.

Massey, P., Gronwall, C. & Pilachowski, C.A. 1990, The spectrum of the Kitt Peak Night Sky, Publ. Astron. Soc. Pacific, 102, 1046-1051.

Matsushima, S. 1964, Site selection for a small observatory in the midwest, Publ. Astron. Soc. Pacific, 76, 224-230.

Osterbrock, D.E., Walker, M.F. & Koski A.T. 1976, The spectrum of light pollution at Mount Hamilton, Publ. Astron. Soc. Pacific, 88, 349-352.

Osterbrock, D.E. & Martel A. 1992, Sky spectra at a Light-Polluted Site and the use of Atomic and OH sky Emission lines for wavelenght calibration, Publ. Astron. Soc. Pacific, 104, 76-82.

Rosoni, S. 1997, Giornale di Astronomia Soc. Astron. It., 23, 3, 38-44.

Turnrose, B.E. 1974, Absolute spectral energy distribution of the night sky at Palomar and Mount Wilson Observatories, Publ. Astron. Soc. Pacific, 86, 545-551.