SPECTRAL CLASSIFICATION USING ANS PHOTOMETRIC DATA

R.J. van Duinen and P.R. Wesselius
University of Groningen, Space Research Department

INTRODUCTION

In this contribution we will discuss the extension of visual photoelectrical photometry into the ultraviolet and its potential impact on stellar classification. As is the case in the visual, classification by photoelectrical photometry in the ultraviolet has some important advantages over classification by inspection of individual spectra. Studies that require global characteristics of stellar properties - such as studies of stellar distribution, extinction properties of interstellar dust, galactic structure - often require large numbers of observations to derive statistical properties. In photoelectric photometry such a large number of observations can usually be obtained in a reasonable amount of time and relatively conveniently processed without subjective criteria being applied to the data. Comparatively, the classical way to obtain stellar classification is a complex process that requires many steps.

In ultraviolet astronomy, because of the advent of small automated spacecraft with acurate pointing capabilities, the advantages of photoelectric photometry can be fully realised. A large number of observations can be made on relatively distant or highly obscured objects with good photometric accuracy.

This paper will report on status of a program carried out by the ANS satellite on stellar classification by photoelectric photometry. We will first briefly describe some characteristics of the photometric system. The observing program will be presented and some preliminary results discussed.

THE ANS ULTRAVIOLET PHOTOMETRIC SYSTEM

The ANS spacecraft was launched in August 1974 in a polar sunsynchronous orbit and has functioned from that date to April 1976 with an interruption of three months the ultraviolet experiment onboard - provided by the Space Research Department at the University of Groningen -

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consists of a 22 cm diameter modified Ritchy-Chretien telescope followed by a five channel intermediate band photometer. Spectral dispersion is by means of a grating, the passbands are defined by masks in the image plane of the spectrometer, which results in sharp cut-offs in the spectral sensitivity curves. The entrance aperture is reimaged onto the five photomultiplier detectors, one for each channel. The field of view on the sky is 2.5 x 2.5 arcminutes (see also Aalders et al. 1975 and van Duinen et al. 1975). Observations are carried out by instructing the spacecraft to find specified star patterns in the field of an image dissector tube camera which uses the Ultraviolet experiment telescope. Once found, the object is centered on the entrance slot of the photometer, while the satellite tracks on a bright (up to 8.5th visual magnitude) star in the field of the camera (1.5 x 1.5 degree). Pointing is maintained for a predetermined duration up to 1000 seconds. Readout of samples from the counting registers in the onboard computer memory is controlled by the processor as are the experiment shutter position.

For weak sources the spacecraft is periodically pointing to the object and to blank sky with the register readout synchronized with the spacecraft pointing direction. Typically 5 such observations (on different objects) are performed per orbit in every third orbit (other orbits are devoted to X-ray experiments onboard ANS).

Observing programs are loaded in the onboard computer memory once per twelve hours during a pass over the groundstation. During this pass the experiment data are read-out. First printouts of results are available within three hours after the pass. Final data are in a few months after the pass.

The quality of the data obtained outside the radiation zones (mainly the South Atlantic Anomaly) is very good. Avoidance of radiation zones was quickly mastered by the people performing the experiment observation scheduling. Reproducibility of data obtained on the same object in different pointings is better than 0.5%. The sensitivity changes were obtained from repeated observations on standard stars at high ecliptic latitude. Corrections were derived by linear least square fits to the observed countrates for each visibility period.

SPECTRAL CLASSIFICATION

One of the aims of the observing program executed with the ANS is to set up a refined classification scheme for early type stars. We try to find parameters using linear combinations of ultraviolet colour indices that are correlated with intrinsic physical properties of stars. As an example we have constructed the parameter

$$\alpha = C_{2500-1800} - 0.257\ C_{2500-2200}$$

This alpha has been calibrated against a sequence of some seventy early type main sequence stars and is correlated with spectral type, hence with effective temperature. At least another parameter independent of

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alpha can be defined, viz. the difference between the narrow and wide band measurement at 1550 Å. This parameter is roughly correlated with the MK luminosity classification. Its physical interpretation is complicated because

1. for O type stars a strong CIV line is present showing a P Cygni profile.
2. for B stars up to B5 the depression at 1550 Å is a blend of mainly Fe III lines ; this depression seems luminosity dependent (Swings et al., 1976).

Luminosity effects, however, show up very clearly in ultraviolet colour-magnitude diagrams that we have obtained on galactic open clusters and associations. These observations may provide a basis for the choice of a luminosity parameter and at the same time provide an excellent luminosity calibration. In surface photometry of the LMC classification criteria have been developed on the basis of a multivariant statistical analysis (Koornneef, 1976). These criteria give information on stellar population and reddening.

The results so far are based on the reduction of a small subset of the data. The bulk of the data will be reduced and analysed in the coming year using a set of computer programs that have just become available.

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