A SIT Vidicon for Surface Photometry

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Introduction

The study of surface brightness distributions of extended cosmic light sources is an essential observational approach to understand their spatial structure. In general, however, surface photometry is difficult to interpret without other supporting observations like spectroscopy, which yields the velocity field or other physical parameters. The reason is that the surface illumination is the total number of light sources within a conical column along the line of sight. This cone is the solid angle of an individual picture element ("pixel") projected onto the sky by the telescope optics. Therefore, astronomical surface photometry yields the surface density of cosmical light sources, which is badly contaminated by light sources in the fore- or background or even in the surrounding field.

Under certain assumptions (spheroidal system, no internal absorption), which seem to be fulfilled in globular clusters, the spatial star and luminosity distribution can be derived using star counts, which give the surface star density, and surface photometry, respectively. Thus the relative mass-luminosity ratio and its variation within these systems can be unambiguously studied.

For some years we have used star counts to investigate the age dependency of physical and structural parameters of open and globular clusters in the Large Magellanic Cloud (LMC). These counts have been made using photographic plates taken with the ESO Schmidt and 3.6 m telescopes. However, this plate collection is not suitable for surface photometry due to different problems inherent to the photographic material. Therefore, we designed at our observatory an efficient area photometer which is based on a digital detector system with a SIT vidicon.

Methods of Surface Photometry and its Difficulties

Until the advent of modern two-dimensional digital detectors like vidicons or charge-coupled devices (CCDs), astronomers had to rely on the photographic plate and the photomultiplier for surface photometry. Though the photographic plate is still unrivalled as an imaging detector as far as its resolution and geometrical size are concerned, it shows a number of drawbacks: photographic material has no linear response with a very limited dynamic range, it shows the reciprocity failure and has a threshold. As the photographic plate can only be used once, point by point photometric calibrations of the whole plate are impossible and restrict its photometric accuracy.

On the other hand the photomultiplier, which has not the drawbacks of the photographic plate, is a none-imaging detector. It detects all the radiation, to which it is sensitive, from the solid angle which the photocathode sees through the telescope optics. Therefore it is not placed into the focal plane of the optics but into their exit pupil. This solid angle is proportional to the ratio of the square of the diameter of the diaphragm in the focal plane to the telescope's focal length. Due to scintillation and diffraction effects encountered in ground-based observations the angular size of the focal plane diaphragm can't be made smaller than typically 10 arcsec. Thus, doing surface photometry with a conventional single-beam photometer, the extended object must be scanned either by moving the telescope relative to the object or by moving the diaphragm in the focal plane. This observing mode is very time-consuming and all information from points outside the diaphragm, but within the telescope's field, is wasted. For example, during an observing run of 5 nights in November 1979 at the ESO 50 cm telescope we could obtain brightness profiles in B and V of only two globular clusters in the LMC. Furthermore, surface photometry with a single-beam photometer suffers from background variations due to atmospheric transmission and/or airglow. A double-beam photometer, as has been designed for ESO in 1976 by one of us (E. H. G.) can overcome these last difficulties.

The SIT Vidicon and the Area Photometer

The situation for astronomical surface photometry has recently changed with the introduction of modern two-dimensional multi-element detector devices like vidicons and CCDs. These detectors not only allow digital image processing but also have a large dynamic range ($> 10^3$) and show linear response within this wide range. This offers the possibility to correct for sensitivity variations of individual pixels.

In considering to purchase a panoramic detector for our project we had to take the limited manpower and budget at our observatory into account. Therefore we decided for a commercial digital two-dimensional detector based on a **s**ilicon **i**ntensified **t**arget (SIT) vidicon. Such vidicons have successfully been used at different observatories for several years, mainly for spectroscopy (e.g. at Cerro Tololo Interamerican Observatory: Atwood et al., 1979, *Publ. A.S.P.*, **91**, 120, Hesser and Harris, 1981, *Publ. A.S.P.*, **93**, 139). Our detector system is called

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Further information can be obtained from:

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