A Supernova Search with the ESO 1 m Schmidt Telescope: Greatly Improved Efficiency

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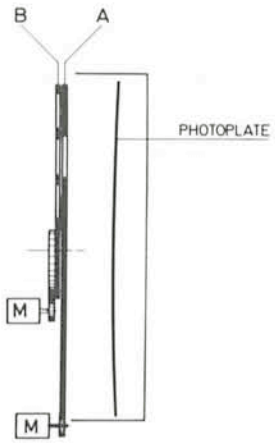
Supernovae are astrophysically extremely interesting objects. It is presently believed that most, if not all, heavy elements are created when stars explode as supernovae. About ten supernovae are presently discovered each year and much thought has been given to the problem of discovering new supernovae as early as possible after the rise in luminosity, in order to study the physics of such objects in their initial phases.

Dr. André Muller from ESO has conceived many ingenious technical solutions to a wide variety of problems. In this article, he describes a new device for the quick and efficient detection of supernovae with the ESO 1 m Schmidt telescope. The results of the first practical tests of this method will soon be available.

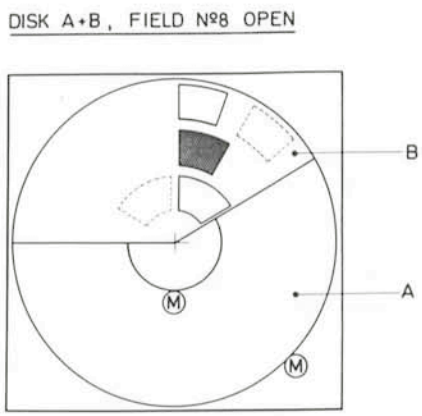
While investigating the possibility to start a routine supernova search programme with the ESO 1 m Schmidt camera, it soon became clear that it was all-important to find an efficient and economic observational method with a minimum of waste of time and photographic material. For many reasons the study of supernovae is a very important subject. However, to be able to observe newly-discovered supernovae with medium-size telescopes equipped with photometers and spectrographs, they must be rather bright, and it was therefore decided to search only for stars apparently brighter than the fifteenth magnitude. This decision once taken, the question then arose how one can photograph a great number of galaxies in an economic way with a Schmidt camera.

After some thinking, a viable solution was found in the form of a double diaphragm device which divides the 30 x 30 cm^2 photographic plate into a number of circular zones and each circular zone into a number of sectors.

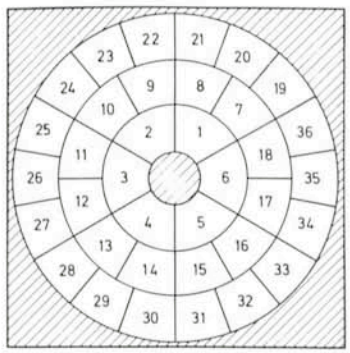
How this is done can be seen in the drawing. The utilization diagram shows one of the possible ways of dividing the photographic plate. In this special case the plate is divided



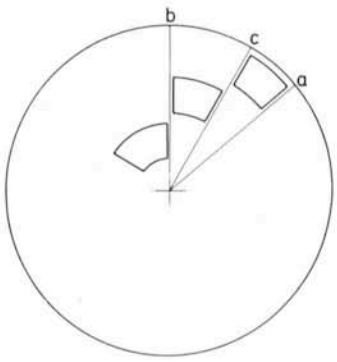
SIDE VIEW



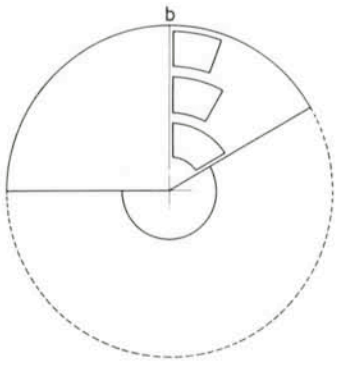
TOP VIEW



UTILIZATION OF THE PHOTOPLATE



DISK A



DISK B

into three circular zones. The inner zone is divided in 6 sectors (1–6), the second zone into 12 (7–18) and the third into 18 sectors (19–36) defining a total of 36 areas on the plate, each measuring about 45 x 47 arcmin^2.

In its present form, the diaphragm device consists of two components: the diaphragm disk A and the sector B which are mounted on top of each other and can be rotated around a common, perpendicular axis. Sector B rotates with respect to A by means of a motor M, mounted on A. When for instance line b on B coincides with line b on A we have access to field 8 as shown in the top view of the drawing, i.e. field 8 is "open", while all other fields are "closed". A second motor mounted at the edge of A rotates both components A and B to make other parts of the plate accessible. In the given example A and B together can move to 12 different positions covering the full second zone. When b on B coincides with c on A, the third zone with 18 fields becomes available. The disk and sector are mounted in a fixed frame which is attached in front of the plateholder. Diaphragms of different designs can be mounted in this frame so that, if desirable, also larger fields can be observed. The fields are vignetted towards the edges because of the distance of about 38 mm between the device and the photographic plate, defined by the position of the shutter with respect to the plate. In case of the f/3 ESO Schmidt, vignetting starts at about 7 mm from the field edges. However, the chosen exposure-time is such that well-exposed images of 15th-magnitude stars are obtained to about 2 mm from the field edges. The dimensions of the diaphragm holes assure that 100 % vignetting occurs along the lines shown in the utilization diagram, in order to avoid field overlap.

Observational Procedure

The procedure is now simple. When the object in field 1 has been exposed, the telescope moves to the next object (the offset must of course be calculated in advance). Meanwhile the diaphragm device rotates to its next position and field 2 is exposed and so on till field 36. With 5 minutes exposure-time per field and 1 minute between successive settings, 36 galaxies can be acquired in just over three and a half hours. In this way the images of 36 galaxies and their surroundings are collected on one plate only and only one plate has to be developed. In this straightforward way, we avoid the repeated loading of the plateholders, the returning of the telescope to plate loading position, the going to the next object from loading position and the repeated plate development. The gain in time is very important. The gain in material is equally impressive: a large reduction of photographic plates and much less chemicals are used in the plate processing.

The same observing sequence is repeated 10 to 14 days later, independently of the moon-phase, because of the short exposure-time. From this second plate a positive copy is made and placed on top of the previous negative one. As one can only discover the supernovae when they brighten, white images as seen through the combined plates are possible supernova candidates and need verification. If it turns out that plate errors are a serious problem for the certain discovery of supernovae in this way, one could repeat the exposure of each galaxy on the same plate. This yields only 18 instead of 36 galaxies per plate, but the gain in certainty may justify this method. However, this is one part of the practical tests of the method which will be realized within short.

Depending on the available telescope time, 72 or 108 galaxies can be taken in one night and thus be kept under routine control. In order to observe regularly as many galaxies as possible, a joint programme with other Schmidt telescopes could turn out to be fruitful.

Other Possibilities

The diaphragm device can also be used for photometric purposes. Known photometric sequences can be collected on one plate together with unknown fields for calibration. With suitable emulsions the different filters can be shaped to cover each one diaphragm of sector B, enabling photometry in different colours on one plate. The advantage is that all exposures are free of the sky background of the previous exposures and are developed under exactly the same conditions. One must of course carefully avoid the vignetted edges.

Assembling and detail drawings of the diaphragm device are available at request from the author at the ESO-Garching address.

In the Mail...

Dear Editor,
Since the *Messenger* is evolving in the direction of serious journals, one should consider the problem of quoting articles in lists of references. The other day I found the reference: "ESO Mess" —which is perhaps not the best compliment to the otherwise fine organisation... H.D.

Dear Reader,
Thanks for your very pertinent remark and for beginning to take this journal seriously—hopefully not too *seriously. You are right about the lack of guidelines for abbreviations of the names of journals. Unless the editors of other journals object, I suppose that "ESO Messenger" will do as reference—at least in this journal...*
The editor of the ESO Mess.

Dear Editor,
Why do you not print a table of contents on the first or last page of the *Messenger?* It is always a hard job to find a particular article which appeared some issues ago...

R.W. and M.H.U.
(*not* the editor)

Dear Colleagues,
That there so far has been no table of contents (and no index), is due to a subtle psychological trick. In other journals, the reader first studies this table and decides that there is nothing of interest. He then throws it away without having seen what is inside. In the Messenger, *however, he is forced to look through the* entire *issue to be sure that he did not miss that most important article! Nevertheless, you may be right, because as was already written in* Messenger *No.... No.... (sorry, I can't find it), well, anyhow... we shall begin with this issue. OK?* *R.W. (the editor)*