ASTROMETRIC APPLICATION OF THE PHOTOELECTRIC SCANNING TECHNIQUE

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Abstract: A new photoelectric area scanner, designed primarily for observations of double stars, has been put into routine use at the Lowell Observatory. A description of the scanner and of the associated data acquisition system is given. The procedure of measuring the relative positions of double star components is described and the accuracy obtainable by this method is discussed.

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Discussion

To question of Laques and Asimov, Franz replies that one astrometric observation requires about five minutes of telescope time, the image being scanned in at least six directions for 10 or 20 sec each. The time needed for a set of photometric observations is about the same. The filters used are standard UBV. The use of narrow-band filters may be considered in the future.

On the suggestion by Nather to use the technique described as a seeing monitor, Franz agrees that from the record of the integrated intensity distribution throughout the image the effects of seeing may be evaluated.

Høg doubts that the observations are not subject to systematic errors. His own results indicate a difference of a typical image profile from a simple Gaussian by such an amount that, for instance, for a pair of $\varrho = 2''$ and $\Delta m = 1^m$, an error of $0^m.1$ would be caused by assuming the profile to be Gaussian. For pairs with small separations and/or large magnitude differences, the true profile has to be used in order to avoid also systematic errors of separations.

Franz: I did not say that my observations have no systematic errors, only that they are not subject to the same errors as the photographic technique, for example, to proximity effects as seen on a photographic plate. I am worried about the effects you just described. But because the observations I have thus far obtained were mostly seeing limited, the profiles I have recorded could simply be represented by Gaussians. Under better conditions the profiles may become less dependent on simple Gaussian smearing and more on diffraction effects, so that different distributions may have to be used. It may well become necessary to use empirical distributions determined from single stars. But all this is a matter of handling the data properly in the computer reductions.

Rösch: Il faut se méfier de l'estimation de qualité par la méthode de balayage à cause des déplacements possibles de l'image pendant la durée du balayage. Idéalement il faudrait faire deux balayages simultanés en directions opposées.

Franz: One may also use individual scans, select the best ones, and then combine them by computation. But it is difficult to say what is a good scan. It is necessary to develop criteria to describe what is a good scan. A scan that simply looks good may not necessarily be free of systematic effects. I agree that scanning in opposite ways would be the best method.

Lacroute agrees that the true profile must be taken into account, and asks if different profiles have been obtained in different scan directions for the same star; this may bear on the systematic errors.

Franz: I have looked somewhat into evaluating effects of this kind, to see whether systematic differences exist depending on scan direction and different distance from the scan center. I have not found an effect of this type. However, I may not have enough material available to evaluate this. I have been more anxious to carry out instead photometric observations.

Rakos reports on some tests of the seeing in Flagstaff. With very fast scanning, ten or twenty scans per second (which is about the fastest currently possible), the image motion between consecutive scans

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is very small. Furthermore, by using a fast computer, and by sorting the scans, a gain in accuracy may be achieved. The computer can estimate the seeing from the shape of each scan, and stores the scans taken at moments of good, average, or poor seeing in respective different accumulators.

Finsen: I think there is a need for more precision in talking about seeing; failure to distinguish between tremor disk and diffraction disk is quite common. The visual observer concentrates his attention on the diffraction disk and if it were really one or two seconds of arc in diameter he would be out of business!

Strand: The disadvantages of the multiple exposure photographic method of double stars was in the past the considerable amount of time and work to measure the plates by conventionned non automatic methods; often two hours and more. With the automatic measuring machine at the US Naval Observatory a 60 exposure plate is now measured in 15–20 min, while the final reductions are carried out in less than 2 min. Since the external mean error of one photographic plate is 0″.016 as compared with 0″.01 with the scanning method, the latter is 2,5 times more accurate by weight unit.

Franz: But can the automatic machine be used on pairs closer than about 4 to 5 arc sec? There is more or less a gap between photographic measures and those visual measures obtained with large enough telescopes. The latter are often limited to pairs of 1 arc sec or less separation, while the photographic technique is limited to pairs wider than about 2 to 3 arc sec. With the scanning technique one can fill in this gap. By providing enough overlap with the visual and photographic measures, one can also establish direct comparison between such series of observations. In the area of astrometry, the scanning technique may therefore be of greatest value if used on pairs with separations ranging from $\frac{1}{2}$ to 3 arc sec.

Rösch: Nous avons photographié à la caméra électronique une étoile brillante avec 1/500 de seconde de pose et 40 poses par seconde. Pendant ce temps l'image de diffraction se déforme. On prépare actuellement une expérience avec 100 images par seconde de pose de 1/1000 seconde.

Muller: Une question qui n'a pas été soulevée, je pense: est-ce que le Dr Franz ou Monsieur Rösch ont une idée sur la limite de séparation de deux étoiles au-delà de laquelle l'agitation affecte les images de façon entièrement incohérente?

Selon mon expérience, l'agitation est toujours cohérente à moins de 2–3″.

Dans les mesures par double image, on rapproche les images des deux étoiles, ce qui rend très sensible leur agitation relative. C'est de cette façon que j'ai constaté souvent des mouvements totalement incohérents dès les séparations de l'ordre de 4″.

Laques: Pour une étoile de 8″ de distance environ, on constate que la similitude des taches de diffraction des composantes est réalisée dans 1 pose sur 2, soit 50% des images enregistrées.