Santiago. The agreement dates from 29 April 1965 [31]. ESO provided the astrolabe with chronograph equipment and a building to house the instrument, and the University of Chile its chronometric facilities. But most important: the observations would be conducted and supervised by the staff of Cerro Calán. After overhaul in Paris, the instrument was installed on Cerro Calán in November and December 1965 with the collaboration of Guinot. Since then it has made, under the supervision of F. Noël, solid contributions to the Fundamental Reference System in the Southern Hemisphere and to research on the Earth's rotation; a first demonstration of the appreciable systematic errors in the southern FK4 declinations was published by Anguita and Noël in 1969 [32]. In ESO Bulletin No. 4 of June 1968 Noël describes the nature of the project and the first years of operation.

ESO Chooses its Emblem

Not only heavy tasks kept the ESO Committee busy. After the Convention had been signed, it acquired its emblem for which at the October 1962 EC meeting Bannier presented some designs by the artist Mrs. G. M. Pot. The Committee had no problem in making up their mind; according to the minutes it chose the design "in which the stars show at their best". The emblem's stars – the Southern Cross – still show well, as is apparent from the front page of this *Messenger*.

References and Notes

Abbreviations used:

EC = ESO Committee (the Committee preceding the ESO Council).

ECM = ESO Committee Meeting.

IC = Instrumentation Committee.

EHA = ESO Historical Archives (see the article in the *Messenger* of December 1988).

FHA = Files Head of Administration at ESO Headquarters.

[1] Circular letter by Oort to EC members preparatory to the ECM of May 1959, in EHA-I. A. 1.9., and minutes of that meeting.

[2] See letters of Oort to Danjon and Funke of May 30, 1962, in EHA-I. C. 1.1.c.

[3] In EHA-I. C. 1.1.d.

[4] In EHA-I. C. 2.1.g.

[5] See correspondence between ZWO and University of Groningen in the years 1962 and 1963 in EHA-I. C. 2.1.e.

[6] Information provided by the Personnel Department of ESO; also: minutes of the ECM of July 1963, p. 12.

[7] *Publ. Astron. Soc. of the Pacific* **72,** 225, 1960.

[8] I. S. Bowen, *Publ. Astron. Soc. of the Pacific* **62,** 95, 1950.

[9] I. S. Bowen, *Publ. Astron. Soc. of the Pacific* **61,** 243, 1949.

[10] Jahresberichte Hamburger Sternwarte 1954 and 1955; *Sky and Telescope* **15,** Nov. 1955, p. 10.

[11] See, for instance, minutes ECM of Oct. 1957, June 1961, Oct. 1962, Nov. 1963, Council Meetings of May 1964 and April 1966 and correspondence between Fehrenbach, Heckmann and Oort of June 1964 in EHA-I. A. 2.9. and I. A. 2.10.

[12] Minutes ECM of April and Oct. 1957; the EHA do not contain the written report.

[13] In EHA-I. C. 1.9.c.

[14] In EHA-I. C. 1.9.a., Visite des Observatoires Américains.

[15] Minutes ECM of November 1961.

[16] See, for instance, the letter by Blaauw to Fehrenbach of April 6, 1961 in EHA-I. C. 1.9.c.

[17] EHA-I. C. 1.9.c.

[18] See letter by Minnaert to Oort and Blaauw of May 1, 1961 in EHA-I. C. 1.9.c.

[19] See Minnaert's letter to Van Geelen of 10 October 1961 in EHA-I. C. 1.9.c.

[20] Maps EHA-I. C. 1.9.f/k contain preparatory correspondence, technical descriptions, and the tender of Rademakers.

[21] Minutes IC of November 1961.

[22] See ref. No. 18.

[23] Minutes ECM of June 1961.

[24] Minutes ECM of November 1961.

[25] EHA-I. C. 1.9.e. contains the Cahier de Charges with drawings and the Marché de Gré à Gré of REOSC of May 20, 1963.

[26] In EHA-I. C. 1.1.c. See also correspondence between Fehrenbach and Oort of October 1958 in EHA-I. A. 2.1.

[27] The Yale and U.S. Naval Observatories planned an instrument in Argentina and the Pulkovo Observatory one in Chile, whereas Greenwich Observatory contemplated a collaborative project with the Cape Observatory and Hamburg Observatory one with Perth.

[28] Minutes Council Meeting of May 1964, p. 10.

[29] Letter by Guinot to Blaauw and follow-up correspondence with Van Geelen in EHA-I. C. 1.9.d.

[30] EHA-I. A. 1.19. and I. A. 2.6.

[31] ESO Ann. Report 1965, p. 10.

[32] *Astron. Journal* **74,** 954. 1969.

Field Strömgren Photometry with a CCD

J. KNUDE, H. JØNCH-SØRENSEN, Copenhagen University Observatory, Denmark

Introduction

The chemical evolution of the Galaxy is somehow coupled to its formation. The location of stars with a certain metallicity may therefore also depend on the Galaxy's dynamical history.

Laws describing the galactic distribution of the various stellar populations introduced to understand the construction of the Galaxy are often based on detailed studies of the solar vicinity. We have been interested in studying particularly the F stars in a few galactic directions of interest, e.g. the SGP, to search for [Fe/H] gradients in space and time. Such studies are mostly based on accurate photoelectric photometry but the cry for data in more remote volumes has been acute lately and as large telescopes are not available for extended photometric surveys we have tried to use a medium sized telescope with a CCD instead.

Stars with a metal content down by a factor of 2.5 relative to the Sun have been suggested to form a spheroid with a local scale height in the range from 600 to 1 000 pc and the stars with [Fe/H] ≤ -0.8 another system with a scale height of several kpc. Strömgren photometry of F stars seems well suited to trace the metal variation with age and distance. The intermediate band photometry thus permits computation of distances based on individual absolute magnitudes. Distances based on a colour – absolute magnitude relation as $(b-y)_o - M_V$ may be quite uncertain. For an F star with $(b-y)_o = 0.3$ the width of the main sequence band is observed to be 2 mag at least. The scale height of the most metal poor stars thus suggests that observations of objects several kpc from the plane should be performed.

According to current models of the Galaxy, it is only several kpc from the plane that extreme population II stars will dominate. Our observing parameters are set by the detection of an F9 star 5 kpc from the plane. The V magnitude is about 18 at this distance. The most critical colour is, however, the u-band, partly because the F stars are cool and partly because this band falls in the wavelength range where the CCD's R.Q.E. is smallest, only 10 to 20%. The stellar metallicity may be computed without u but the band is required for estimating M_V. An F9 star has $(b-y) = 0.4$ and $(u-b) = 1.5$, $V = 18$ then implies that

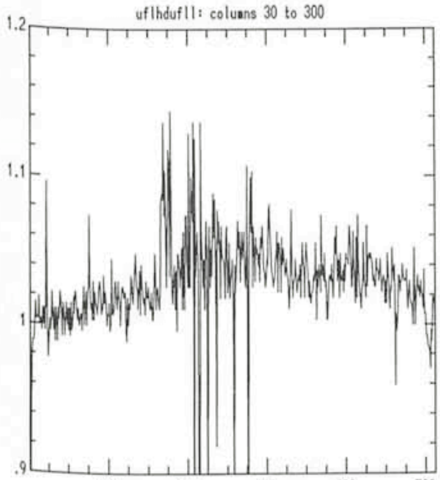

Figure 1: *The ratio of a u flat field with original intensity about 650 ADU to a u flat with original intensity 75 ADU. Both flat fields are normalized to a unit median sensitivity. The abscissa indicates the row number and the average is taken through column 30 to 300. The ratio of the two flat fields is seen to show a variation of ~3%.*

u ≥ 20 mag. So the problem concentrates on how one obtains high-precision Strömgren photometry for stars with u ~ 20. Depending on the actual chip available, the necessary integration times may be estimated. We used ESO CCD # 8 which required 70 to 80 minutes to go down to the 20th mag in u with a S/N of 30.

Photometric Procedure

As an objective of our study is to make possible a distinction between F stars with [Fe/H] = 0.0, −0.4 and less than −0.8 representing the disk, the intermediate population II and the extreme population II respectively, we require a standard error of 0.02 (or better) in the colours v, b and y to have a one-sigma difference in [Fe/H] only. A similar accuracy of u and thus of c_1 gives a relative distance error of 20%.

For the CCD observations, we try to adopt the procedure established for photo-electric measurements with extinction determination in all four colours and with copious standard star observations each night.

Standard Stars

No primary standard stars are faint enough to be used with a CCD on a 1.5-m telescope; instead we have been using secondary standards down to the 14th mag from the literature. Standards were exposed with a defocused telescope and with sufficiently long exposure times so the uncertainty in the shutter timing was of no importance and the images still did not saturate. As a second approach we also tried to use open clusters with deep uvby photometry allowing several stars in a single frame but this may result in difficult transformations of the m_1 index because of the cluster's narrow metallicity range. About 20 standards in each colour is preferable per night. With the extinction determination, one third of the night is spent on the photometric calibration of the system.

Flat Fielding

Correct flat fielding is of the outmost importance when an accuracy of 0.02 mag or ~2% is required. It would of course be most convenient if a scientific frame with its astronomical objects and background could be flat fielded with a single, well-defined, response frame. Considering the possible intensity range in a frame bracketed by the background and a source, the CCD's response surely must be linear. However, we may have seen indications that this is not quite the case. The response seems to obey a power law, response $\sim I^{1.03}$, valid for intensities from a few hundred to several thousands. Figure 1 shows the ratio of two u flat fields at a low and a high intensity. A three per cent variation is noted. A non-linearity means that we cannot use identical flat fields inside a stellar image and for the background. Using a flat field pertaining to the background level or to some intermediate level leaves the stars slightly too bright. For a y = 17 mag star we make an error in the range Δy = 0.01–0.02 mag.

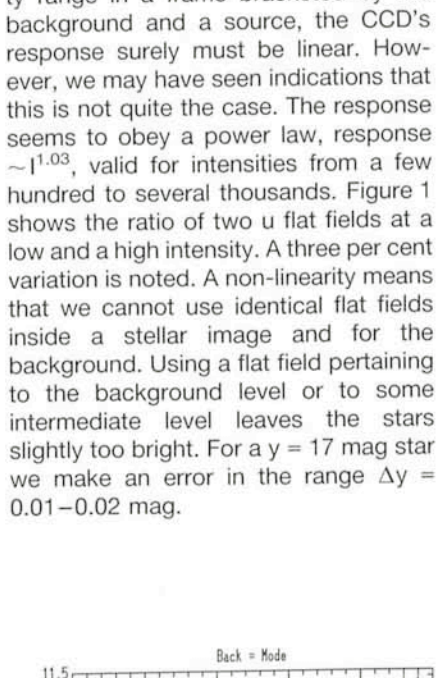

Figure 2: *Aperture-magnitude versus aperture. The star brightens with aperture. The tic marks on the curve indicate a one-pixel step. The magnitudes are computed with a background estimated as: mode = 3× median − 2× mean. Due to the large stellar images the background is measured in an annulus with radii 35 and 45 pixels.*

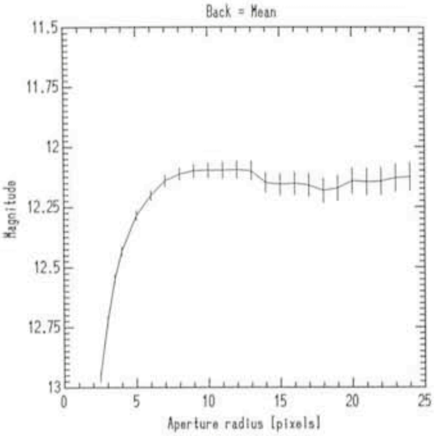

Figure 3: *As Figure 2, but the mode is now replaced by mean and a convergence is established.*

Background Subtraction

After correcting for the sensitivity variation across the frame, we noticed that the background depended on the brightness of the star and that the stellar magnitudes did not converge with aperture.

From the seeing conditions during our runs and the scale of the Danish 1.5-m telescope we expected stellar images of 5 pixels or smaller.

Figure 2 shows the variation of the stellar magnitude with aperture when we use the background suggested by the DAOPHOT photometry package. The star brightens with the aperture. Obviously we don't correct for all the signal in the background. DAOPHOT derives the background as, mode = 3× median − 2× mean. A good background estimator in crowded regions like a globular cluster, but apparently not in the sparsely populated general field. We replaced the mode by the simple mean and the result is shown in Figure 3 where we obtain a good convergence after ~10 pixels. For the faint programme stars we thus use a stellar radius of 12 pixels and not the 2–3 suggested by the seeing measurements.

Transformation to the Standard System

The instrument magnitudes resulting from the aperture photometry are then corrected for extinction and transformed to our secondary standard system by means of our standards. We are using the transformations for the whole range of apparent magnitude of our programme sample. We have approximately three stars per frame at the SGP, also indicating that our limiting magnitude is about V = 20 mag, so the transformation is used 6 magnitudes beyond the fain-

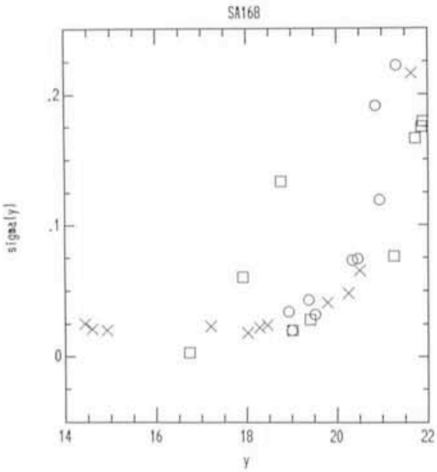

Figure 4: σ_y *versus y for three frames in SA 168. The magnitudes are in the instrumental system, but the transformation coefficient is about unity.*

test standard stars. Our results are surely depending on the detector linearity. m_1, c_1, and (b-y) have almost linear transformations whereas V includes, as expected, a more significant colour term.

Results

Figure 4 shows as an example the variation of σ_y with y for three frames in the selected area SA 168 and apparently σ_y stays below the maximum acceptable error 0.02 mag down to about the 19th mag. The three other colours have an identical behaviour.

Towards the SGP we have so far identified about 39 F stars, $0.2 < (b\text{-}y) < 0.4$ mag, in the whole magnitude range down to V = 20 and in a solid angle only ~one tenth of a square degree. 33 of these stars also have good u measurements, so the sample already is of some significance.

When u, v, b and y are obtainable with an error 0.02 mag, the study's objective to investigate the [Fe/H] variation of the F stars beyond D = 5000 pc from the plane seems within reach. We have $\sigma_{[Fe/H]}$ = 0.4 dex and $\Delta D/D \sim 20\%$ or better. However, we do not see how the error may be improved to better than ~0.01 mag or ~1% implying that the best obtainable error is 0.3 dex in the metal content [Fe/H]. Regarding F stars, observations are just feasible at 5 kpc from the plane with a 1.5-m telescope.

It will be particularly interesting to see the relative population shift with distance, but also to see if there exist stars with solar metallicity at these remote distances.

As our general results are not too encouraging concerning the obtainable errors we want to stress that it seems possible to do CCD photometry – also in the u region – in the field without having to establish standards in each frame.

We should mention that the reduction of the several thousand frames forming the basis of this note have been performed with the MIDAS, IRAF and DAOPHOT packages.

δ-Scuti Stars in NGC 6134

H. KJELDSEN and S. FRANDSEN, Institute of Astronomy, University of Aarhus, Denmark

The CCD camera on the Danish 1.5 m telescope has been used to obtain exposure time series of small areas in open clusters. The purpose is to study the frequencies of different types of pulsating variables. Very low noise levels have been reached by the use of differential photometry carefully considering the error sources.

Noise Levels

To illustrate the high precision one can obtain with CCD's, we present the data from one night in late May 1988 on NGC 6192. Exposure times were 20 seconds and exposures were collected each minute for nearly 7 hours. The time series has some gaps, when tapes had to be changed or the seeing and the tracking checked. The resulting 370 frames were reduced with the DAOPHOT package and relative magnitudes determined for all reasonably isolated stars. A small set of not too bright, well isolated stars define the reference.

Two corrections turned out to be of critical importance. A colour correction to eliminate differential extinction effects on stars of different colours. And a correction for non-linearity of the CCD. The CCD (# 8) turned out to have a nonlinear response at high exposures before saturation of the order of two per cent. Consequently, for the bright stars, the change of seeing introduces a variation due to the non-linearity. We were able to correct for this effect using the large number of exposures and large number of stars we have.

All time strings were transformed into power amplitude spectra. Figure 1 presents the mean amplitude in three frequency intervals for stars over a range of 7 magnitudes. For high frequencies the amplitudes scatter very little about a

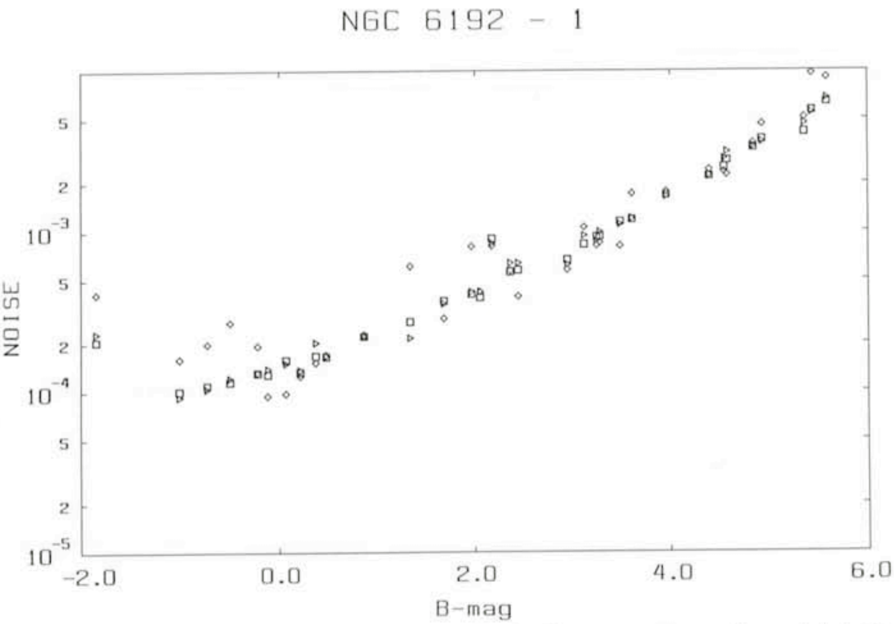

Figure 1: *The noise level for different frequency intervals. Squares correspond to periods in the range 3–10 min, triangles 10–60 min and diamonds 1–2 h. The abscissa is the B magnitude relative to a set of reference stars on the frame.*