PHOTOGRAPHIC CATALOGUE OF 200000 SOUTHERN STARS - POCAT-S

N.F.BYSTROV, D.D.POLOJENTSEV, H.I.POTTER, L.I.YAGUDIN
Pulkovo Observatory
Leningrad, Pulkovo
USSR, 196140
R.F.ZALLES, J.A.ZELAYA
Observatorio Astronomico Nacional
Tarija, Bolivia

ABSTRACT. The catalogue of about 200000 stars in the zone from equator to southern pole was compiled from photographic observations carried out during 1982 - 1989 years in USSR and Bolivia by Pulkovo astrograph (D=23 sm, F=230 sm, working field $4^{\circ} \times 4^{\circ}$). The plates were measured by Zeiss Ascorecord measuring mashines in Pulkovo, Tarija, and others observatories. The process of measurement and compilation of catalogue were carried out in Pulkovo by ES-1033 computer. The observations were made with a four-fold overlap of the sky. Reference catalogue is SRS catalogue (FK5 system). The differencial refraction, differencial aberration and objective distortion were taken into account. The mean accuracy of catalogue POCAT-S positions is $\pm 0.123''$.

1. INTRODUCTION.

The project of the reference photographic catalogue of the southern sky was proposed by D.Polojentsev and H.Potter in 1977 [1]. Its aim was to extend the fundamental system for 8-11 magnitude stars as uniformly as possible over the sky. The planned density of the catalogue was 10 stars per 1 square degree.

Up to now the accurate stars position determination is completed; its brief description is given below. The proper motion determination will be continued in the near future. The POCAT-S catalogue is now being used by astronomers: its preliminary version is the main part of PPM-S compiled catalogue which was created in Heidelberg [2].

2.THE SOURCE STARS LIST.

The POCAT-S source list is to contain about 210000 stars in declination zone from 0° to -90° according to the planned density of 10 stars per 1 square degree. SAO catalogue was used as the basis for the source list. It numbers about 130000 stars. The rest 80000 stars were taken from Bonner Durchmusterung ($+2^{\circ}$, -18° declination zone) and Cape Durchmusterung (-18°, -90° declination zone).

SAO catalogue stars were included into source list as a whole. Durchmusterung stars were choosen under the following conditions:

- magnitudes range is 8^{m} - 13^{m};

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- the stars number in every $1^{\circ} \times 1^{\circ}$ area is no less then 10;
- the neighouring stars distance is no less then 3 arcminutes.

The total number of FOCAT-S source list is 214475 stars. Their magnitude and spectrum distributions are shown in Table 1.

Table 1. Source list stars distribution

spectr	num.of stars	mag	num.of stars
B	19572	<7	4646
A	18307	7- 8	12274
F	29183	8- 9	52347
G	32648	9-10	120477
K	20589	10-11	12547

3. OBSERVATIONS.

Observations were started in Marth, 1982 at Pulkovo Ordubad station ($\lambda = -3^{h}02^{m}25^{s}$, $\phi = +39^{\circ}06'20''$, H = 2000 m) by Pulkovo astrograph (D = 23 sm, F = 230 sm, working field $4^{\circ} \times 4^{\circ}$). The observations in Ordubad were carried out in declination zone from 0° to -30° and lasted till August, 1982. Then astrograph was transported to Tarija, Bolivia ($\lambda = 4^{h}18^{m}32^{s}$, $\phi = -21^{\circ}35'08''$, H = 2100 m). The observations there began in April, 1983 and continued till the mid of 1989.

The observations were made with a four-fold overlap for obtaining the star image in different parts of plate. The neighouring plates intersection is 2°: that is a half of the working field of astrograph. Such technique permits to reduce systematic errors due to objective field such as coma, astigmatizm, etc.

All observations were carried out near meridian on photographic plates ZU-1 and ZU-21. The exposure-times are 12 min and 4 min accordingly. The total number of FOCAT-S programm plates is 6440.

4. MEASUREMENTS AND PRELIMINARY PROCESS.

Plates were measured by Ascorecord measuring mashines. The measurement procedure was divided into two steps. Approximate coordinates of two bright stars on plate edges were measured during the first step. Then these data were used for the determination of the plate orientation in Ascorecord and for calculation of measurement ephemerides of FOCAT-S stars. Using these ephemerides the search of FOCAT-S stars and their measurements was made during the second step. SRS reference stars were measured twice: before and after FOCAT-S stars for stability control of plate position in Ascorecord.

Data base on magnetic disks was obtained during preliminary measurement, with possible instrumental and personal errors being controlled. The plates wich failed to meet any controle condition were re-observed.

5. REDUCTION OF OBSERVATIONS.

The measured stars coordinates were corrected by differential refraction and differential aberration. Then equatorial coordinates of stars were

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determined by the 8 constant method, which connects the measured (X, Y) with ideal (x', y') coordinates by the following expression

$$x' = a_1X + b_1Y + c_1 + dx'X + ex'Y$$
$$y' = a_2X + b_2Y + c_2 + dy'X + ey'Y \qquad (1)$$

Unknown parameters (a_1, b_1, c_1, a_2, b_2, c_2, d, e) were determined by least square method as applied to the joint solution of equations (1) for reference stars. The rough data were not taken into account.

The subsequent analysis of residual vectors of reference stars in different parts of plates for all plates showed us that equation (1) wasn't satisfactory for the whole working field of the plate (Figure 1). There are the systematical errors in the form of the positive distortion in residuals which can be up to 0.1" at the edges of plates and can be aproximated by

$$v = -0.051" + 12.75" \times r^3,$$

where r is the distance of the star from the plate centre. The above errors were excluded from all the measured coordinates as well.

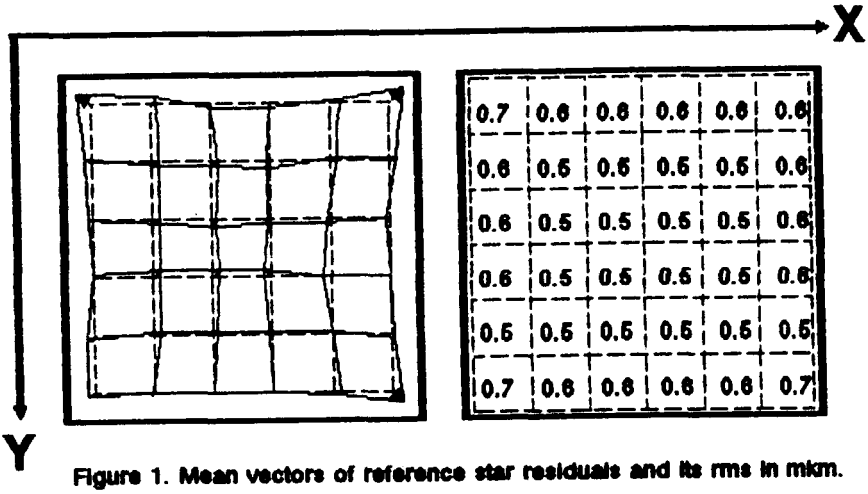

Figure 1. Mean vectors of reference star residuals and its rms in mkm.

Right part of Figure 1 (rms of residuals) shows us the good quality of the astrograph objective randomly. We can see that the random error of the corner points of the plates are no more than twice as large as the ones in the centre. At the same time for the greater part of plate the measurement error is practically the same.

Rms of unit weight in the plate as obtained by least square method charactirizes the quality of our data in a different way. Thus the analysis of the distribution of these errors for different plates shows that the measurement accuracy doesn't depend on the observational season and temperature, it is the same for different observers and measuring mashine operators and at the same time it differs for different declination zones. The latter evidently reflects the properties of the refernce catalogue. The mean rms of unit weight for all FOCAT-S catalogue is ±0.27".

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6. FINAL PROCEDURE.

The coordinates of every star were determined indepently 4 time due to four-fold overlap during observations. Final catalogue positions of stars were obtained as mean-weighted of all determinations by the expression

$$\bar{X} = \sum P_i X_i \; / \; \sum P_i ,$$

where $\bar{X}$ - a star position (right ascencion or declination),
X_i, P_i - a star coordinate on i-th plate and its weight.

The mean epoch and star position rms were computed by the same formula. The weight of every separate solution was computed as the function of two parameters: rms of unit weight on i-th plate S_i and the star distance from the plate centre in millimetres r_i:

$$P_i = (0.27'' \; / \; S_i)^2 \times (1-(r_i/182)^2).$$

The first multiplier characterizes the plate property in general. The second one is connected with the star disposition on the plate and was obtained empirically using Figure 1 data.

The two-steps procedure was used for sorting out rough determinations. Firstly, the Dicson method for small samples was applied. Rough data were tested by 3σ criterion, and external evaluation being taken as σ (mean for all declination zone). In case both criteria give the same result, data were omitted. About 1% data obtained were discarded from the catalogue.

7. CATALOGUE INVESTIGATION.

The study of the magnitude equation and color equation provided by reference stars shows that the mentioned dependences are practically absent within the magnitudes and spectral classes of SRS catalogue.

External analisys, that is the comparison of FOCAT-S with Carlsberg meridian catalogue CMC [3] by U.Bastian and S.Roeser (Figure 2) confirms this result and at the same time shows that there are the possibility of the magnitude equation in declination for the most faint stars.

Figure 2 shows the declination dependent and right ascention dependent differences (FOKAT-S - CMC) too.

Mean rms of star position is $\pm 0.123''$ for the whole FOCAT-S catalogue. Figures 3,4 show its dependence on the declination and its value distribution.

References

1. D.D.Polojentsev, H.I.Potter, 1978, in Modern Astrometry. Proc. IAU Colloq. Nr.48, pp.523-526.
2. U.Bastian, S.Roeser, 1990, Astron. Rechen-Inst. pp.1-11.
3. CMC (1985-1988); Carlsberg Meridian Catalogue La Palma, Numbers 1 to 4. Copenhagen Univ. Observ., Royal Greenwich Obs. and Real Inst. y Obs. de la Armada, San Fernando.

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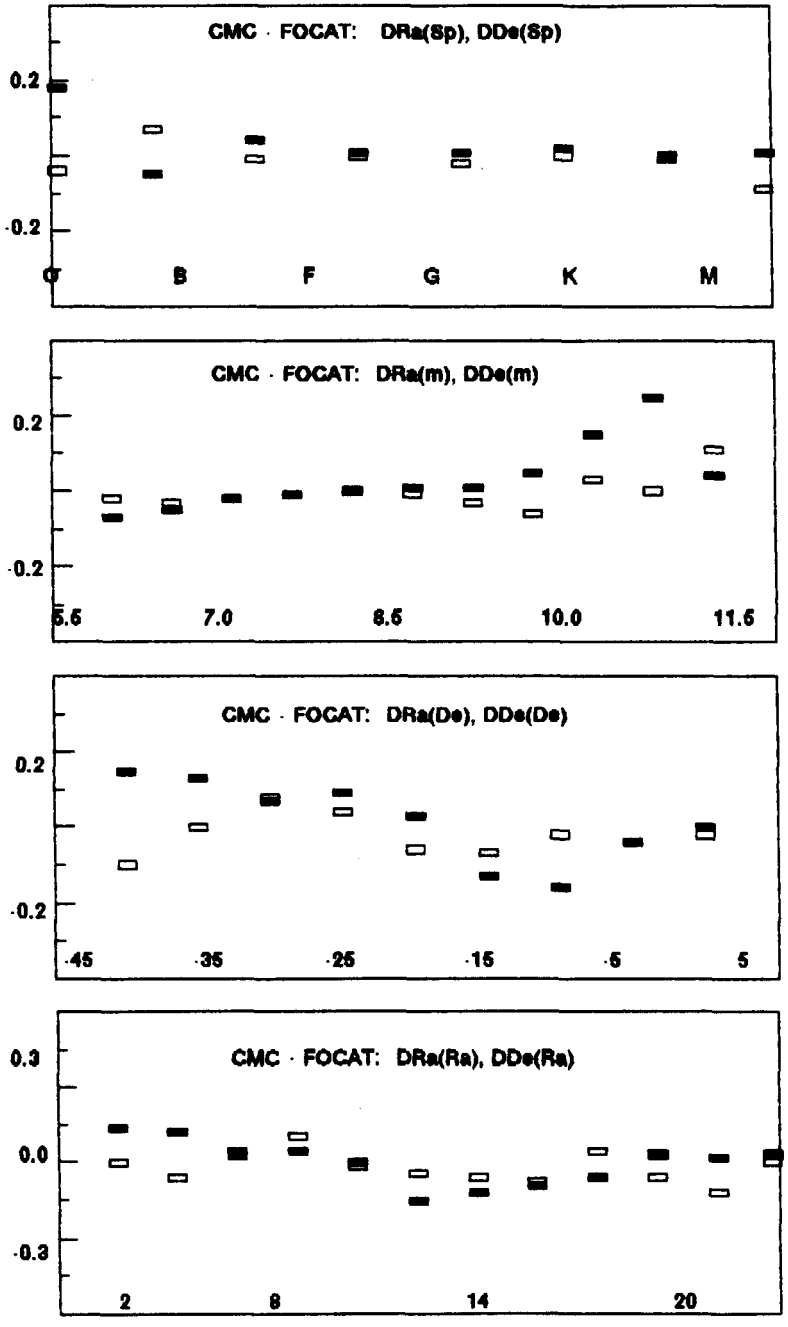

Figure 2. The systematic differences CMC · FOCAT.

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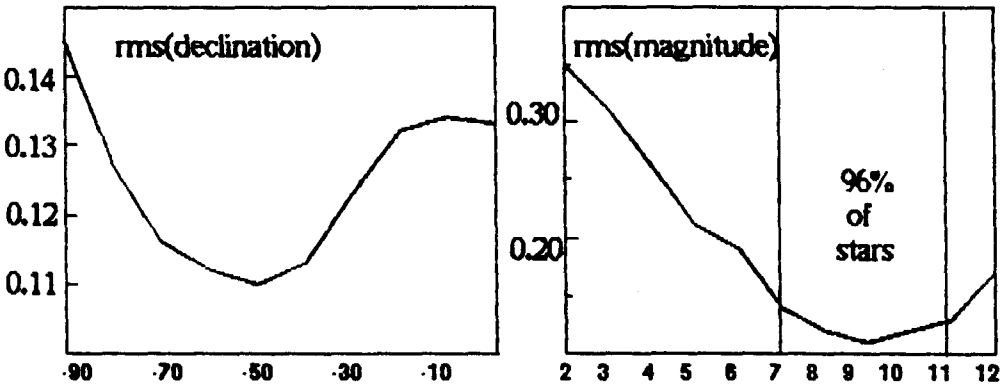

Figure 3. FOCAT-S rms-declination and rms-magnitude dependence (in arcsec).

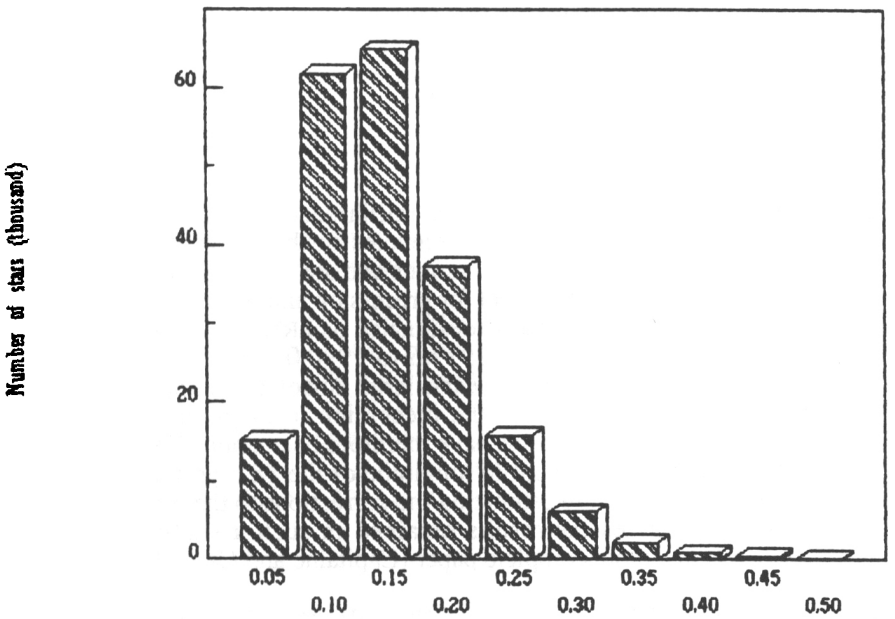

Figure 4. FOCAT-S positions rms distribution.

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