Results of reduction of photographic plates taken with 26-inch refractor in Pulkovo observatory

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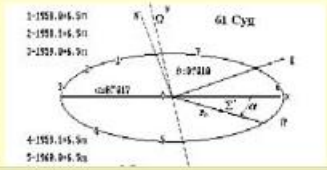
System of astrometric databases of Pulkovo observatory.

To database request form Previous page Main Page

Pulkovo database of observations of visual double stars

61 Cygni



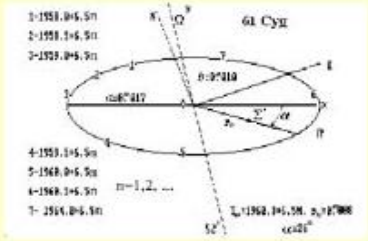
Observations of visual double stars at Pulkovo continue stellar astronomy studies, which were started by F. Struve in 19 century and have become traditional for Pulkovo observatory. The scientific purpose of Pulkovo program of complex study of visual double stars is the determination of basic kinematic and dynamic properties of double and multiple stars located in neighbourhood of the Sun. The first goal of this program is to find close (up to 100 parsec) double stars, which have significate proper motion. The next goal is to obtain dense homogeneous series of relative positions of double star components for the determination of their orbits and masses, and for revelation of possible invisible satellites.
Till 1941 observations of double stars were performed, mostly, on the Normal Astrograph, and since 1960 and till present time they have been performed on 26-inch refractor of Pulkovo observatory. Till 1995 there were only photographical observations, and since autumn of 1995 - photographical and CCD observations.

The 3rd database contains relative positions of selected double and multiple stars, and stars with possible invisible satellites. The database requires catalog of relative positions of visual double stars, based on photographic observations performed since 1960 on

System of astrometric databases of Pulkovo observatory.

Pulkovo database of observations of visual double stars

61 Cygni



Orbit of 61Cyg

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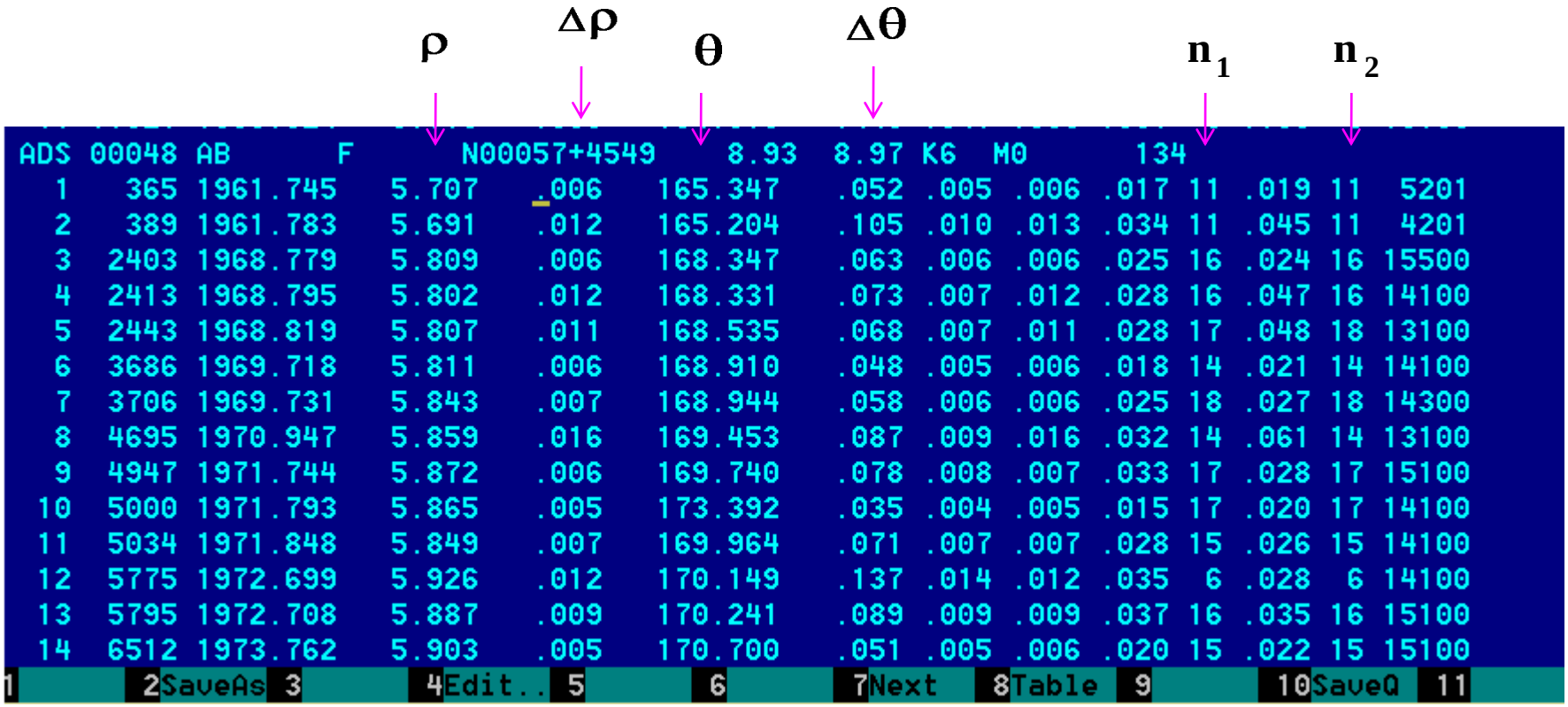
The 3rd database contains relative positions of selected double and multiple stars, and stars with possible invisible satellites. The database requires catalog of relative positions of visual double stars, based on photographic observations performed since 1960 on Pulkovo 26-inch refractor, and similar catalog based on CCD observations, obtained since 1995. The database also requires results if long-term observation series of ADS7251 and 61 Cygni. Presented material makes it possible to determine orbits and masses of double stars, and to perform various studies in stellar astronomy.
Publications

The on-line version of Pulkovo Visual Double Star Catalog contains the relative distances and positional angles of secondary component with respect to the main component referred to the mean-year dates (normal places).

JD	Epoch	S arcsec	e(S) arcsec	P deg	e(P) deg	N	N(S)	N(P)	e1(S) arcsec	e1(P) deg	Ori.	Meas.	De
2437575	1961.753	5.704	0.006	165.309	0.057	2	2	2	0.011	0.006	1	0	
2440146	1968.793	5.807	0.002	168.396	0.065	3	3	3	0.004	0.007	1	0	
2440486	1969.723	5.825	0.016	168.916	0.037	2	2	2	0.023	0.004	1	0	
2440933	1970.947	5.859	0.016	169.445	0.087	1	1	1	0.016	0.009	1	0	
2441242	1971.794	5.862	0.011	169.855	0.112	2	2	2	0.016	0.012	1	0	

We were interested in comparing the errors at measurement of relative coordinates at each plate, so we used current version in different form:



ORWO

WO-1, WO-3
NP-27, NP-22
Kodak 103 OaD

yellow filter GS-18

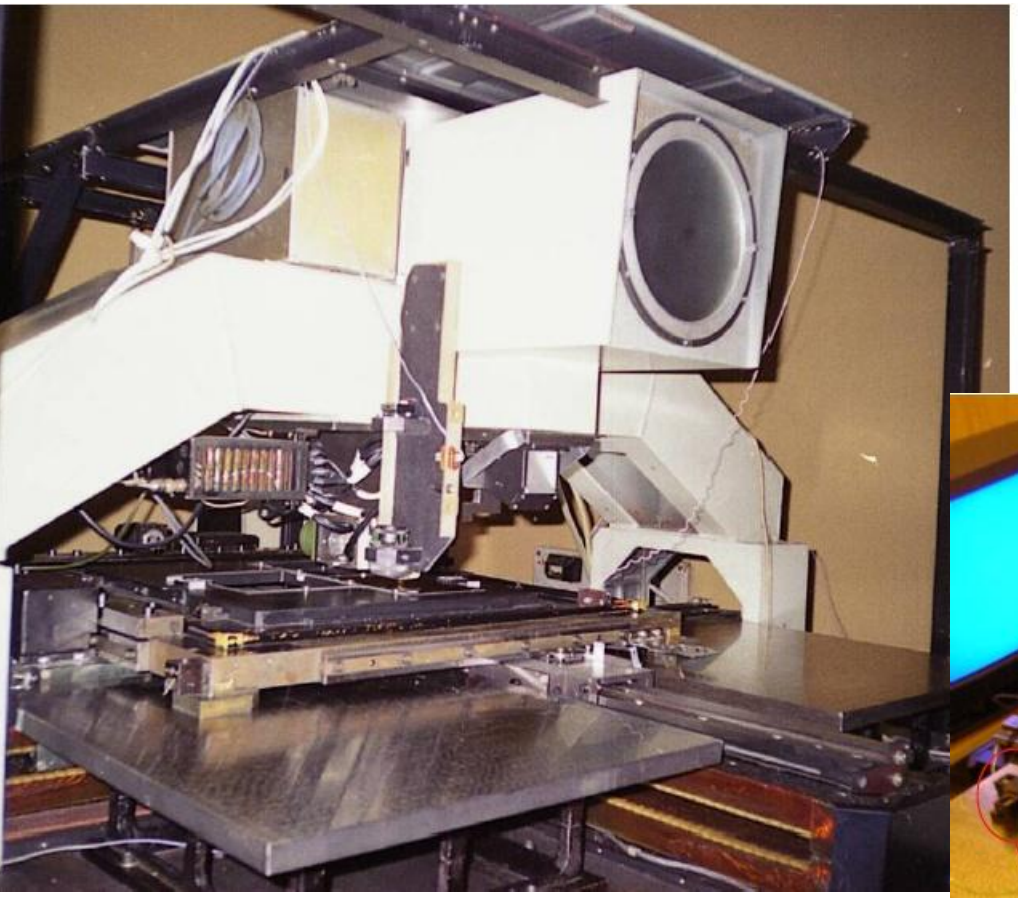
5500 A

8000 plates

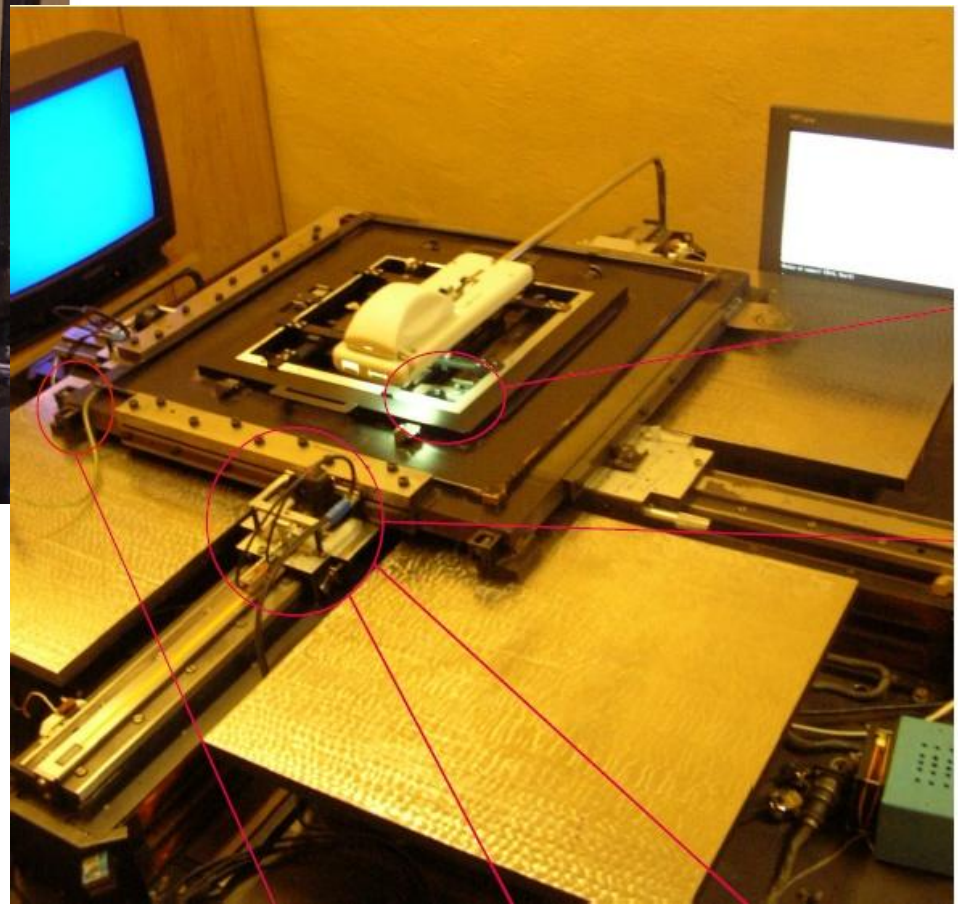
300 stars

To obtain the separations and positional angles for nearly 300 pairs of double and multiple stars, approximately 8000 photographic plates were processed. Three mashines were used for measuring the plates:

UMAX POWER LOOK II



Fantasy I 1986 - 2004



Fantasy II till 2004

At the end of 90-s the Fantasy was perfect machine with exception of time needed for taking information from a plate – this long time was reason for decision for reconstruction of Fantasy

Accuracy of positional measurements 0.32 micron at possible 0.08 micron

At absence of financing, the efforts to improve the Fantasy resulted in prolonged reconstruction

Recently a new camera was worked into Fantasy which provides 500 px/mm scanner 48 px/mm

Fantasy / resolution 4 micron

ADS 8742

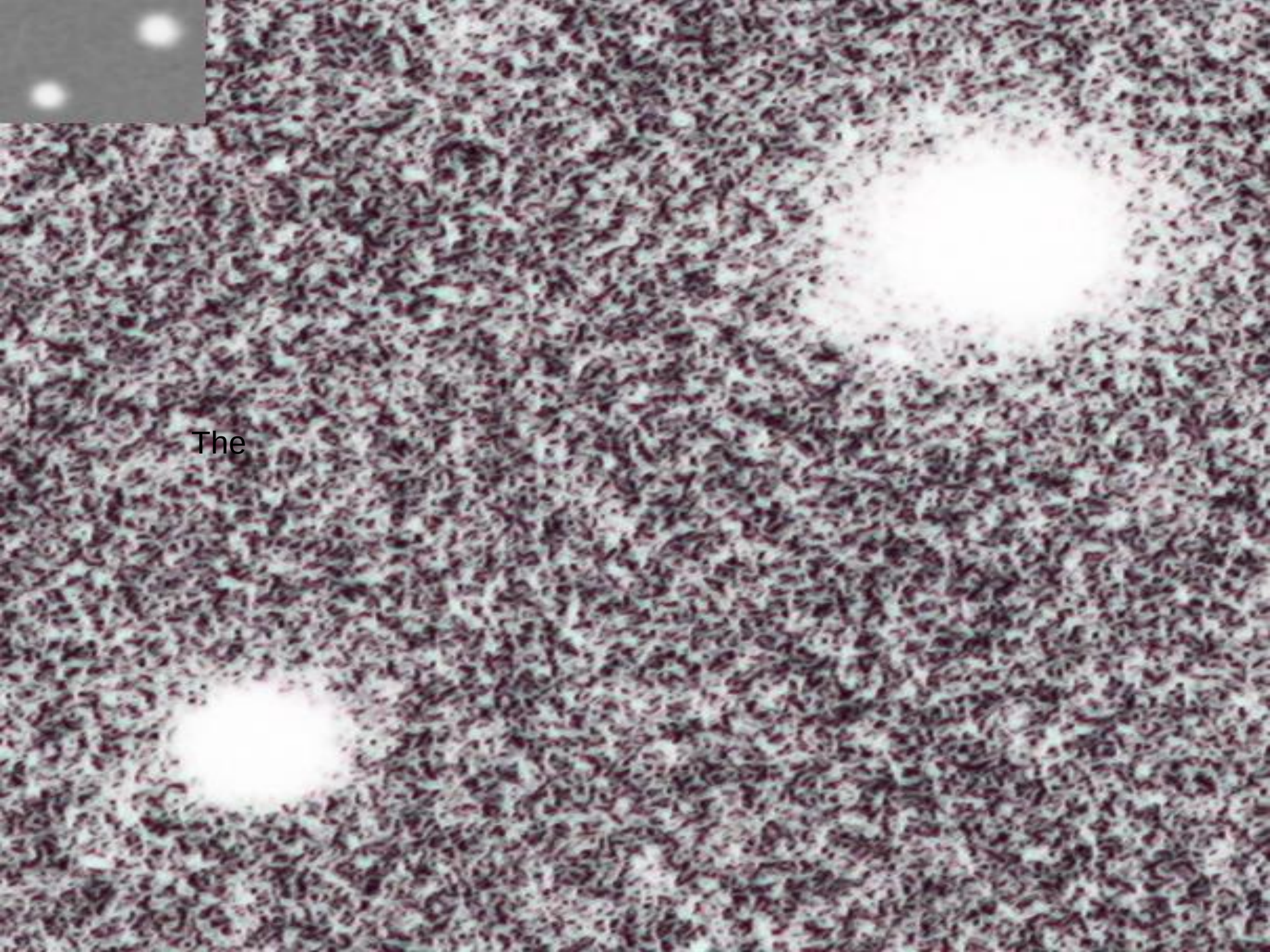
Just few days ago the new camera was maintained at Fantasy and results show the following accuracy at repeated measurement of the same plate

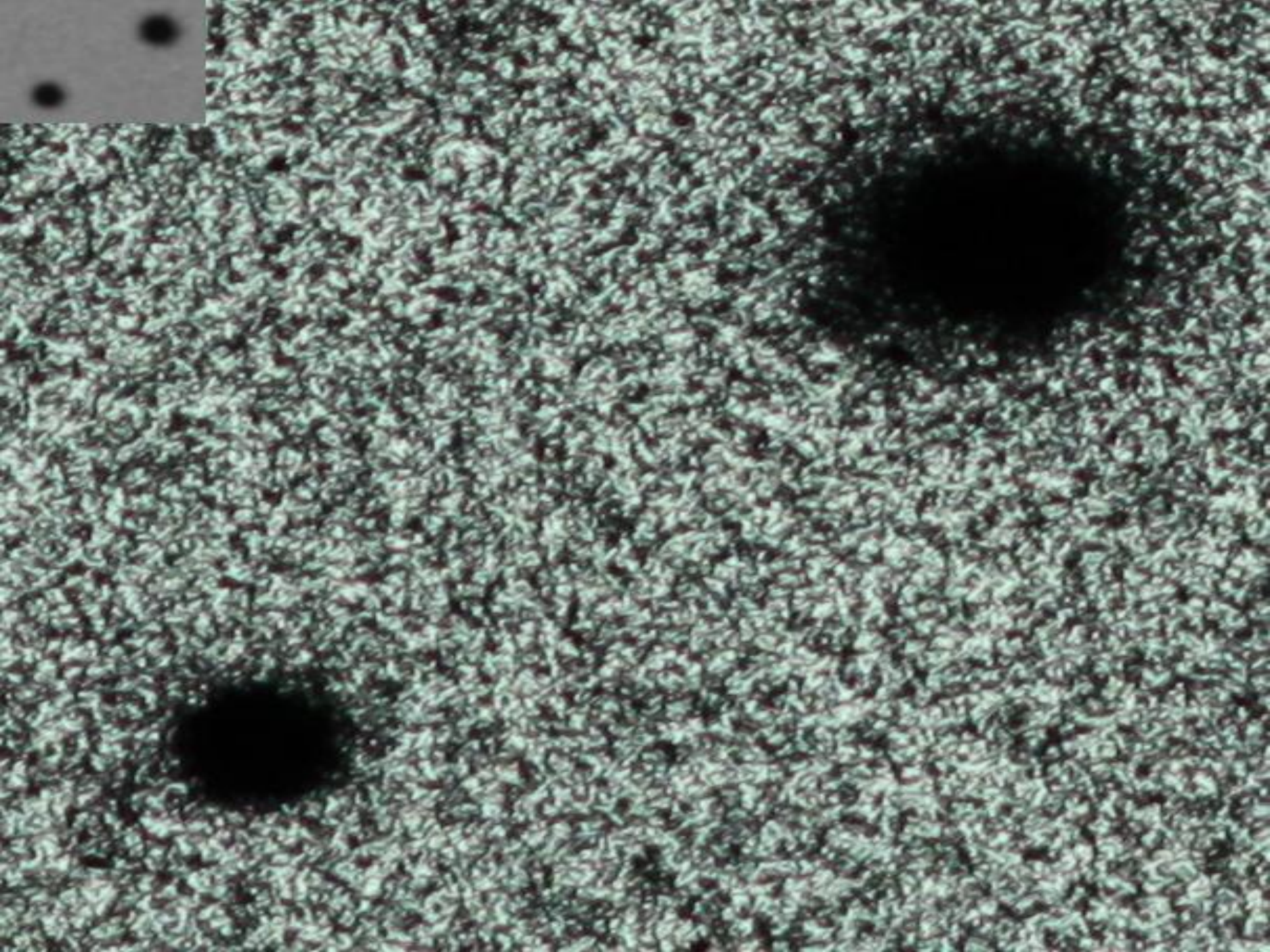
total number of measured plates 34

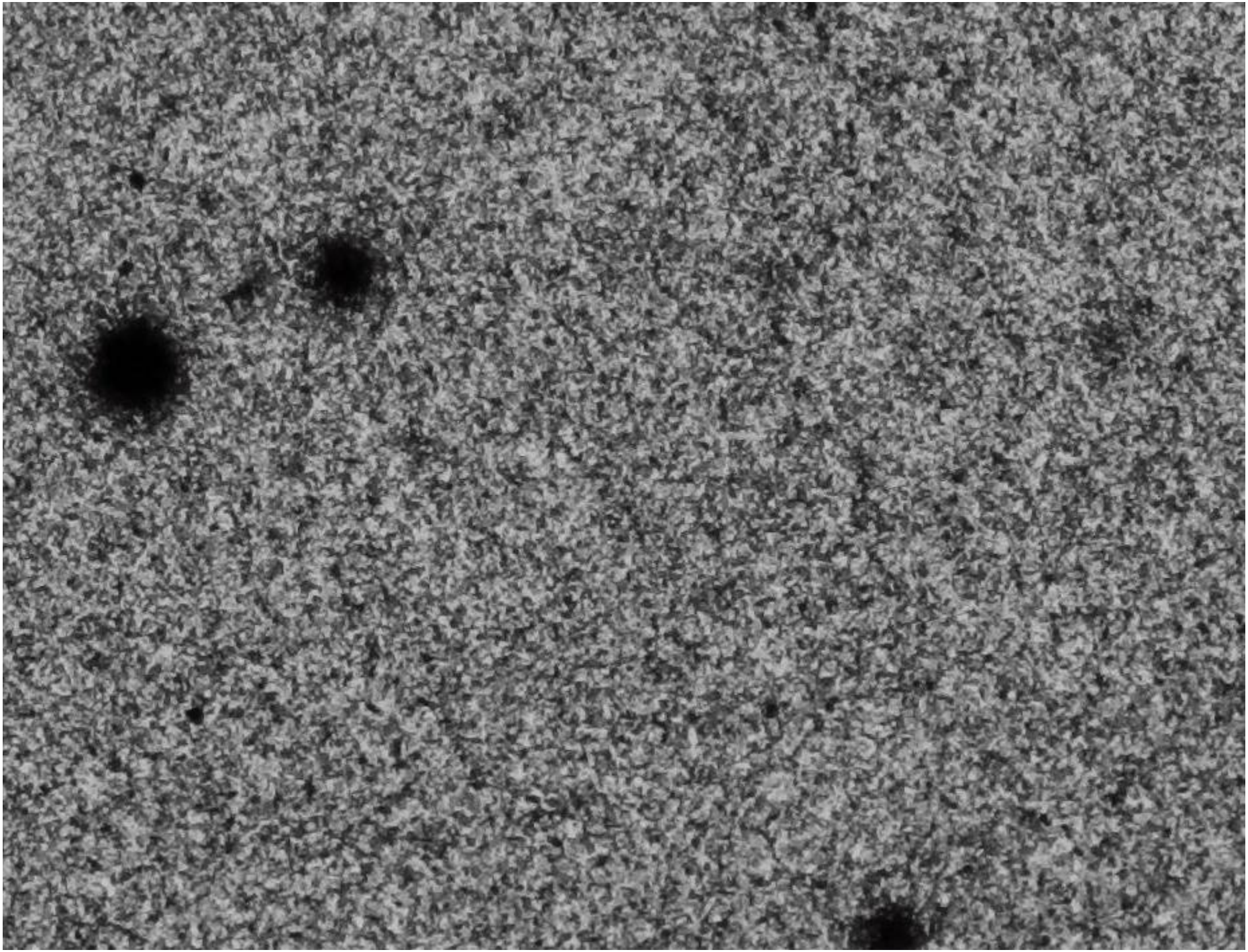
for plates of good quality the error 0.5 micron

for plates of bad quality the error 2.0 micron

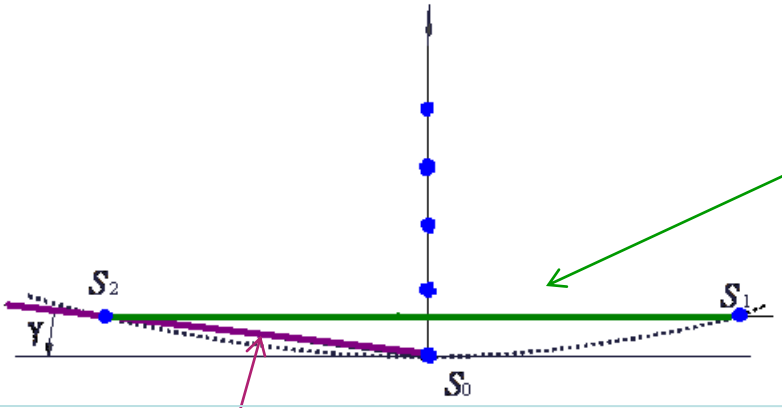
Scanner


The





DETERMINATION OF ORIENTATION



1) SYMMETRIC TRAIL S_1S_2

$$\gamma = 0$$

2) ASYMMETRIC TRAIL

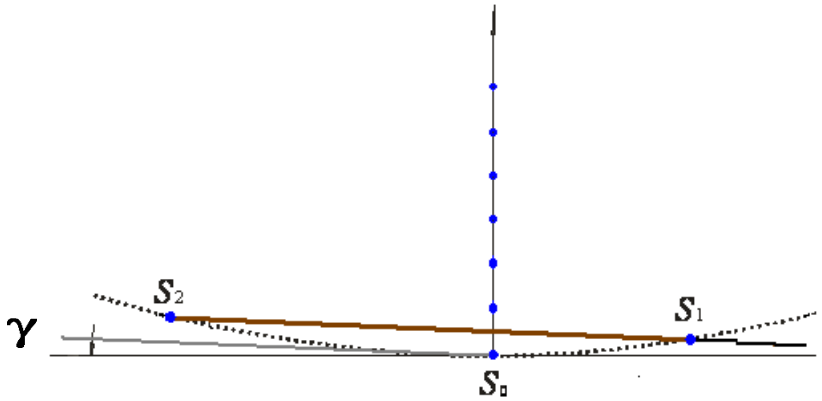
S_0S_2

introduced in Pulkovo observatory
by A. Kiselev (Kiselev 1988)
shorter time method used till 60-s

$$\gamma = \frac{l \cdot \mathrm{tg}\,\delta}{2 f_o} \qquad (1)$$

3) QUASI-SYMMETRIC TRAIL

S_1S_2

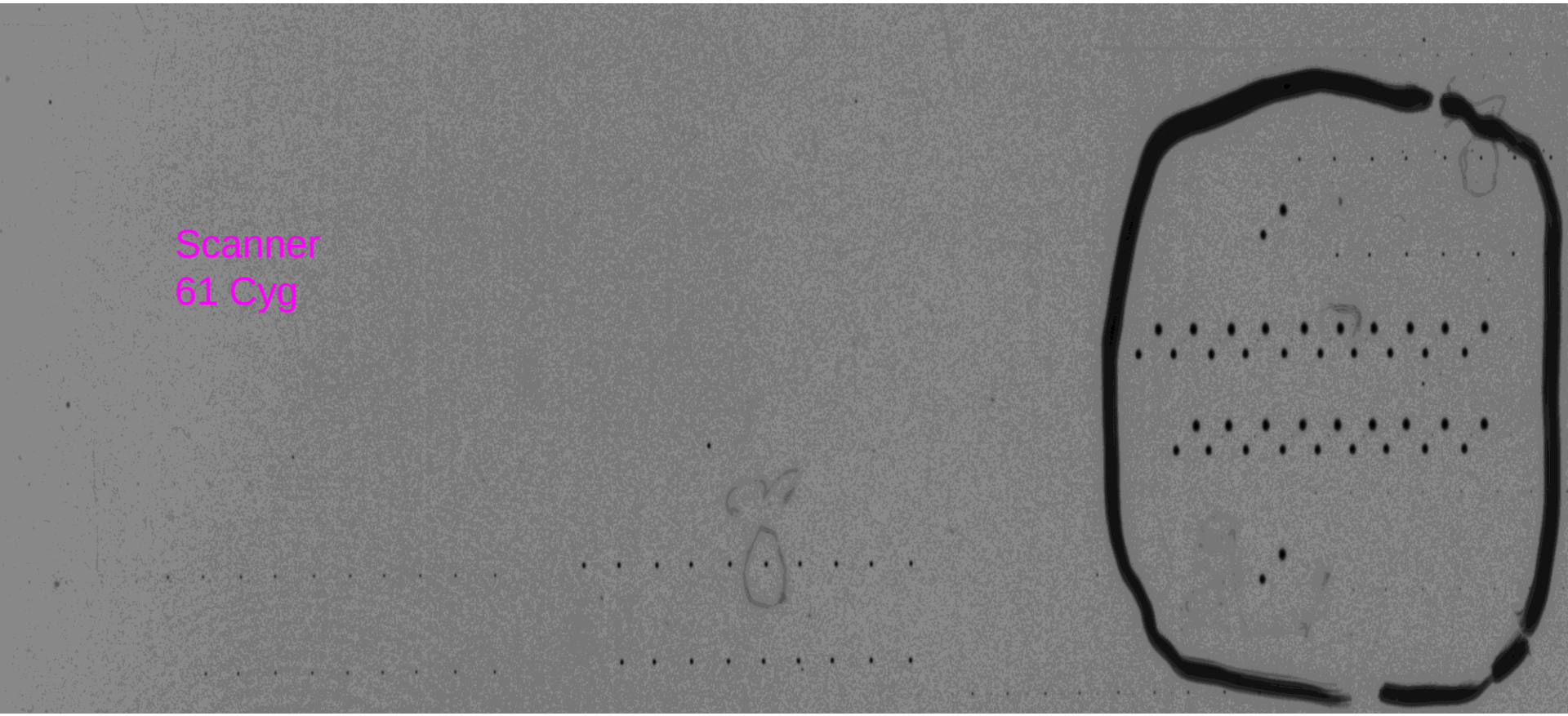


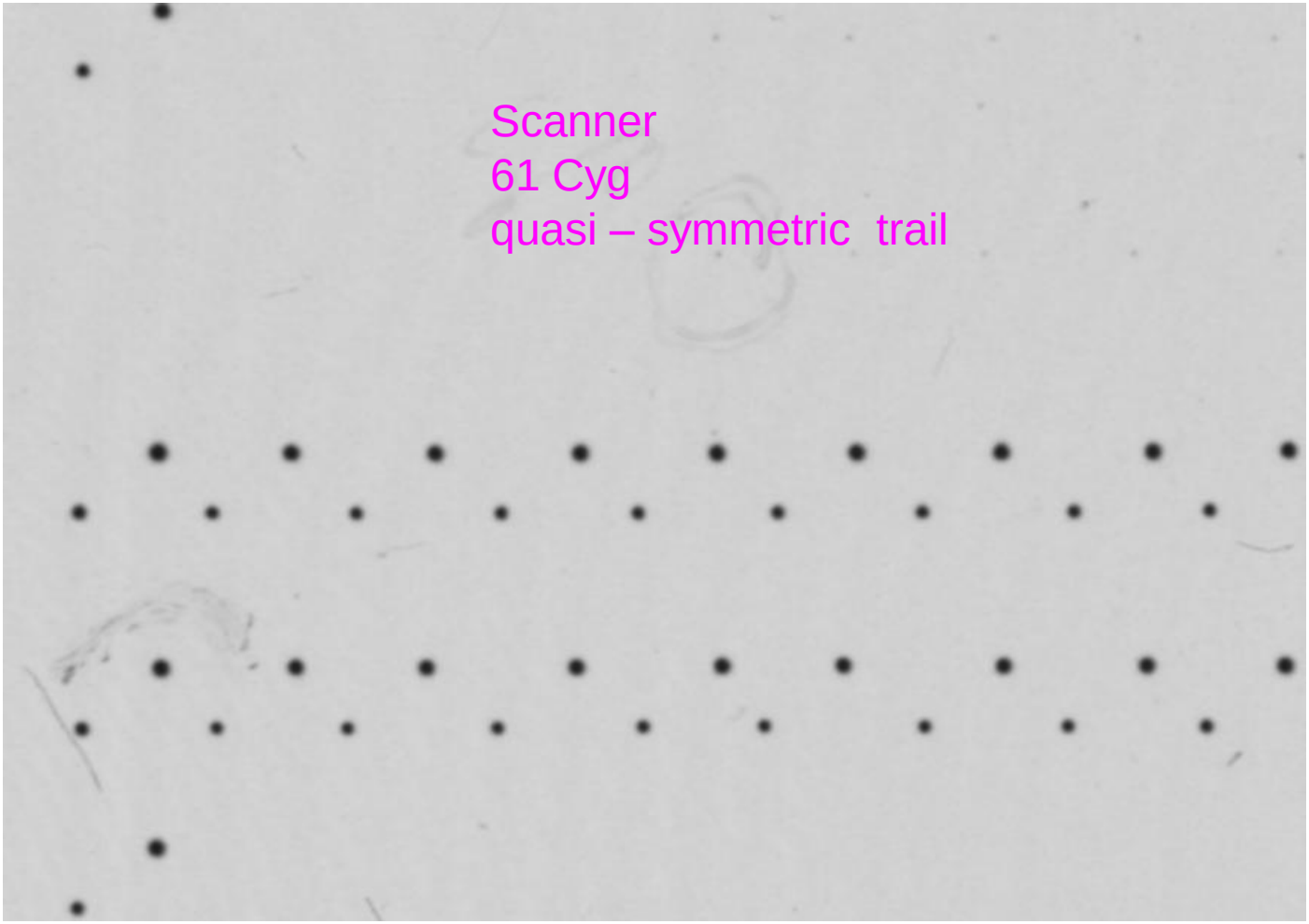
$$\gamma = \frac{l \cdot \mathrm{tg}\,\delta}{f_0}\left(\frac{x_2 + x_1}{2} - x_0\right)\frac{1}{x_2 - x_1} \qquad (2)$$

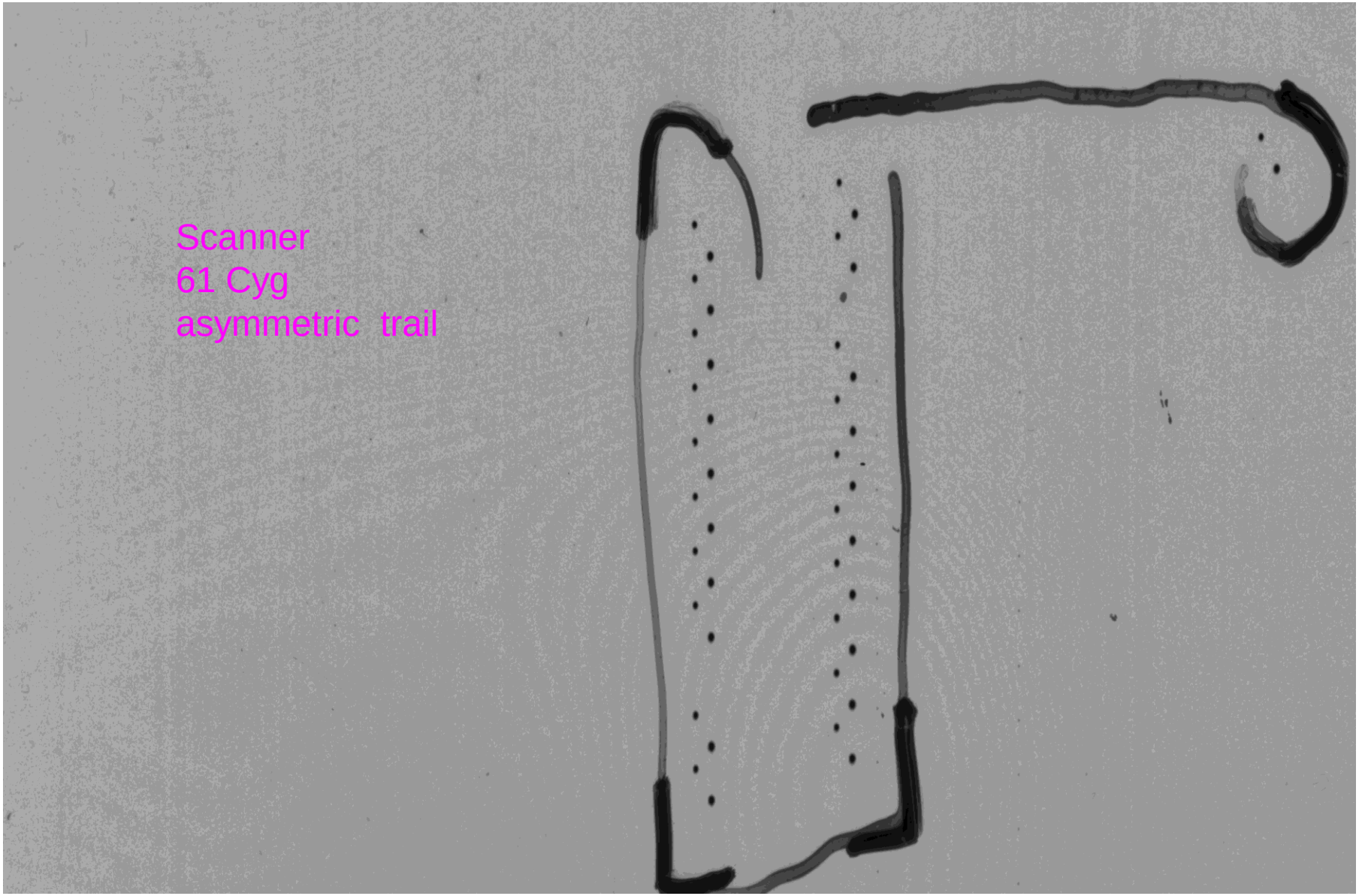
$l = S_1S_2$ the length of the trail

δ — declination of the star

f_0 — the telescope focal distance


Scanner
61 Cyg


Scanner
61 Cyg
quasi – symmetric trail


Scanner
61 Cyg
asymmetric trail

The angle gamma and refraction are taken to account at computing the relative equatorial coordinates of component B with respect to component A (Kiselev 1988)

$$\left.\begin{aligned}\xi &= M_0 x'(1+\beta(1+k_1^2)) + M_0 y'(2\beta k_1 k_2 + \gamma)\\ \eta &= M_0 y'(1+\beta(1+k_2^2)) - M_0 x'\gamma\end{aligned}\right\}$$

β - coefficient of refraction

k_1 , k_2 - tangential coordinats of zenith at the plate

M_0 - geometric scale of instrument

$$\beta = (\beta_1 + \beta_2 \mathrm{tg}^2 z)\,\frac{B}{1013}\,\frac{273^\circ}{t^\circ}$$

$\beta_1 = 60''.31$, $\beta_2 = -0''.091$ – coefficients for spectral sensitivity range of instrument

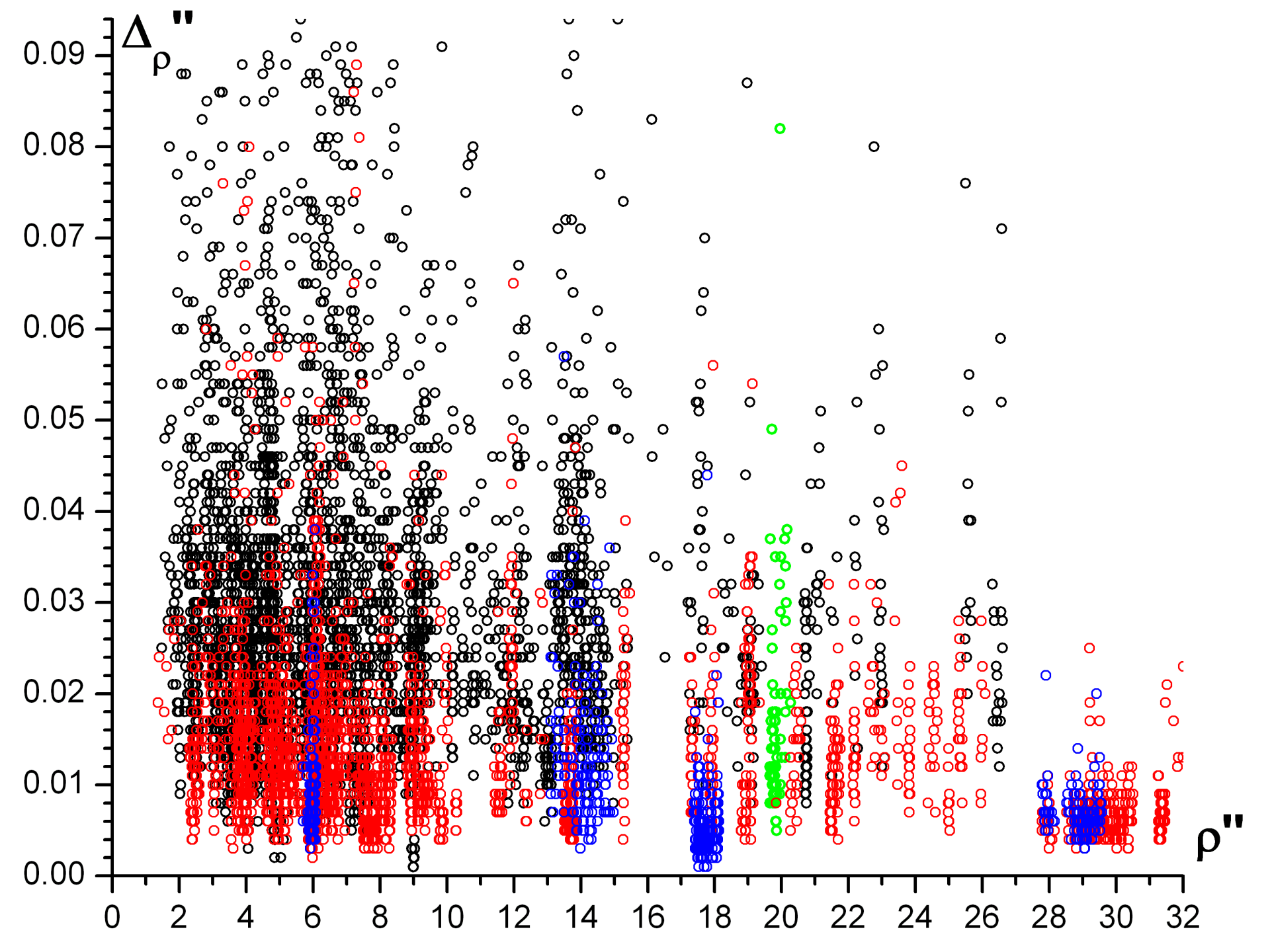
$$k_1 = \frac{1}{\mathrm{tg}\ n_2 \sin(n_1 + \delta)} \qquad k_2 = \mathrm{ctg}\,(n_1 + \delta) \qquad \mathrm{tg}\ n_1 = \mathrm{ctg}\ \varphi \cos t \qquad \mathrm{tg}\ n_2 = \frac{\sqrt{\sin^2\varphi + \cos^2\varphi \cos^2 t}}{\cos\varphi \sin t}$$

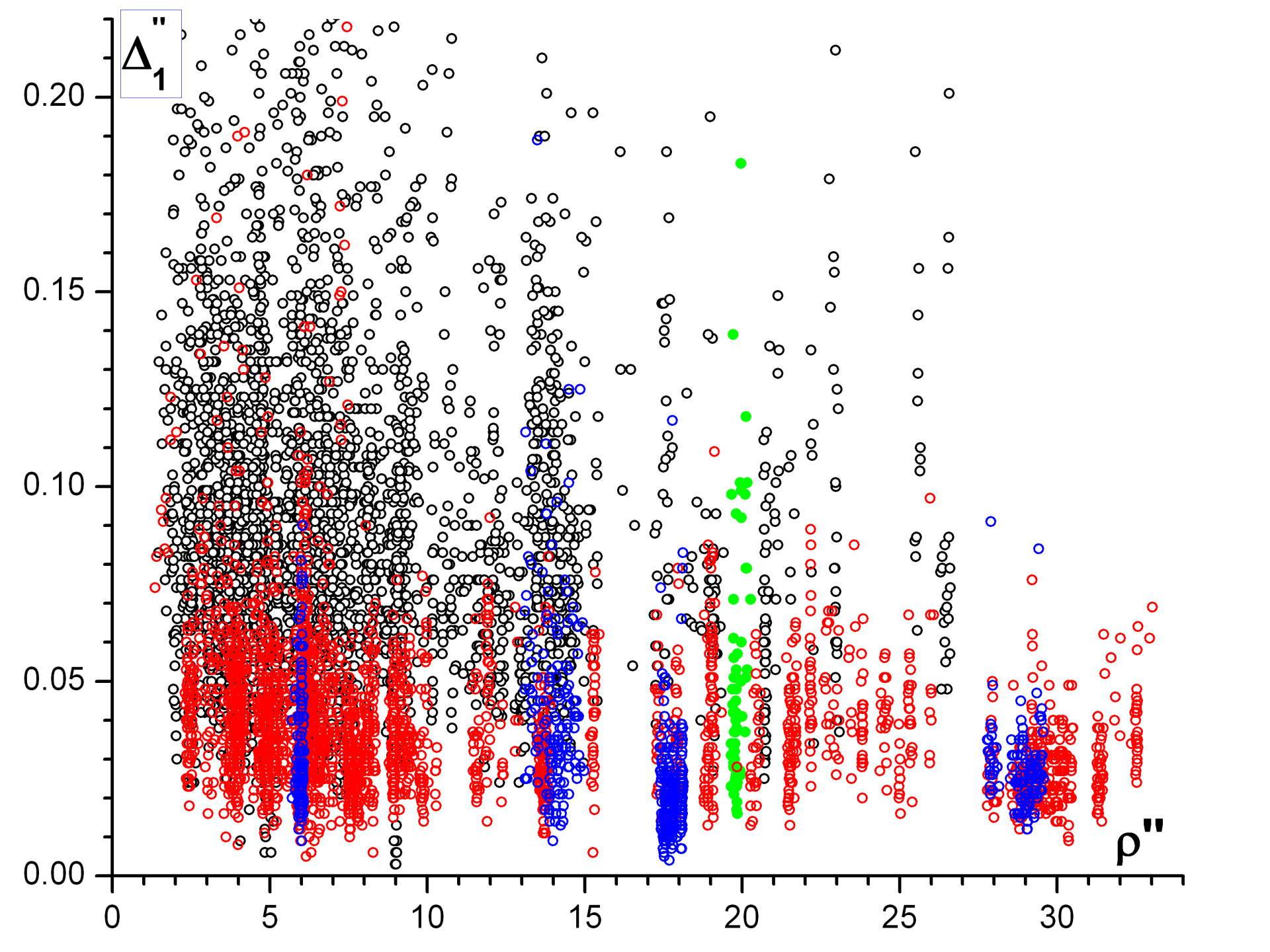
z - zenith distance of a pair

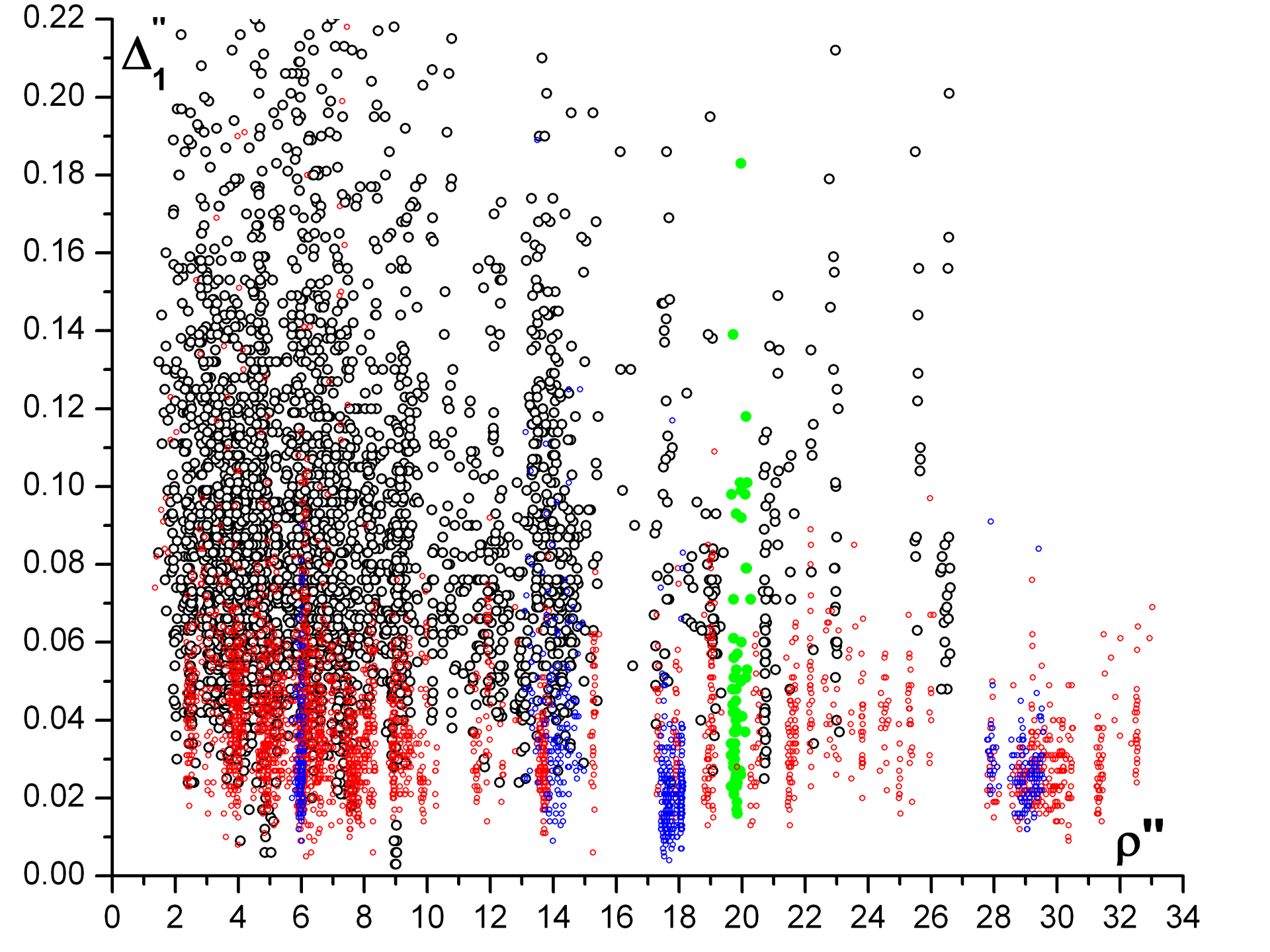
B, t^o – atmospheric pressure and the temperature during taking the plate

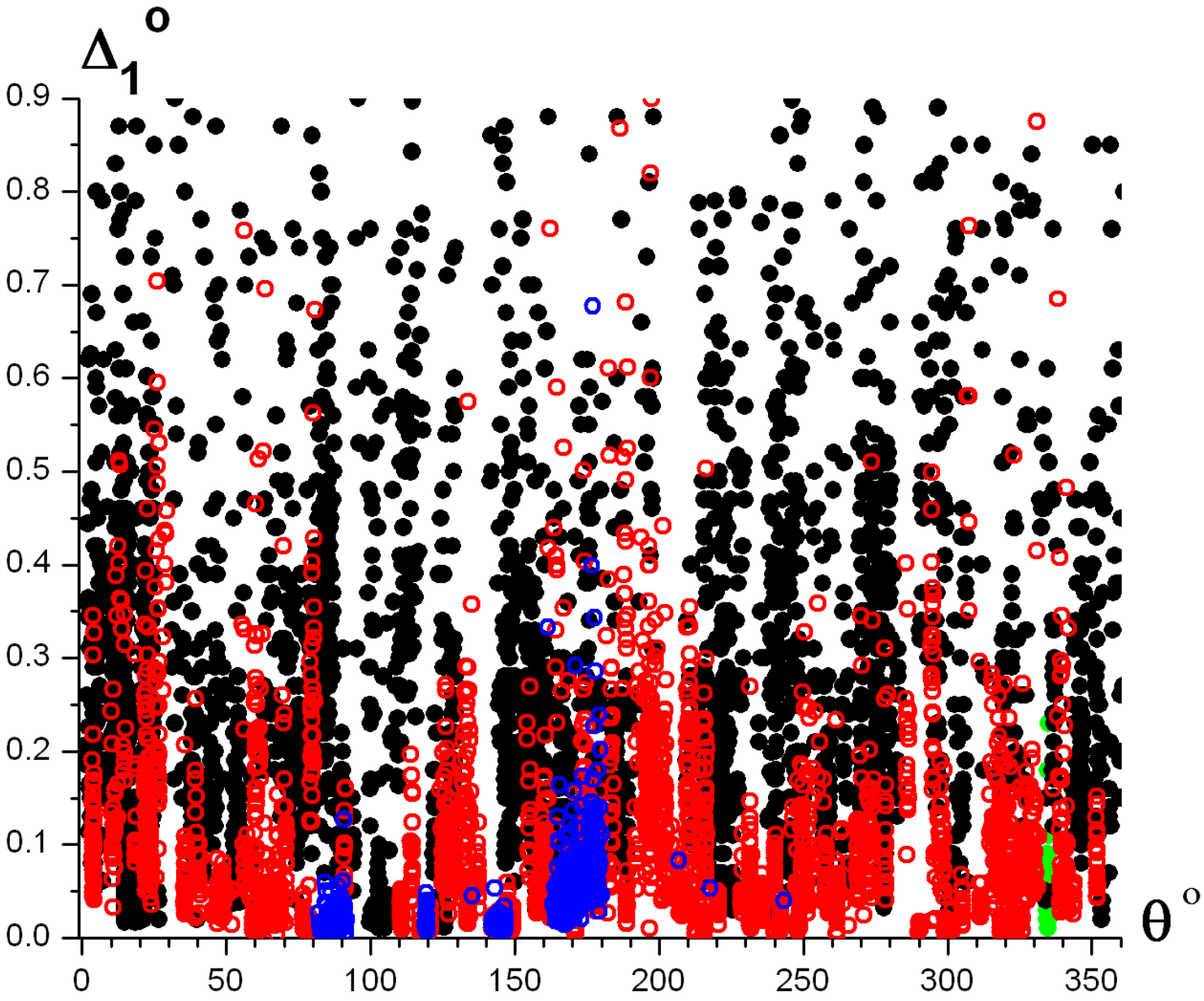
φ - hour angle of the star

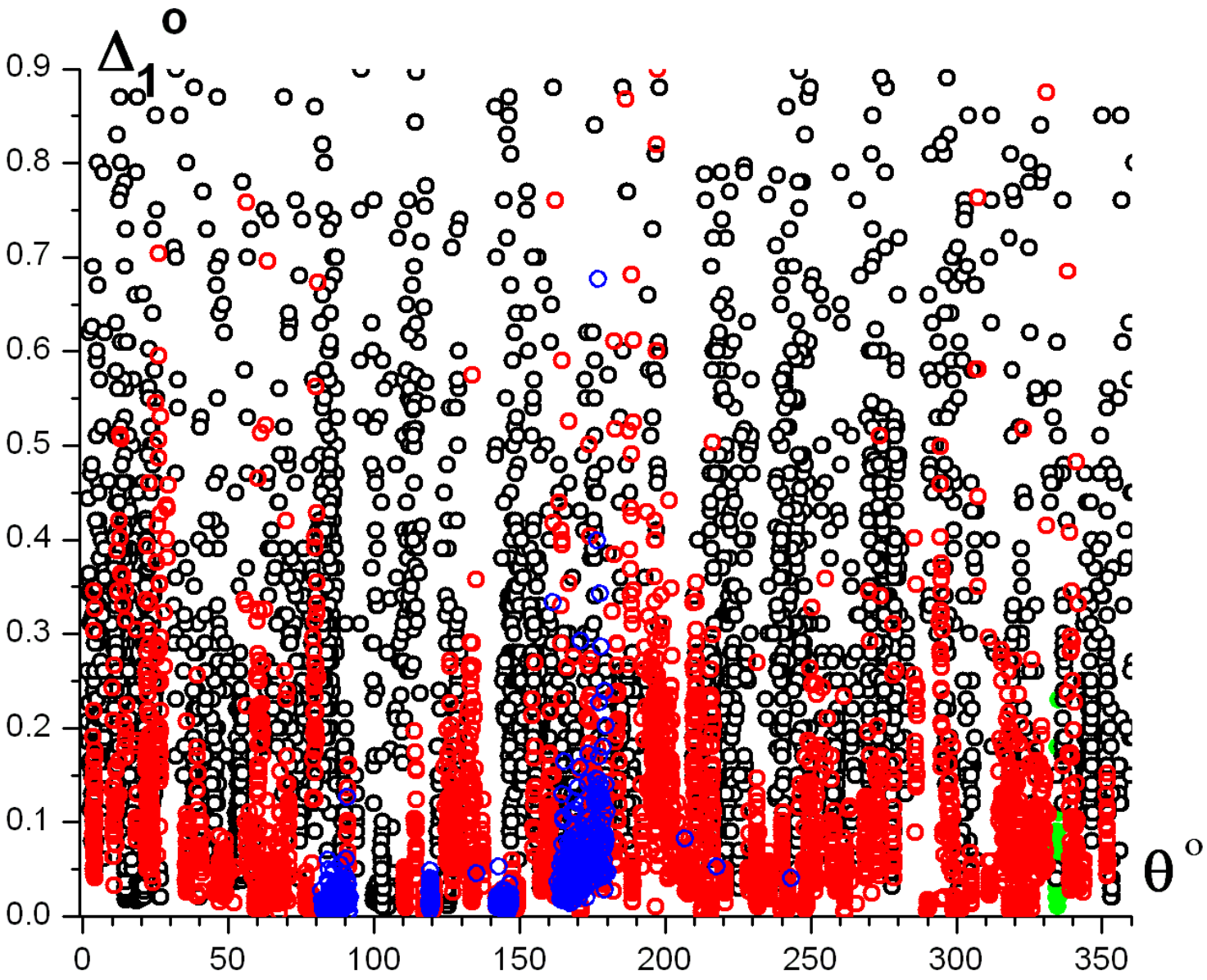
t - hour angle of the star

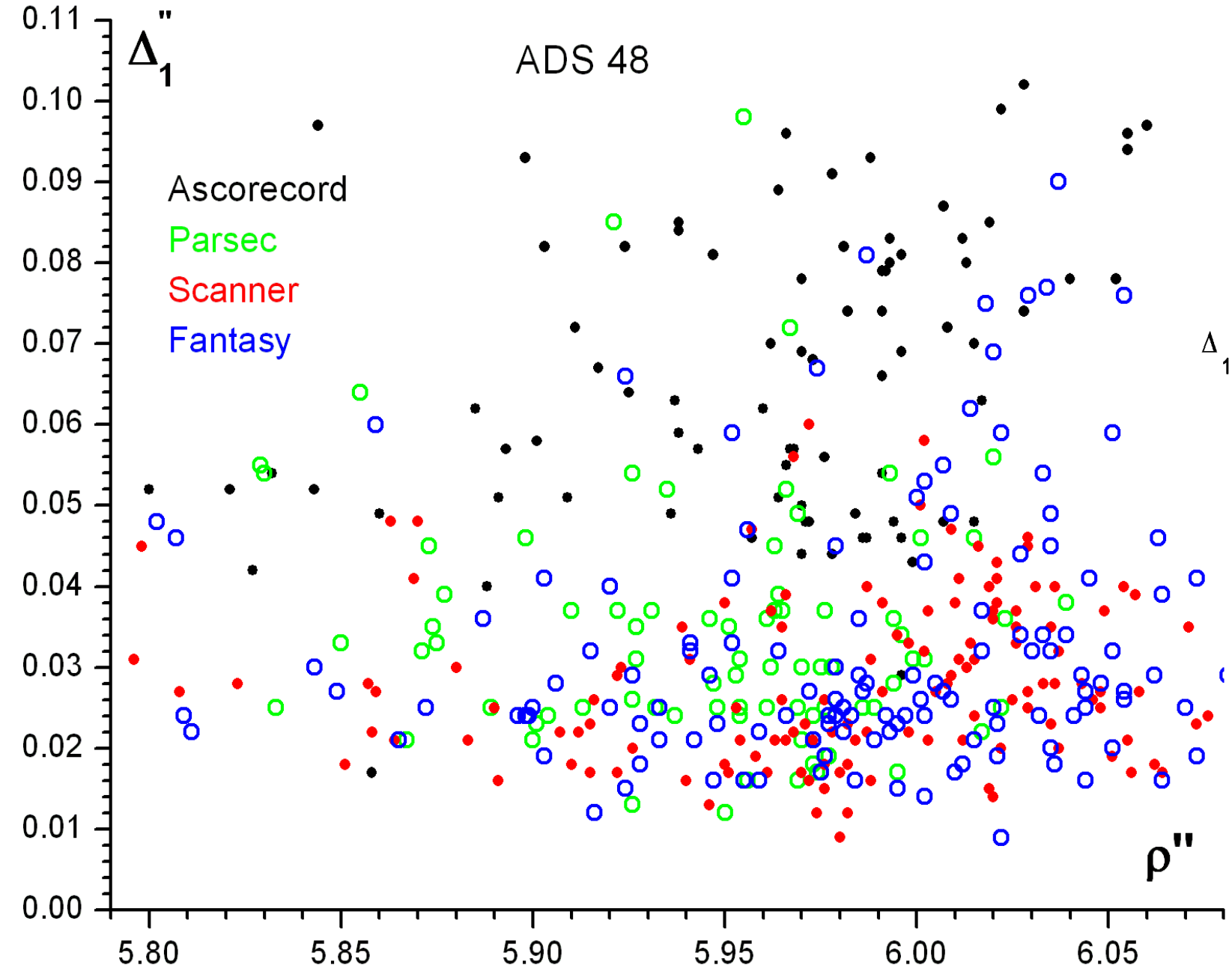

Δρ"
ρ"
0.00
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32


Δ_1''
0.20
0.15
0.10
0.05
0.00
0
5
10
15
20
25
30
ρ''


Δ1"
ρ"
0.22
0.20
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34


Δ_1^o
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0
50
100
150
200
250
300
350
θ °


Δ_1^o
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0
50
100
150
200
250
300
350
θ°



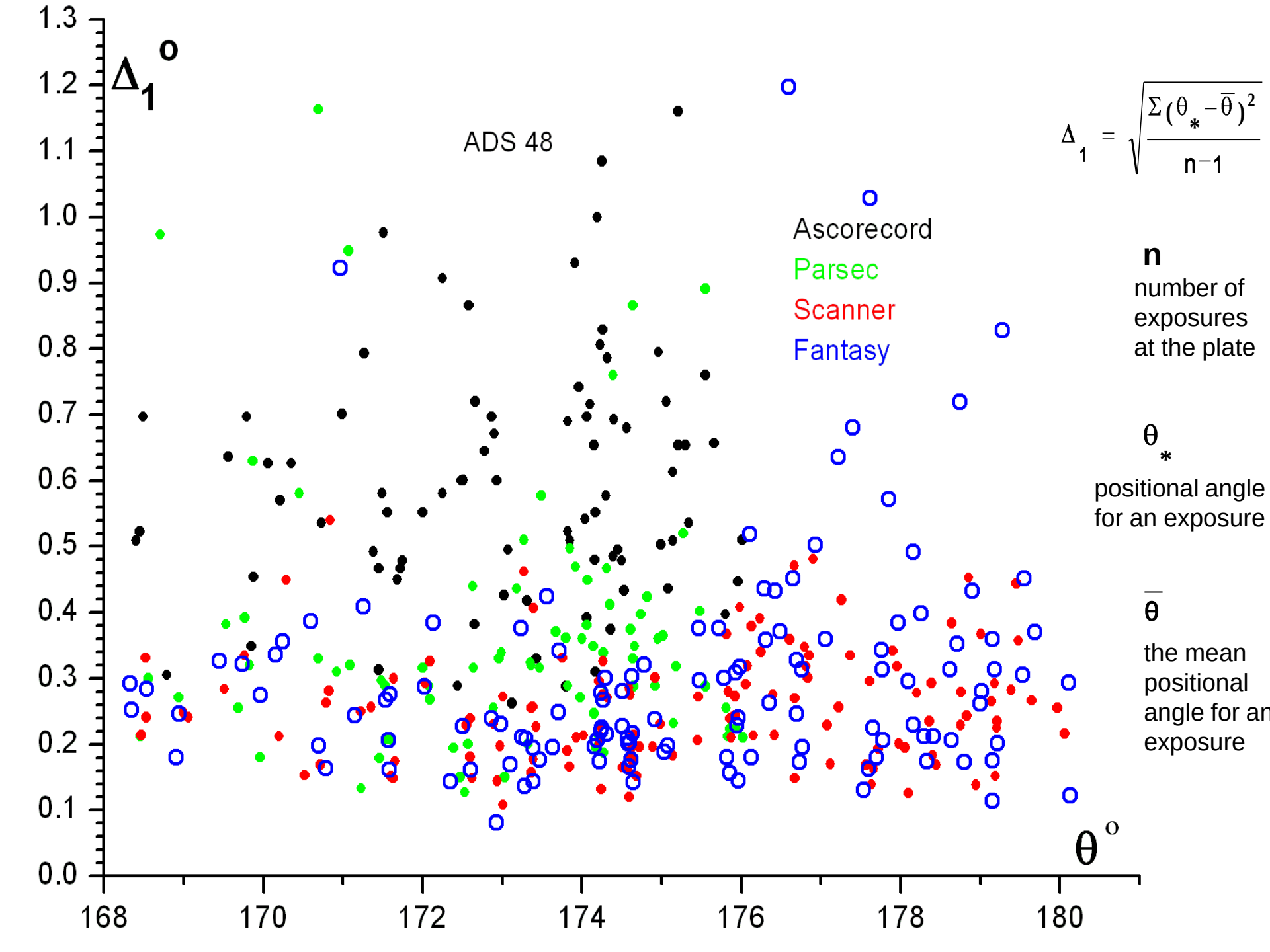
ρ (as) distance between the components of double star ADS 48 AB

$$\Delta_1 = \sqrt{\frac{\Sigma(\rho_* - \bar{\rho})^2}{n-1}}$$

n number of exposures at the plate

ρ_* distance for an exposure

$\bar{\rho}$ the mean distance for an exposure



$$\Delta_1 = \sqrt{\frac{\Sigma(\theta_* - \bar{\theta})^2}{n-1}}$$

n
number of exposures at the plate

θ_*
positional angle for an exposure

$\bar{\theta}$
the mean positional angle for an exposure

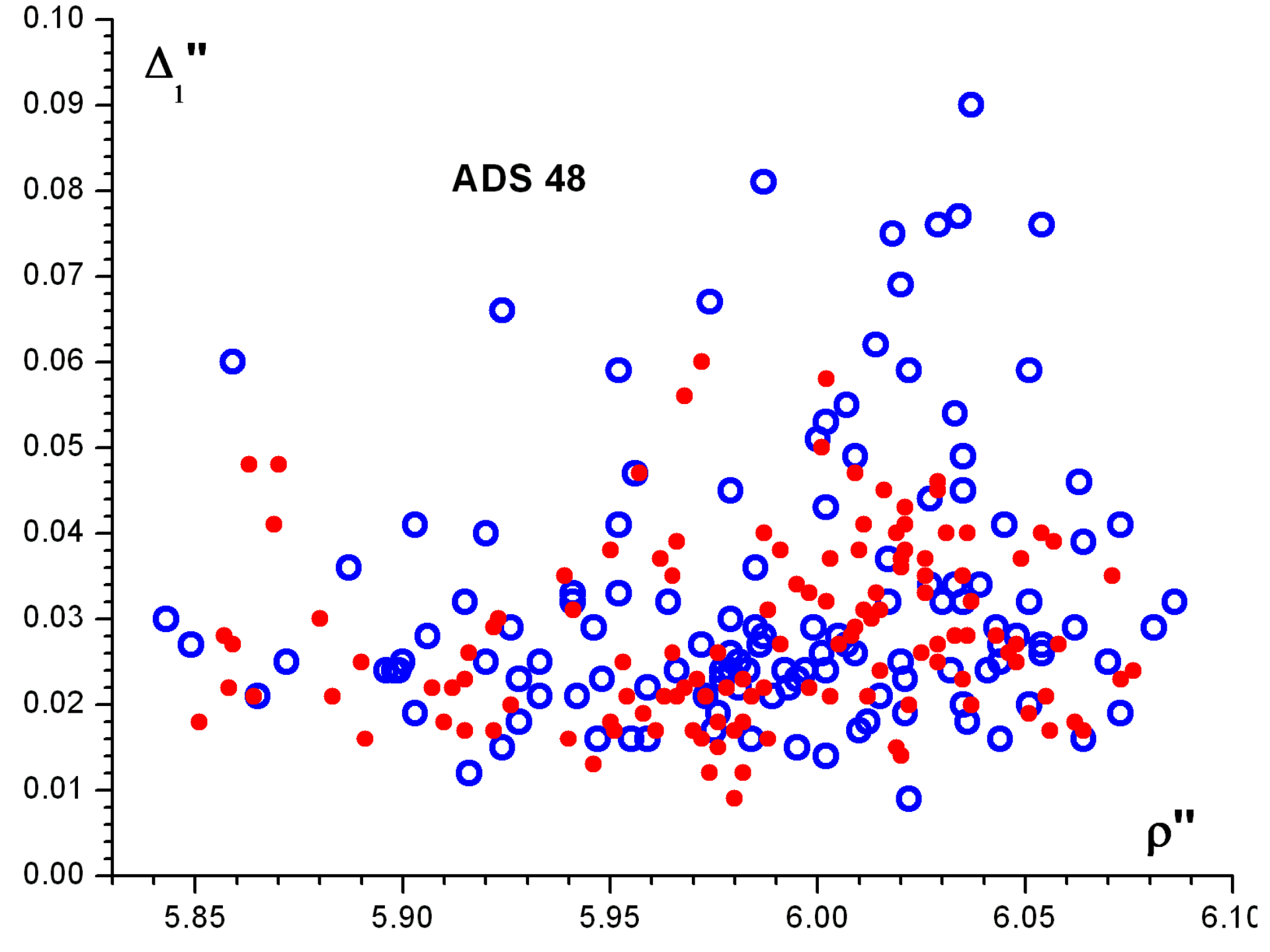
Table I Ascorecord - Scanner

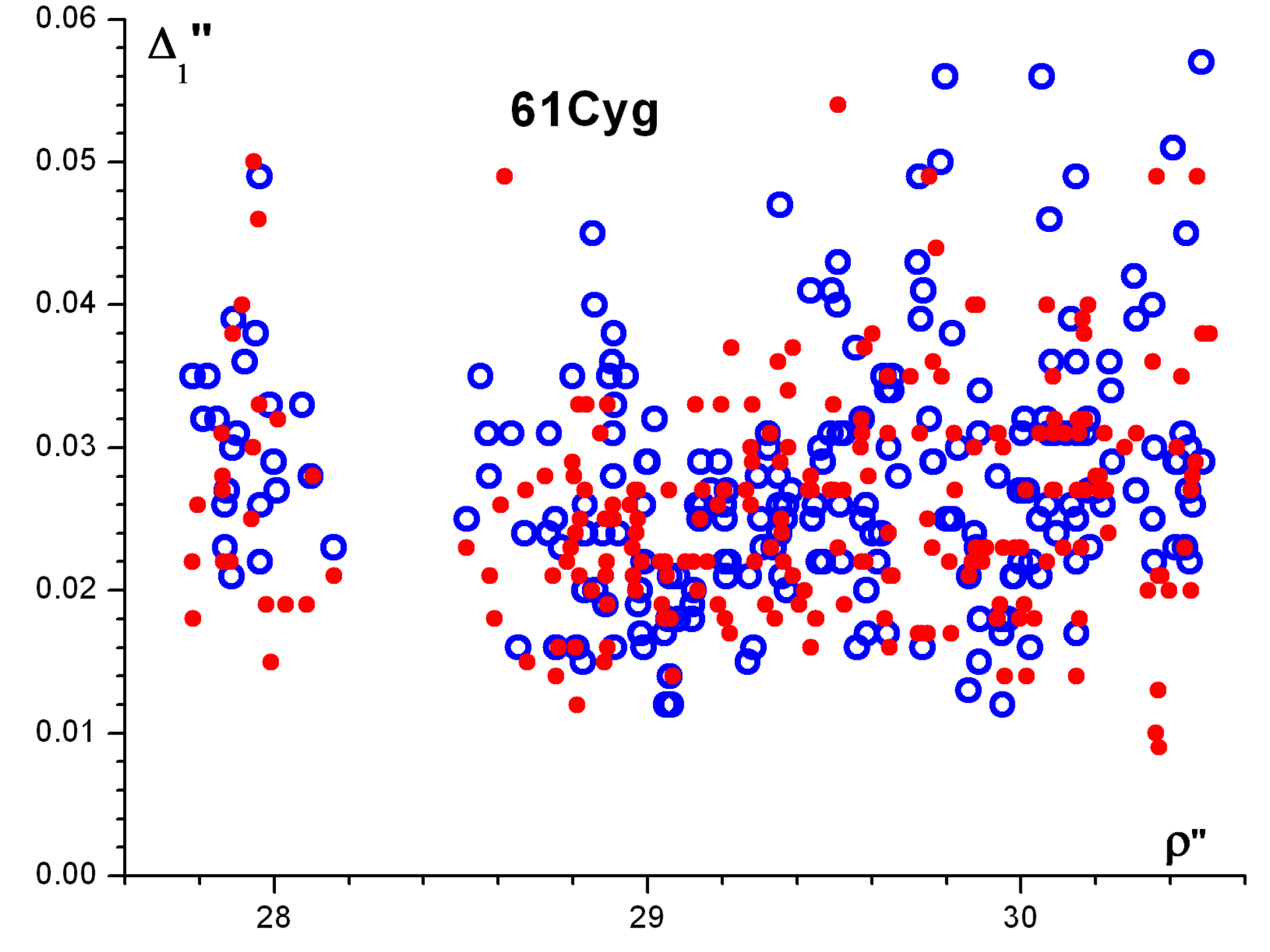
ADS	2757	8236	10759	12815
$(\alpha,\delta)_{2000.0}$	$03^h\ 47.0^m$ +41° 26'	$11^h\ 36.6^m$ +56° 08'	$17^h\ 41.9^m$ +72° 09'	$19^h\ 41.8^m$ +50° 32'
mA mB	8.2 8.8	7.3 7.8	4.0 5.2	5.1 5.3
ρ_{SCA}	7.399" ±.041	6.066" ±.016	30.122" ±.008	39.333" ±.029
$\Delta\rho_{(ASC-SCA)}$	+0.019" ±.009"	+0.034" ±.008"	-0.036" ±.007"	+0.012" ±.005"
θ_{SCA}	53.651° ±.170	166.705° ±.110	15.549° ±.037	133.501° ±.023
$\Delta\theta_{(ASC-SCA)}$	+0.074° ±.055	+0.033° ±.056	-0.035° ±.024	-0.029° ±.008
$\Delta\tau_{(ASC-SCA)}$	+0.010" ±.007"	+0.004" ±.006"	-0.009" ±.007"	-0.020" ±.005"
n0	17	11	26	34

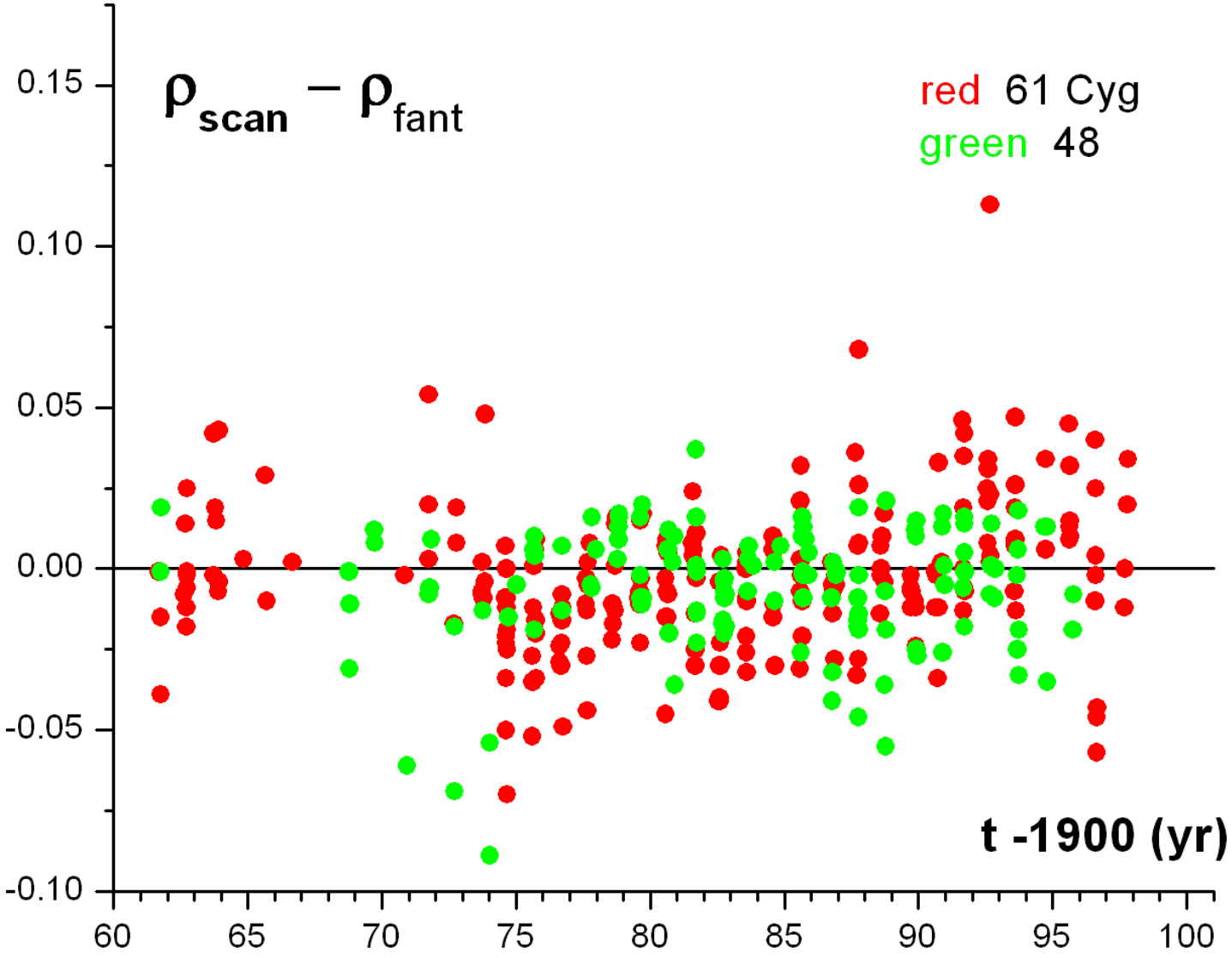
n_0 – number of the same plates measured with both Ascorecord and Scanner

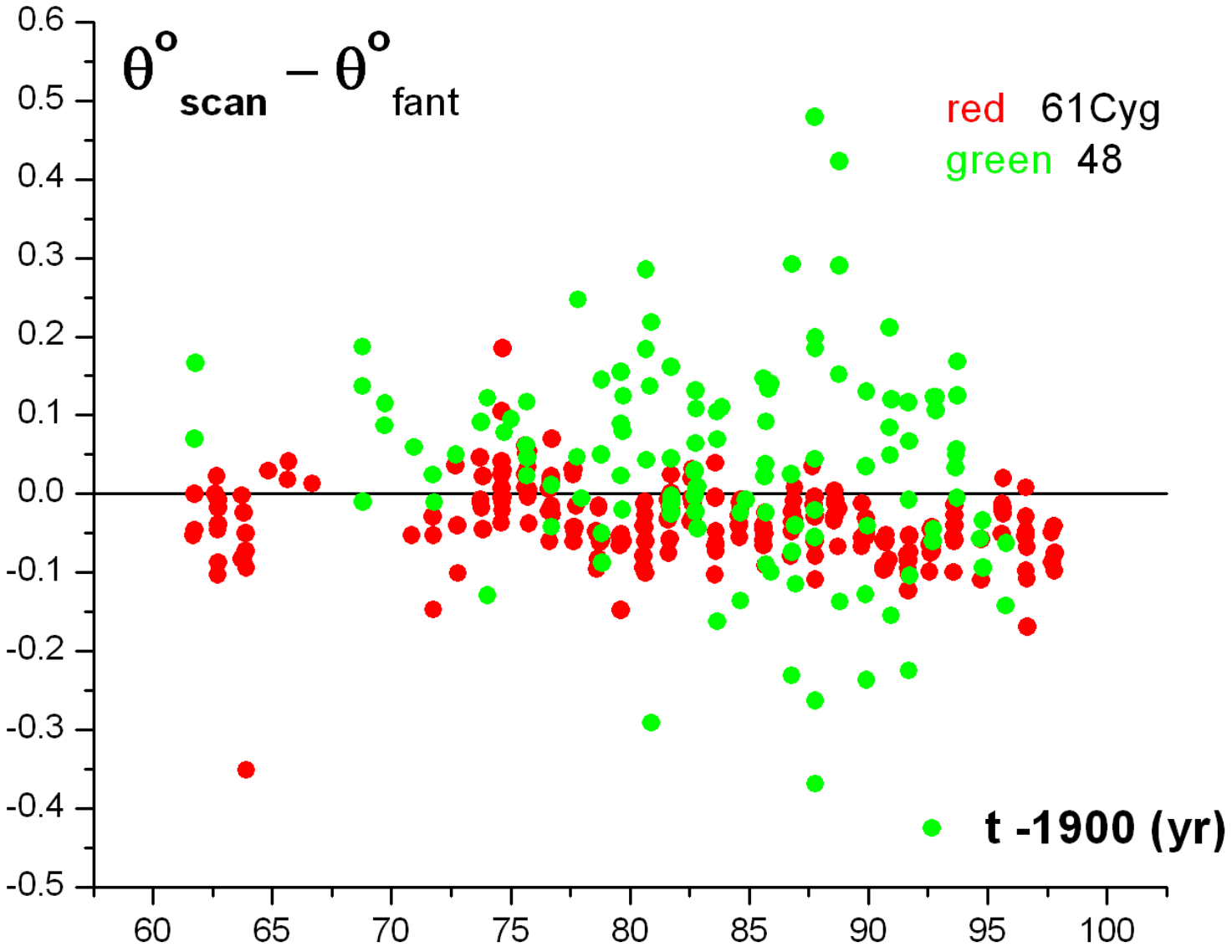
$\Delta\tau=\rho\Delta\theta(\pi/180)$

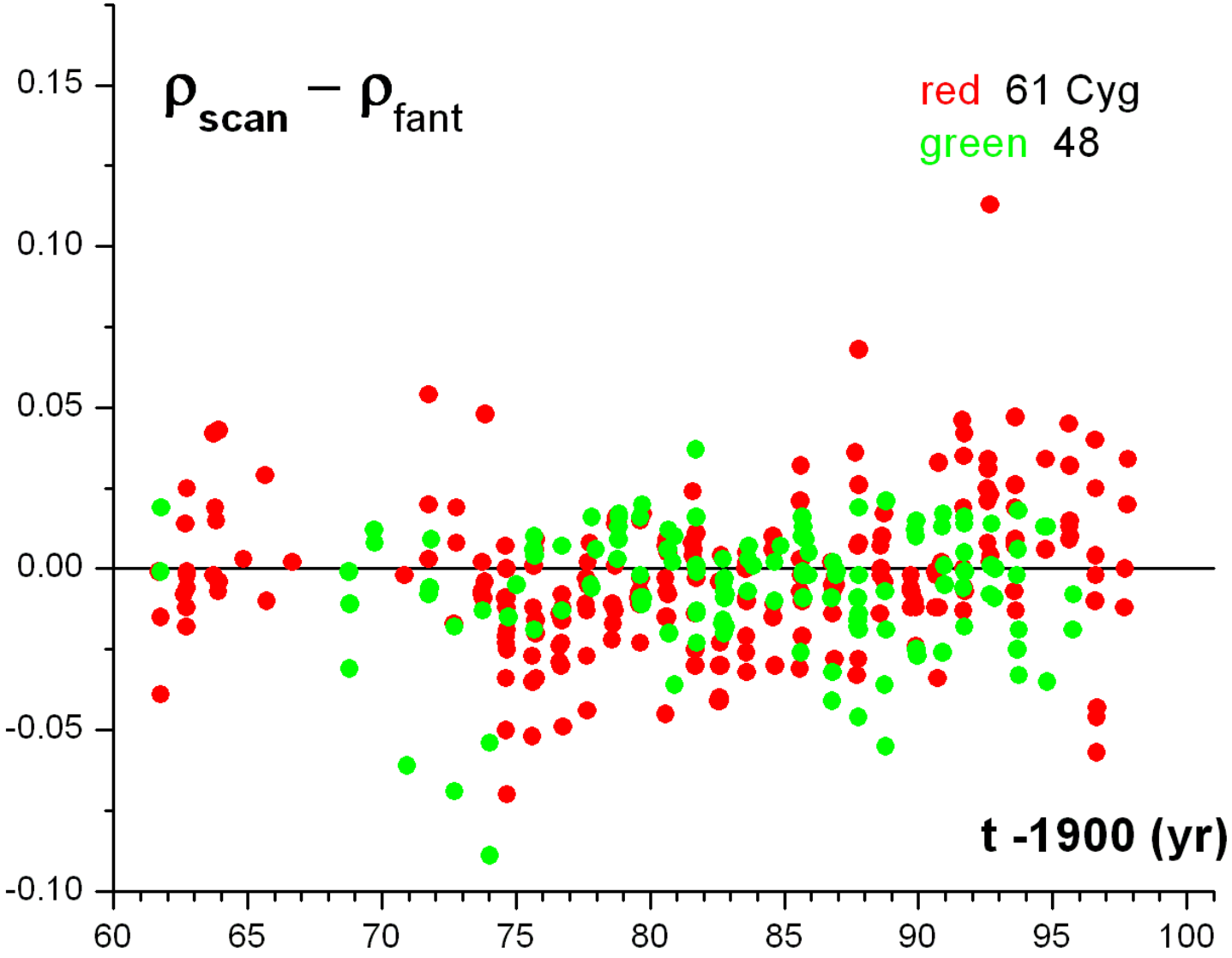
ADS	48	14636
$(\alpha, \delta)_{2000}$	$00^{h}05^{m}.7$ $45^{h}49^{m}$	$21^{h}06^{m}.9$ $38^{h}45^{m}$
m_A, m_B	8.93 8.97	5.20 6.05
$\overline{\rho}$	5.974 ± 0.072	29.391 ± 0.706
$\rho_{sca} - \rho_{fan}$	- 0.006 ± 0.019	- 0.002 ± 0.023
$\theta_{sca} - \theta_{fan}$	- 0.074 ± 0.555	- 0.037 ± 0.049
$\tau_{sca} - \tau_{fan}$	- 0.008 ± 0.058	- 0.019 ± 0.025
n	128	230


ADS 48
Δ1"
ρ"
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
5.85
5.90
5.95
6.00
6.05
6.10


Δ1"
61Cyg
ρ"
0.06
0.05
0.04
0.03
0.02
0.01
0.00
28
29
30


ρscan − ρfant
red 61 Cyg
green 48
0.15
0.10
0.05
0.00
-0.05
-0.10
60
65
70
75
80
85
90
95
100
t -1900 (yr)


θ° scan – θ° fant
red 61Cyg
green 48
t -1900 (yr)
0.6
0.5
0.4
0.3
0.2
0.1
0.0
-0.1
-0.2
-0.3
-0.4
-0.5
60
65
70
75
80
85
90
95
100


ρscan − ρfant
red 61 Cyg
green 48
0.15
0.10
0.05
0.00
-0.05
-0.10
60
65
70
75
80
85
90
95
100
t -1900 (yr)

1) From investigations by Polyakov :
The stars located on a plate due to the atmospheric turbulance with deviations 1.5 -- 3.5 micron from the computed ones which are comparable with the size of the emulsion grain

2) If somebody is going to measure a log, he doesn’t need micrometer

THE LONG-TIME HOMOGENEOUS SERIES MEASURED WITH THE SAME MACHINE ARE IMPORTANT

THE POSSIBLE LEVEL OF ACCURACY IS RESTRICTED TO THE ACCURACY OF IMAGES LOCATION AT A PLATE