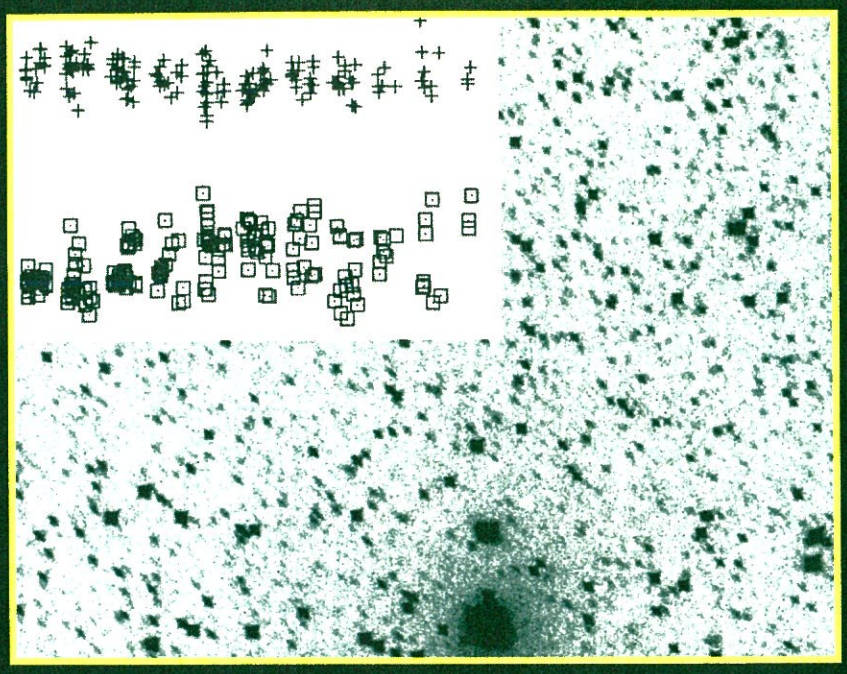
Treasure-Hunting in Astronomical Plate Archives

Proceedings of the International Workshop held at Sonneberg Observatory, March 4 to 6, 1999

Edited by Peter Kroll,
Constanze la Dous, Hans-Jürgen Bräuer



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edited by
Wolfgang R. Dick and Jürgen Hamel

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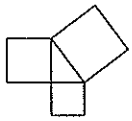

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The cover picture shows a digitized field of a Sonneberg sky patrol plate, which was investigated by N. Vogt and P. Kroll in order to find stars that are variable on a long-term scale. The light-curvers of several constant and variable objects are inset.

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USNO CCD Astrograph Catalog – South

Theodore Rafferty, Norbert Zacharias,
Washington, D.C.

1. Project Summary

In January 1998, the US Naval Observatory started an astrometric survey at Cerro Tololo, Chile. The survey will be used to produce the USNO CCD Astrograph Catalog – South (UCAC–S). The telescope, originally designed for photography, uses a 4k CCD camera which gives a one degree field at 0.9″/pixel scale.

entrance pupil diameter	206 mm
focal length	2057 mm
plate scale	100 ″/mm
spectral bandpass	550–710 nm
useable flat field of view	≈ 9.0 degrees
CCD	Kodak KAF16800
number of pixels	4096×4096
pixel size	9.0 μm
pixel scale	0.905 ″/pixel
spectral bandpass	579–642 nm
field of view	61×61 arcmin

The combination of the one square degree field and small aperture works well to provide good coverage of the reference star density and brightness from the Hipparcos/Tycho/ACT catalogs. Longer exposures (200 seconds) of areas around quasars will be used with data taken with the CTIO 0.9–m reflector to link the UCAC positions to the ICRF.

preliminary reductions	Tycho(ACT)
global adjustment	Hipparcos
2-fold overlap	each star on two fields

observing rate	200 frames (100 fields) per night
rejection rate	10% frames per night
$-90°$ to $+25°$ decl.	60359 fields
Cerro Tololo, Chile	250 nights per year
program length	3.0 years
25 seconds exp	8.0–14.5 mag
125 seconds exp	10.0–16.0 mag
8 mag	positional error 25 mas
9–14 mag	positional error 20 mas
15 mag	positional error 40 mas
16 mag	positional error 70 mas

Currently, as of February 21, 1999, 20931 survey fields have been taken, with the coverage completed to nearly -35 degrees declination. Plans are to release a preliminary catalog of the first year's results sometime in 1999.

2. Proper Motion Errors

For the catalog positions to be useable much beyond the epochs of observations, proper motions are required. To determine the proper motions for the UCAC stars at least a second set of positions taken at a different epoch is needed. The errors of the proper motions vary as a function of the positional errors as well as the difference in their epochs:

$$\epsilon_\mu = \frac{\sqrt{\epsilon_1^2 + \epsilon_2^2}}{\mid t_1 - t_2 \mid}$$

where: ϵ_μ – proper motion error, ϵ_1 – positional error at epoch 1, ϵ_2 – positional error at epoch 2, t_1 – epoch 1, and t_2 – epoch 2.

Though in an old catalog the positional errors may be high, the large epoch differences can reduce their effect on the errors for the determination of good proper motions. Table 1 shows the positional accuracy and epoch difference required to attain proper motions of 2 mas/year versus 8 mas/year for the UCAC.

Positional errors at other epochs can be computed by:

$$\epsilon pos = \sqrt{\epsilon_o^2 + (\epsilon_\mu \times \mid t_o - t_{pos} \mid)^2}$$

where: ϵ_{pos} – new positional error, ϵ_o – original positional error, ϵ_μ – proper motion error, t_o – epoch of original position, and t_{pos} – epoch of new position.

Table 1

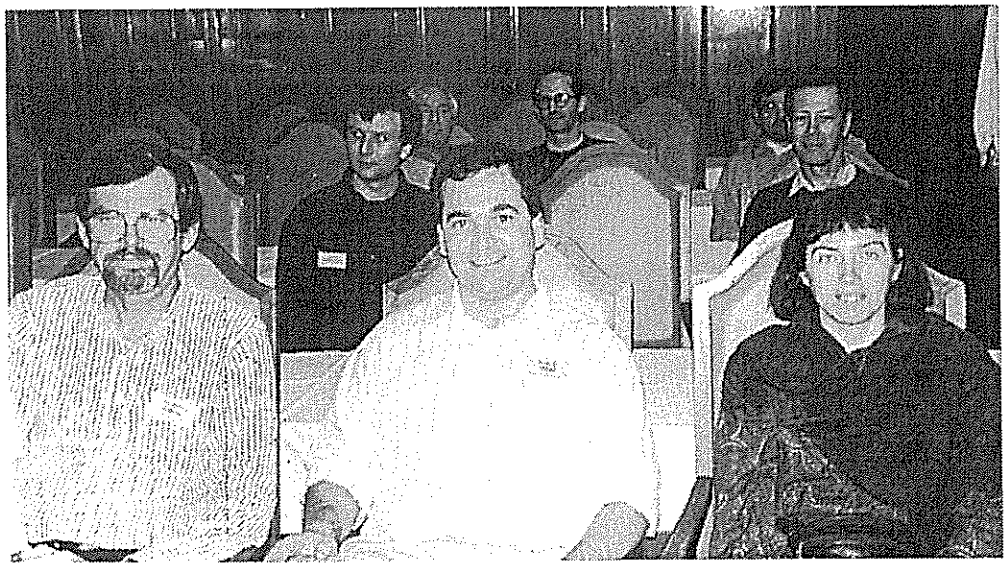
Assuming $\epsilon_2 = 20$ mas for UCAC		
	for $\epsilon_\mu = 2$ mas/yr	for $\epsilon_\mu = 8$ mas/yr
$\lvert t_1 - t_2 \rvert$	ϵ_1	ϵ_1
5 yrs	-	35 mas
10 yrs	0 mas	80 mas
15 yrs	20 mas	120 mas
20 yrs	35 mas	160 mas
30 yrs	60 mas	250 mas
40 yrs	80 mas	320 mas
50 yrs	100 mas	400 mas
75 yrs	150 mas	600 mas
100 yrs	200 mas	800 mas

With the passage of time, the positional errors of the original catalog can be degraded rapidly by poor proper motions. For example, ten years after the epoch of the UCAC, a 2 mas/year proper motion error would increase the error of a UCAC position from 20 mas to 28 mas. Whereas an 8 mas/year error in the proper motion would increase the error in position to 82 mas after ten years. So what are "good" proper motion errors? HIPPARCOS has proper motions of 1 mas/year, ACT of 2.5 mas/year, and ACRS/PPM of 4.5 mas/year. If our goal is to prevent a significant degradation of the UCAS positions ten years from its epoch, proper motions with errors between 2 mas/year to 4 mas/year are necessary. Proper motions for the fainter stars in the UCAC will be impacted by the lack of good positions from another epoch. Table 2 shows various other catalogs, their range of magnitude coverage, positional accuracies, and the errors of the proper motions if used with the UCAC.

Table 2

Assuming $\epsilon_2 = 20$ mas for UCAC				
catalog	magnitudes	$\lvert t_1 - t_2 \rvert$	ϵ_1	ϵ_μ
Tycho I	8 – 11	10 yrs	30 mas	4 mas/yr
POSS II	12 – 21	10 yrs	200 mas	20 mas/yr
POSS I	12 – 21	45 yrs	250 mas	6 mas/yr
AC	8 – 12	90 yrs	200 mas	2 mas/yr
UCAC II(?)	8 – 16	14 yrs	20 mas	2 mas/yr

The sky surveys using Schmidt telescopes for the southern hemisphere (SRC, SERC, PPARC, EOS, and AAO) cover the faint stars included in the UCAC, but their poor positions and small epoch differences from the UCAC will result in poor proper motions. Improved results from the Schmidt plates would help. The Yale plates will likely offer some improvement for the south, but the epoch differences with the UCAC vary greatly depending on the area of the sky. Though a second epoch UCAC is not currently planned, such a project using the same equipment would have to be done 14 years after the current project to achieve 2 mas/year errors in the proper motions. The recently released ACT is a good example of how the 90 year old AC plates could still have a significant impact on modern astronomy. Old photographic plates of open clusters or other special interest areas of the sky likely exist that, IF MEASURED ACCURATELY, could be used with positions from the UCAC to produce excellent proper motions.



Listening to the Mayor explaining Sonneberg's history.

Peter Kroll et al. (eds.
Astronomical Plate Ar

Proper moti observations

Michel Rapap
Michael Oden
Christine Duc

1. Meridien 200

The Meridien 200 in 1997. Its aim is the CCD meridian will be combined to derive accurat with a positional around 2 mas/yea

2. The open clus

NGC 2355 is a spa It is located in th from the Sun and has not yet been i precise stellar pro clarify the questio magnitude diagra and to determine

Measurements c deaux Astrograph of two glass-copie scanners at Müns were reduced to th ACT catalogue. 1955 were matche