UCAC4 status

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Abstract: The 4th and final release of the USNO CCD Astrograph Catalog (UCAC4) is upcoming. Shortcomings with the previous UCAC3 release have been resolved and the inclusion of positions from the Northern Proper Motion (NPM) plate material provides accurate proper motions for UCAC stars all-sky without the use of any Schmidt data. Corrections for systematic positional errors have been updated again and the UCAC4 system is now close to that of UCAC2. External comparisons of UCAC4 data are presented as well as radio-optical position differences of a sample of ICRF extragalactic sources. UCAC4 will be the basis for the input catalog of the funded JMAPS space mission. The public release of UCAC4 will also be supplemented by all bright stars not observed by the UCAC astrograph using Hipparcos and Tycho-2 data to provide a complete, all-sky catalog to about R=16 mag. Photometry from 2MASS and APASS will be included in the UCAC4 release.

Project:

The USNO CCD Astrograph Catalog (UCAC) project is an astrometric survey of the entire sky with the following features:

telescope	USNO astrograph		
	aperture	206	mm
	focal length	2060	mm
	bandpass	579–642	nm
camera	single CCD	4k x 4k	pixels
	scale	0.905	arcsec/pixel
	field of view	1.029	degree

Timeline:

Observing was completed in 2004 and 3 catalogs were produced so far, with the final release coming up this year.

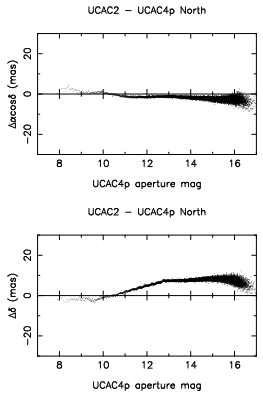
1995	planning for "electronic astrograph" at USNO
1997	feasibility studies at USNO, Washington DC completed
1998	begin survey observations at CTIO
2000	UCAC1 : 80% of southern sky, 27 mill.stars, prelim. PMs
2001	move astrograph to NOFS to complete northern sky
2004	UCAC2 : −90 to +40 Dec, 48 mill.stars, 2MASS photom
2004	all–sky observations completed
2009	UCAC3 : first all-sky catalog, 100 mill.stars, issues
2011	UCAC4 : final release, improved PM north, APASS photom.

Improvements of UCAC4 over UCAC3:

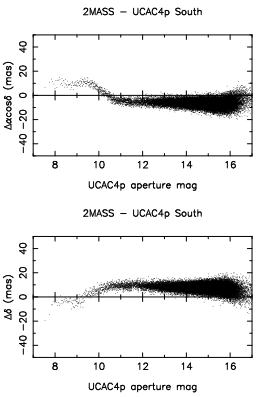
- fix bug missing stars / multiple entries of same star
- more stars at faint limit (change in threshold parameters)
- new systematic error model for CCD positions (CTE, mag.eq.)
- use of NPM 1st epoch plates for proper motions $\delta \geq -20°$
- use APASS optical photometry

UCAC4 positions:

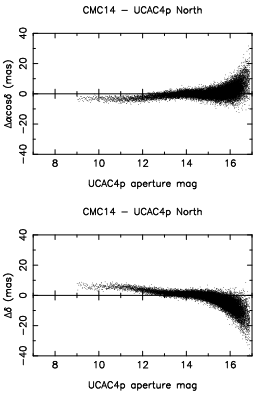
A major difference between the UCAC2 and UCAC4 positional system is the deviation of UCAC4 from strictly Tycho-2. A final linear magnitude equation in declination was applied to UCAC4 positions based on calibration data taken with the astrograph on the East and West side of the pier ($180°$ field rotation).



The new model for systematic positional error corrections as a function of magnitude and coordinates (coma-like terms) brings the UCAC4 system closer to UCAC2 and 2MASS (particularly at the faint end) than UCAC3. The small offset in declination is caused by the above mentioned deviation from the Tycho-2 system for UCAC4. However, the "magnitude equation" is now flat within ± 10 mas.



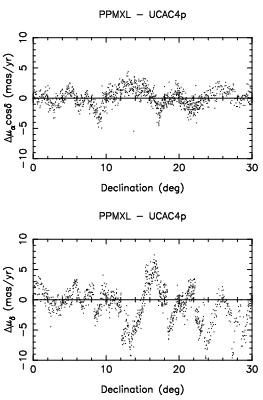
UCAC4 positions agree very well with positions from the CMC14 catalog, as the following example shows for the northern hemisphere with no proper motions applied (small epoch difference to UCAC4).

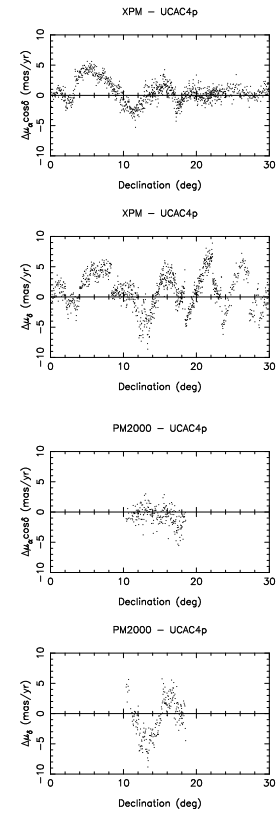


UCAC4 proper motions:

Here preliminary data (UCAC4p) are shown. UCAC4 proper motions are based on over 140 catalogs (similarly to Tycho-2) but also including data from StarScan measures of over 5000 astrograph plates (Zacharias et al. 2010). However, positions of faint stars are based only on Southern Proper Motion (SPM, YSJ1, Girard et al. 2011) and Northern Proper Motion (NPM, 1st epoch catalog, priv.com.) programs combined with UCAC CCD observations.

The following plots show sample data along a narrow slice in RA $= 302.4°$ to $303.85°$ as a function of declination: differences in proper motions between UCAC4p and PPMXL (Röser et al. 2010), XPM (Fedorov et al. 2009), and PM2000 (Ducourant et al. 2006).

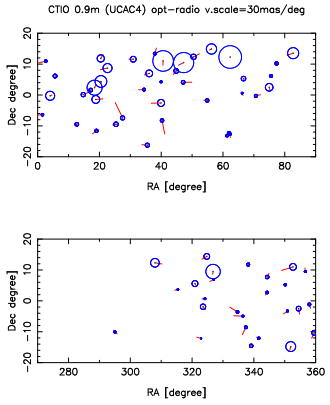




All external catalogs claim to be "on ICRF" with absolute proper motions. Remaining systematic errors in the UCAC4p proper motions based on the NPM plate pattern are present, however, there are also inconsistencies on several mas/yr level between the other catalogs. Galaxies are utilized to correct UCAC4p proper motions.

Extragalactic link:

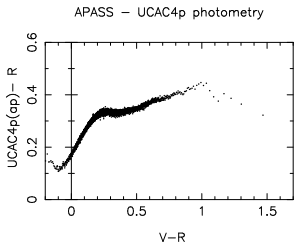
CTIO 0.9m observations of ICRF quasars were reduced with UCAC4p reference stars. The following plot shows an example of optical−radio position offsets (vectors) in comparison to estimated, total 1−sigma errors (circles).



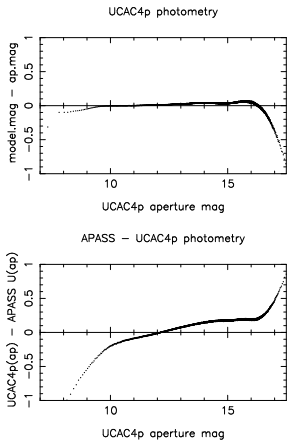
Many high S/N sources show position differences consistent with error estimates (on 20 mas level), however a few sources have unexplained large errors (up to $\approx 6\sigma$, $\approx$ 100 mas).

UCAC4 photometry:

Over 9 million UCAC4 stars were found to have APASS (Henden et al.2011) photometry. The UCAC4p bandpass relation to standard R and V is given here.



This information has been used to predict UCAC4 magnitudes based entirely on standard R and V, called APASS U. The differences to individual UCAC4p aperture magnitudes as fct. of UCAC4p ap.mag and difference to UCAC4p image profile fit model magnitudes are shown below.



Only for very faint stars the model and aperture magnitudes deviate substantially. The comparison of UCAC4p magnitudes to "real" photometry shows a significant non-linearity of internal UCAC4p magnitudes which will be corrected for the final release.

Ducourant,C. et al. 2006,
The PM2000 Bordeaux proper motion catalogue
A&A 448, 1235
Evans,D. et al. 2006,
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Girard,T. et al. 2011,
The Southern Proper Motion Program IV. The SPM4 Catalog,
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APASS: The AAVSO Photometric All-Sky Survey,
www.aavso.org/apass, 2nd release
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The PPMXL catalog of positions and proper motions
on the ICRS. AJ 139, 2440
Zacharias,N. et al. 2000,
The first US Naval Observatory CCD Astrograph Catalog,
AJ 120, 2131
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(UCAC2), AJ 127, 3043
Zacharias,N. et al. 2009,
The third US Naval Observatory CCD Astrograph Catalog,
(UCAC3), AJ 139, 2184