UCAC, NOMAD, URAT
star catalogs for astrometry

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layout of talk

- overview: global astrometry
- UCAC (finally, 3rd release is out)
- NOMAD (merged dataset)
- URAT / U-mouse
overview

other projects / catalogs

where do UCAC, URAT, fit in?
## catalogs / projects

<table>
<thead>
<tr>
<th>name of ground</th>
<th>proper mag</th>
<th>numb</th>
<th>pos.err</th>
<th>year</th>
</tr>
</thead>
<tbody>
<tr>
<td>catalog space</td>
<td>motion</td>
<td>range</td>
<td>stars</td>
<td></td>
</tr>
<tr>
<td>catalog</td>
<td>stars</td>
<td>(mas)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ICRF</td>
<td>G</td>
<td>QSO</td>
<td>radio</td>
<td>500</td>
</tr>
<tr>
<td>Hip.</td>
<td>S</td>
<td>yes</td>
<td>&lt;= 12</td>
<td>100 K</td>
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<tr>
<td>Tycho-2</td>
<td>G/S</td>
<td>yes</td>
<td>&lt;= 12</td>
<td>2.5 M</td>
</tr>
<tr>
<td>UCAC2</td>
<td>G</td>
<td>yes</td>
<td>8..16</td>
<td>40 M</td>
</tr>
<tr>
<td>UCAC3</td>
<td>G</td>
<td>yes</td>
<td>8..16+</td>
<td>100 M</td>
</tr>
<tr>
<td>2MASS</td>
<td>G</td>
<td>no</td>
<td>IR</td>
<td>500 M</td>
</tr>
<tr>
<td>USNO-B</td>
<td>G</td>
<td>yes</td>
<td>12..21</td>
<td>1000 M</td>
</tr>
<tr>
<td>PanSTARRS</td>
<td>G</td>
<td>yes</td>
<td>17..23</td>
<td>2000 M</td>
</tr>
<tr>
<td>U-mouse</td>
<td>G</td>
<td>yes</td>
<td>9..18</td>
<td>500 M</td>
</tr>
<tr>
<td>JMAPS</td>
<td>S</td>
<td>yes</td>
<td>2..15</td>
<td>40 M</td>
</tr>
<tr>
<td>Gaia</td>
<td>S</td>
<td>yes</td>
<td>6..20</td>
<td>1000 M</td>
</tr>
<tr>
<td>SIM</td>
<td>S</td>
<td>yes</td>
<td>0..20</td>
<td>20,000</td>
</tr>
</tbody>
</table>
position error increases with time

![Graph showing position error increase over time](image)
accuracy of catalogs

The diagram presents a scatter plot showing the relationship between position error (mas) epoch 2010 and the number of stars per square degree. The catalogs are represented by different symbols and colors. The data points include Tycho-2, Hipparcos, UCAC, 2MASS, USNO-B, and URAT.
U S N O
C C D
A s t r o g r a p h
C a t a l o g

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modify dome at CTIO
UCAC overview

- 1997 – 2004 (all-sky completed), CTIO, NOFS
- single, 579 – 642 nm bandpass
- R = 8 to 16 mag
- positions accurate to 20 mas (10 – 14 mag)
- incl. proper motions (various early catalogs)
- UCAC1 (2000): part of Southern Hemisphere
- UCAC3 (2009): all-sky, 100.7 million stars
observing at CTIO
x-y slide

backend of astrograph

4k camera
re-processing pixel data

- 4.5 TB compressed
- dark, flat handling
- double star fits
- empirical profiles
- identify overexposed
- multi-level results
StarScan plate measuring

- early epoch data for proper motions
- CCD camera, step-stare mode
- accurate to <= 0.5 micrometer absolute
- 1930 AGK2: 1,950 plates
- 1976..1995 ZA: 2,300 plates
- 1983..1990 BB: 900 plates
- 1985..1995 Lick Astrograph: 300 plates
StarScan plate measure machine
Washington, DC
StarScan calibration

2 um x,y table errors
faint stars early epoch

- **SPM** (Southern Proper Motion program)
- take PMM scans (D.Monet)
- re-process pixel data with StarScan pipeline
- T.Girard (Yale Univ.): magnitude equations
- get over 50 mill. stars -90...-10 Dec, YSJ1
- 2...4 mas/yr errors in proper motion to UCAC limit
- **SuperCosmos** (N.Hambly)
  - copy of “source” catalog, all-sky, + B,R,I photometry
  - add 100 mas RMS for system.errors -> 6...8 mas/yr
UCAC3

number of stars:
100,766,420 total
98,114,307 2MASS
51,112,855 SPM, YSJ1
85,563,642 SuperCosmos
~ 9,000,000 StarScan positions
4,098,873 AC2000
2,386,607 Tycho-2
65,392 Hipparcos
51,297 known high PM stars

release on double-sided DVD (8 GB)
Naval Observatory
Merged Astrometric Dataset

Naval Observ. Flagstaff Station
Astrometry Department
U.S. Naval Observatory
NOMAD overview

• all-sky, all stars: Sirius to 21\textsuperscript{st} mag
• positions + proper motions + photometry
• pick “best” data each star (not compiled cat.)
  • Hipparcos + Tycho-2
  • UCAC2 + “Yellow Sky” + USNO-B
  • 2MASS ... 
• http://www.nofs.navy.mil/nomad on-line
• 100 GB hard disk copy upon request
work in progress ...

- NOMAD needs update
  - *calibrate* systematic errors in USNO-B
  - substitute UCAC3 for UCAC2
  - merge many *other catalogs*: CMC, ...
  - *weighted mean* instead of “best pick”
- future: **DyAD** = dynamic astrometric database
  - project lead by S.Levine (NOFS)
- new observational data: URAT, PanSTARRS...
Robotic Astrometric Telescope

PI: Norbert Zacharias

Astrometry Department

U.S. Naval Observatory
status of URAT project

• telescope:
  • optical design studies completed, \( f = 3.6 \) m
  • 0.85 m primary mirror: delivered Feb. 2008
  • unlikely to be completed

• detector:
  • 10.5k by 10.5k CCD chip produced successfully
  • 10k camera complete, 1st light October 2007
  • “4-shooter” camera funded in 2008
“U-mouse”

(if you can't get the “rat”, how about a “mouse”?)
10k camera dewar
astrograph with 10k camera
**URAT phase 1 = U-mouse**

- currently no funding for new telescope
- take "4-shooter" camera, put at astrograph
- complete re-make of astrograph 2008/09
- move instrument to NOFS, CTIO
- 28 sq. deg. per exposure!
- 10 mas per image (well exposed star)
- multiple sky overlaps / year, 7 - 18 mag
- solve for positions, motions + parallax
STA1600B 2x2 Mosaic Camera Head Concept – Front View

- Cryostat window – 320mm diameter, 300mm clear aperture.
4-shooter camera dewar assembly
(drawing)
10 k chips:

thinning successful, July 2009 (DALSA)

packaging for detector
dewar head,
June 2009
G.Luppino
dewar head completed (G.Luppino)
Aura Camera  
(STA)  
1 Mpx/s  
16 ch./chip
rebuilding astrograph in 24in dome, 2008
astrograph
May 2009
at USNO
summary

- **UCAC3**: all-sky to 16\(^{th}\) mag, *release 2009 Aug 10*
- **URAT -> Umouse**: first light 2009
  - use re-furbished astrograph for phase 1
  - 4 x 111 million pixel CCD detector at astrograph
  - 28 sq. deg per exposure; new all-sky obs.program
- **NOMAD**: needs update (in progress)
  - stay tuned for more USNO products to come!