Development of plate and CCD archives, databases, VO-tools at Nikolaev Astronomical Observatory

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## **Development of the digital database**

- Development of the digital data bank has been started since 1995, when the first CCD observations were begun.
- Development of astronomical databases has been started since 2004.
- All obtained data and results of data processing are added to the common data bank of NAO. The daily average volume of the new astronomical information obtained from the CCD instruments makes from 1 GB up to 12GB, depending on the purposes and conditions of observations. The total data volume of obtained plate and CCD images was about 2 TB at the end of 2012. The total volume of information obtained from other sources such as astronomical catalogues makes near 140GB.

# Volume of the CCD raw data obtained in NAO and stored in the data bank



All receiving data are stored on servers in two copies, namely, working and backup. Also we made copies of observational data as archives on DVD. All obtained observations have been stored in FITS format since 1998.

Program for digitizing of photographic plates has been started since 2007.
The scanning resolution for astrometric image reduction is 1200
DPI and 600 DPI for preview images.
First astrometric results of data processing were obtained in 2009.
Images of 50 plates containing about 17000 stars were processed. The obtained accuracy was about 0."07 for both coordinates and resolution of 1200 DPI.

In 2012, using 2100 images of 220 plates distributed close to the Galactic plane we obtained a catalogue of coordinates and proper motions for about 200000 reference stars. The catalogue accuracy is about 0."03.

Also we obtained a catalogue of coordinates for more than 900000 stars. The catalogue accuracy is about 0."06. Databases of photographic observations. Distribution of photo plates by year of observation.



Now databases contain information about CCD observations obtained in 1996-2012 and photographic observations obtained in 1929-1931 and 1961-1999. The glass library of NAO contains near 8500 of photographic plates.

Databases of photographic observations. Distribution of photoplates by RA & DEC.





## Data volume of photo plate images obtained at NAO and stored in data bank



## Number of preview images obtained in NAO



May 2013: Preview images - 96% of plate archive, 80% in FITS format. 75% of images are available in UkrVO.

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## UkrVO catalogues in Votable standard



## Catalogue visualisation:



#### <u>VOtable</u> <u>Web service - simple cone search</u>

The XPM catalogue contains ICRS positions of stars, original absolute proper i magnitudes from GSC2.3; B, R magnitudes from USNO-A2.0 and J, H, Ks magn We combined data from the Two-Micron All Sky Survey (2MASS) and USNO-A2 derive the absolute proper motions of about 280 million stars distributed all o small region near the Galactic Centre, in the B magnitude range 12 to 19 mag derived from the 2MASS Point Sources and USNO-A2.0 catalogue positions wi of about 45 years for the Northern hemisphere and about 17 years for the Sou of the absolute proper motion frame (the absolute calibration) was specified w million galaxies from 2MASS. Most of the systematic zonal errors inherent in t were eliminated before the calculation of proper motions. The mean formal er less than 1 mas/yr.

Six catalogues were added in 2012: AMC (2008-2009), MEGA-G, MEGA-H, ASCC, FONAC, XPM.

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## Search system for XPM catalogue



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## Data mining by using web services

Three catalogues: ASCC, FONAC, XPM are available for data mining in accordance with the IVOA standard – Simple Cone Search.

<b>Ukrainian Virtual Observatory</b>	additional corrections dV and d(B-V). These additional corrections were determined by comparison with ground-based data in the Johnson system. These corrections depend non-linearly on colour and reach 0.02 and 0.04 mag, respectively. Infrared stellar magnitudes J, H, Ks and their errors were copied from the 2MASS catalogue. Spectral classes in the MK or HD systems were taken from Hipparcos, CMC11, PDM, and Tycho-2 Spectral Type catalogues. Multiplicity and variability flags were taken from Tycho-1, Tycho-2, Hipparcos, CMC11, and PDM catalogues. Stars in the ASCC-2.5 are divided into 30 files ordered by declination (North and South polar caps and 28 bands of 5 degrees width), and sorted in order of right ascreming within each file.
Web service - simple cone search	<pre></pre> CDESCRIPTION> <description> All Sky Compiled Catalogue of 2.5 million stars (ASCC-2.5, 3rd version) Kharchenko N.V., Roeser S. Kinematics and Physics of Celestial Bodies. 17, 409 (2001) 2001KPT17e.409K</description>
The Simple Cone Search (SCS) provides handy data selection from a large astronomical catalogue for a relatively small region of interest in the sky. The SCS protocol contains the following three parameters as a part of the URL:	 <group id="J2000" utype="stc:AstroCoords"> <param datatype="char" name="cooframe" ucd="pos.frame" utype="stc:AstroCoords" value="UTC-ICRS-TOPO"/> <fieldref ref="col1"></fieldref> <fieldref ref="col2"></fieldref></group>
RA - a right-ascension in the ICRS for the positon of the center of the cone to search, given in decimal degrees; DEC - a declination in the ICRS for the positon of the center of the cone to search, given in decimal degrees; SR - the radius of search, given in decimal degrees.	<pre><preeddret ret="col3"></preeddret> <freddret ret="col4"></freddret>   <pranm datatype="char" name="Author_name" ucd="meta.bib.author" value="Kharchenko N. V."></pranm> <pranm datatype="char" name="Bibcode" ucd="meta.bib.bibcode" value="2001KFNT17e.409K"></pranm>  </pre>
The results are returned in accordance with the VOTable format.	<pre><fibld 12"="" <br="" datatype="double&lt;br&gt;width=" id="col1" name="ra" precision="6" raf="J2000" ucd="POS_BQ_RA_MAIN" unit="deg" utype="stc:AstroCoords.Position2D.Value2.C1"><pre>constraint of the state of the s</pre></fibld></pre>
All Sky Compiled Catalogue (ASCC-2.5, Version 3.0) containing more then 2.5 million stars (J2000, epoch 1988.19) is available for the SCS. The largest search radius is 2.5*	Right Ascension J2000.0, epoch 1991.25 
Try this SCS via your browser:	<pre><field 12"="" <br="" datatype="doub&lt;br&gt;width=" id="col2" name="dec" precision="8" ref="J2000" ucd="POS &lt;u&gt;EQ DEC MAIN&lt;/u&gt;" unit="deg" utype="stc:AstroCoords.Position2D.Value2.C2"><description></description></field></pre>
http://nao.db.ukr-vo.org/VOTable/ASCC/ASCCws.php?RA=30&DEC=20&SR=2	Declination J2000.0, epoch 1991.25  
One can change search parameters inside URL address, and obtain catalogue data for different regions of interest in the v.	<pre><field <="" id="col3" name="erRA" ref="J2000" td="" ucd="stat.error;pos.eq.ra" utype="stc:AstroCoords.Position2D.Error2.Cl"></field></pre>
FON Astrographic Catalogue (FONAC, Version 2.0) containing more then 2.0 million stars (J2000, epoch 1991.25) is available for the SCS. The largest search radius is 0.9	Standard error in RA*cos(DEC) 
If you submit a search radius more than the largest given value, the service will return an error. Try this SCS via your browser:	<pre></pre>
http://nao.db.ukr-vo.org/VOTable/FONAC/FONACws.php?RA=30&DEC=20&SR=0.9	Standard error in declination  
One can change search parameters inside URL address, and obtain catalogue data for different regions of interest in the sky.	<pre><fibld datatype="float" id="col5" name="Plx" precision="2" ucd="pos.parallax.trig;meta.main" unit="mas" width="7"></fibld></pre>
XPM catalogue containing absolute proper motions for more then 280 million stars (J2000, epoch 2000.0) is available for the SCS. The largest search radius is 0.49	//DESCRIPTION>
If you submit a search radius more than the largest given value, the service will return an error. Try this SCS via your browser:	<pre><ristup datatype="rloat" ip="colo" name="erpix" precision="2" udg="stat.error;pos.parallax.trig" unit="mas" width="6"></ristup></pre>
http://xpm.db.ukr-vo.org/XPMws.php?RA=30&DEC=20&SR=0.49	<field datatype="float" id="col7" name="pmRA" precision="2" ucd="pos.pm:pos.eg.ra" unit="mas/a" width="8"></field>

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## Web services via Aladin graphical interface

ASCC, FONAC, XPM SkyBot SuperCOSMOS catalog (SSS.cat) Others.. LEDA Hypercat Generic Cone Search query Aladin v7.0 XPM Catalogue: Absolute proper motions of 280 million stars. FON Astrographic Catalogue (FONAC, Version 2.0) 2.0 million stars All Sky Compiled Catalogue (ASCC-2.5): 2.5 million stars GALEA (STScI) +14:00 2 Reset Clear SUBMIT Close +13:00 Server selector \_ D × Sextractor Others +12:00 Catalog Image servers servers Aladin D AII +11:00 VizieR images SkyView • UkrVO: Simple Cone Search for ASCC (max Radius=2.5°) ? Surveys +10:00 Fill in all these fields and press the SUBMIT button Missions 🖥 🖳 KIDSS Target (ICRS, name) 11 11 11.93 +11 11 41.7 Grab coord GAEMIC Sloan Radius 3.371° +09:00 D\$5... SkyBot +08:00 Archives. Others.. ra Others... Reset Clear SUBMIT Close ?



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## Database of photographic observations via Aladin

Aladin v7.0

File Edit Image Catalog Overlay Tool View

😂 🚽 🤇 🌒 Location 09:08:54.93 +01:49:42.6

Interop Help

Clear Frame ICRS

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More than 34000 plates from 15 telescopes (GAO+MAO). More than 6000 preview images (MAO): 300 or 600 dpi.



## Database of CCD observations via Aladin



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### UkrVO resources in the registry



## 2013 Database of photographic and CCD observations via browser

More than 34000 plates from 15 telescopes (GAO+MAO). More than 6000 preview images (MAO): 300 or 600 dpi. More than 56000 CCD frames from 3 telescopes (MAO). Preview images for all frames.

FITS for AMC (2002-2005) and MCT (2001-2005).



Number of plates in the database: 34198 . 300dpi 600dpi Object :40:00 +02:00 1990/08/29 Equatorial catalog preview. preview +02:00 1990/08/29 Equatorial catalog preview preview -02:00 1990/09/24 Equatorial catalog preview. preview 00 -02:00 1990/09/24 Equatorial catalog preview preview -05:44 1978/10/22 Zodiac catalog - B preview. preview 0:42:36 -01:44 1979/08/25 Zodiac catalog - B preview preview 0:42:36 +02:16 1980/08/17 Zodiac catalog - B preview preview 00 -00:00 1990/08/25 Equatorial catalog preview preview 0:48:00 -00:00 1990/08/25 Equatorial catalog preview preview 0:50:30 -03:44 1977/10/12 Zodiac catalog - A preview preview 0:50:36 +00:16 1977/10/06 Zodiac catalog - A preview preview 0:50:36 +04:16 1978/10/07 Zodiac catalog - A preview preview 0:56:00 +02:00 1990/08/26 Equatorial catalog preview preview 0:56:00 +02:00 1990/08/26 Equatorial catalog preview preview 0:56:00 -02:00 1990/08/27 Equatorial catalog preview preview 0:56:00 -02:00 1990/08/27 Equatorial catalog preview preview 0:58:36 -01:44 1977/09/16 Zodiac catalog - B preview preview 0:58:36 +02:16 1978/12/19 Zodiac catalog - B preview. preview 1:04:00 -00:00 1990/10/14 Equatorial catalog preview preview 1:04:00 -00:00 1990/10/14 Equatorial catalog preview preview 1:06:30 -03:44 1977/09/14 Zodiac catalog - A preview. preview 1:06:36 +00:16 1977/10/10 Zodiac catalog - A preview preview Number of found plates in the table: 34

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- Web services for three catalogues were created in accordance with the IVOA standard – Simple Cone Search. The web services were registered and passed all tests at the VAO site (USA).
- Photographic and CCD databases work via graphical interfaces of browser as well as Aladin.
- We continue to develop database of stellar catalogues in accordance with the VOTable standard.

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