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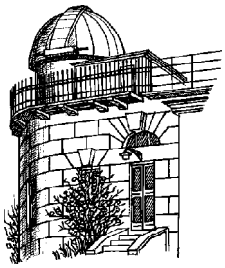

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DEVELOPMENT OF MYKOLAIV VIRTUAL OBSERVATORY

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ABSTRACT. Results obtained in 2010-2013 on the development of astronomical databases and web services are presented. Mykolaiv Virtual Observatory (MVO) is a part of the Ukrainian Virtual Observatory (UkrVO). At present, MVO consists of three major databases containing data on: astrometric catalogues, photographic plates, CCD observations. The databases facilitate the process of data mining and provide easy access to the textual and graphic information on the results of observations and their reduc-tion obtained during the whole history of Nikolaev Astronomical Observatory (NAO).

Key words: database, web service, virtual observatory

Astrometric catalogues of stars were compiled in the form of XML files in accordance with the VOTable standard. Access to the databases of photographic and CCD observations is implemented via a graphical web interface on the MVO site (http://nao.db.ukr-vo.org/vo3.php), as well as via the web interface of the stand alone application - Aladin (http://nao.db.ukr-vo.org/vo1.html), which has been developed at Strasbourg Astronomical Data Center (CDS) since 1999. Despite the difference between the web interfaces, in both cases we use the same databases, which are managed by using the MySQL database management system. Using the Aladin web interface, the server of MVO is integrated with other leading astronomical servers located in different parts of the world.

The first version of MVO containing astronomical data resources of NAO was created in 2008 (Protsyuk et al., 2005; Protsyuk et al., 2008). The further development of MVO has been carried out since 2010 (Mazhaev, Protsyuk, 2010) by integrating data of photographic observations and astronomical catalogues, which were obtained in other observatories of Ukraine.

In 2012, the first astronomical web services (AWS) were created in Ukraine. The AWS provide data mining for three astrometric catalogues. The operation of these AWS is fully compliant with the Simple Cone Search standard, which was adopted and has been developed by the International Virtual Observatory Alliance (IVOA). All three AWS were successfully tested on the web site of the Virtual Astronomical Observatory (VAO, USA) by means of special test programs. The AWS were also inscribed in the astronomical registry, which operates in accordance with the IVOA standard. The registry includes all available astronomical resources for carrying out further investigations. The AWS were developed in the form of search scripts in a programming language – PHP. Application of the AWS for data mining can be implemented by using a browser as well as by any other application that supports the standards adopted by the IVOA.

Databases of the MVO

Stellar astrometric catalogues, obtained in 1832-2012 years, are available on the corresponding web page (http://nao.db.ukr-vo.org/vo2.html). The database contains 33 short descriptions and relevant files compiled in accordance with the VOTable standard, which was adopted and has been developed by the IVOA for storing and sharing any astronomical tabular data. In 2010-2012, we compiled and added to the database six astrometric catalogues obtained at three observatories: NAO (AMC2009 catalogue); the Main Astronomical Observatory (MAO) of Ukraine (MEGA-G, MEGA-H, ASCC-2.5, FONAC-2.0 catalogues); Institute of Astronomy of Kharkiv National University (XPM catalogue).

The XPM is the largest astronomical catalogue in Ukra-ine, which contains about 280 million stars. To facilitate access to astronomical data from this catalogue for selected region of interest within the celestial sphere, we created a search engine for 360 archive files of XPM catalogue in two formats: xml.gz and txt.gz (Fig. 1).

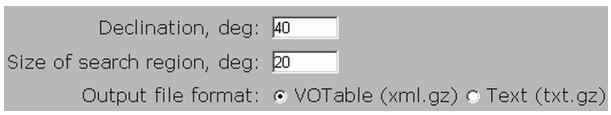


Figure 1. The search interface for the XPM catalogue.

The user may easily choose the necessary format of the catalogue data (Fig. 1). The XML files were compiled in accordance with the IVOA standard - Votable1.2. The search results are available for download (Fig. 2). The search system is available on the corresponding web page of the UkrVO site (http://xpm.db.ukr-vo.org/xpm.php).

32° to 32.5° -> 244.xml.gz | 32.5° to 33° -> 245.xml.gz

34° to 34.5° -> 248.xml.gz | 34.5° to 35° -> 249.xml.gz

36° to 36.5° -> 252.xml.gz | 36.5° to 37° -> 253.xml.gz

Figure 2. Search results for the XPM catalogue.

The databases of photographic and CCD observations operate on the basis of the MySQL relational database management system. The databases allow users to conduct automatic search of astronomical images in accordance with the IVOA standards and the IAU Resolution – Public access to astronomical archives, adopted in 2003. The database of photographic observations contains more than 34 thousand plates (Fig. 3), which have been obtained and stored at two institutions: NAO and MAO. It contains textual information for all plates as well as preview images in JPG format for more than 8000 plates.

☑ Stars around Radio Source: 485 plates ☑ Stellar Cluster: 2350 plates
☑ Variable Star: 1842 plates ☑ Nebula: 48 plates
☑ Fundamental Star: 2105 plates ☑ Association of Stars: 4 plates
☑ Zodiac Stars: 1127 plates ☑ Equatorial stars: 489 plates
☑ Moon: 854 plates ☑ Asteroid: 4527 plates
☑ Artificial Satellite: 4156 plates ☑ Field: 5925 plates
☑ Undefined object: 52 plates ☑ Galaxy: 1320 plates
☑ Group of Galaxies: 139 plates ☑ Cluster of Galaxies: 5 plates
Check all 34198 plates Uncheck all plates

Figure 3. Observational campaigns with photo plates.

The preview images of plates are available in two resolutions of 300DPI and 600DPI, obtained by reducing the original scanning resolution of 1200DPI. Original images are available by request. The database of CCD observations contains more than 72 thousand frames. All preview images of plates and CCD frames are available without user registration. The user may get access to CCD images in FITS format only after online registration. The access is automatically granted after receiving email confirmation from the user.

The web interface of the database allows the users to make flexible requests taking into account the following parameters: equatorial coordinates, search sizes, time period, object types, plate parameters, CCD parameters, telescope names (Fig. 4).

☑ Triple Astrograph 11/120 cm, GUA011: 72 plates ☑ Triple Astrograph 15/170 cm, GUA015: 159 plates
☑ Double Astrograph 40/550 cm, GUA040A, GUA040B: 9135 plates ☑ Double Astrograph 40/200 cm, GUA040C, GUA040D, GUA040E: 9720 pl.
☑ Double Astrograph 40/300 cm, TAS040A, TAS040B: 169 plates ☑ Schmidt 53/183 cm, BYU053: 52 plates
☑ Reflector 70/1050 cm, GUA070B: 443 plates ☑ Reflector 70/311 cm, GUA070C: 66 plates
☑ Zeiss Double Astrograph 40/200 cm, EAO040B: 146 plates ☑ Zonal Astrograph 12/200 cm, MYK012, PUL012: 8402 plates
Check all telescopes Uncheck all telescopes

Figure 4. Telescope names for selection of photo plates.

We have developed the search scripts written in PHP programming language. The user may easily make requests from one database or both of them, and obtain one or two result tables, correspondingly (Fig. 5).

Plate	RA, h:m:s	Dec, d:m	300dpi	600dpi
MYK012 000488B	00:52:42	+03:53	preview	preview
MYK012 000489A	00:52:42	+03:53	preview	preview
MYK012 000489B	00:52:42	+03:53	preview	preview
GUA040A 007229	00:53:17	+00:35	–	–
GUA040A 000421B	00:53:22	+03:57	–	–

Figure 5. Search results for photo plates.

The user may also get access to the databases of observations via the web interface of such stand alone application as Aladin (Fig. 6), which has been developed since 1999 in Strasbourg astronomical Data Center (CDS). Aladin allows the user to retrieve and process astronomi-cal images and catalogues from many servers around the world. The user may get access to the UkrVO databases by taking several simple steps described on the corresponding web page (http://nao.db.ukr-vo.org/vo1.html).

The databases were used to compile the astrometric catalogues. In 2012, a catalogue of positions, proper motions and magnitudes for about 200 thousand stars up to 16^m was compiled. The stars in the frames within a declination range of ±15° near the galactic plane were processed by using the databases of photo plates, modern CCD observa-tions as well as cross identification of stars taken from ot-her catalogues. A catalogue of about 2000 stars with pro-per motions exceeding 150 mas/year was also compiled by using the results of modern CCD observations and the cross identification of stars taken from many other astro-metric catalogues.

We continue to expand and populate the databases.

Archives...
Others...
SuperCOSMOS H-alpha Survey (SHS)
SuperCOSMOS images (SSS.img)
Hubble press release images
VO-Paris MAMA Atlas
Generic SIA query
CCD observations of Ukrainian VO
Photo plates of Ukrainian VO

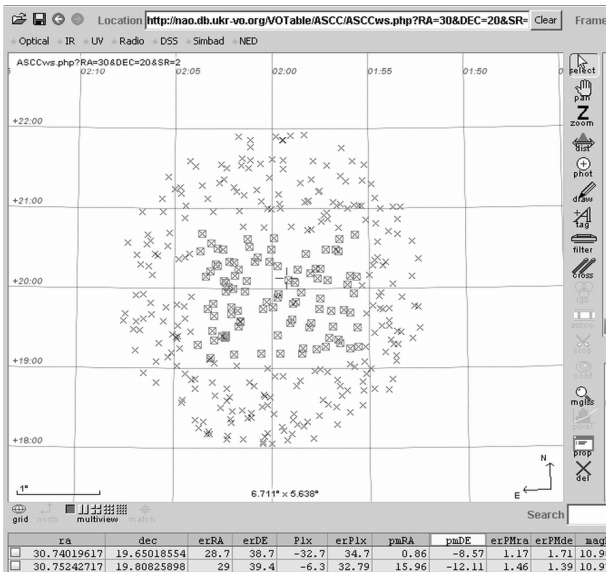
Figure 6. Selection of image servers via Aladin.

Web Services of the UkrVO

In 2012, we created the astronomical web services (AWS) for three astrometric catalogues: the All Sky Compiled Catalogue (ASCC-2.5, 3rd version) (Kharchenko et al., 2009), the FON Astrographic Catalogue (FONAC 2.0) (Kislyuk et al., 2005), the Catalogue of Absolute Proper Motions (XPM) (Fedorov et al., 2009). The web services operate in accordance with the IVOA standard – Simple Cone Search (SCS). The user may get access to the web services via a browser and web address (http://nao.db.ukr-vo.org/ws_SCS.html) or through any other program that supports the IVOA standards, for example Aladin (Fig. 7). The AWS permit the user to carry out the search of scientific information by using: a network server, a browser, special scripts, data directories.

The search scripts were written in the programming language PHP. The ASCC contains more then 2.5 million stars (J2000, epoch 1988.19). The FONAC contains more then 2.0 million stars (J2000, epoch 1991.25). The XPM catalogue contains absolute proper motions for more then 280 million stars (J2000, epoch 2000.0). Each entry of any catalogue contains the textual data of a star, and consists of 10 to 30 values of astronomical parameters. The user may select any combination of equatorial coordinates and radius of search on the celestial sphere, using the appropriate Uniform Resource Locator (URL). The search results are displayed in the browser window in accordance with the IVOA standard – SCS.

In essence, the AWS allow the user to carry out data se-lection from the large astronomical catalogues for a re-latively small region of interest in the sky. The radius of search is limited by the maximum value, which varies from 0.49° to 2.5° depending on the data volume of a gi-ven catalogue. The SCS protocol contains the following three parameters as a part of the URL:



	ra	dec	erRA	erDE	Plx	erPlx	pmRA	pmDE	erPMra	erPMde	mag
☐	30.74019617	19.65018554	28.7	38.7	-32.7	34.7	0.86	-8.57	1.17	1.71	10.9
☐	30.75242717	19.80825898	29	39.4	-6.3	32.79	15.96	-12.11	1.46	1.39	10.9

Figure 7. Search results via Aladin for the AWS.

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.

The AWS also provide users the possibility of further data processing of these astronomical catalogues by using additional software developed in accordance with the IVOA standards.

Information about the AWS was included into the re-gistry developed by VAO. The AWS were successfully tested (Fig. 8) by using special programs at the web site of VAO (USA) (http://heasarc.gsfc.nasa.gov/vo/validation /vresults.pl?querystring=nao.ua).

The AWS were created and established for the first time in Ukraine. General information on the web services and examples of their usage, including technical details omitted in this paper, are available on the relevant page of the UkrVO site (http://nao.db.ukr-vo.org/ws_SCS.html).

Virtual Astronomical Observatory

Validation Results

VAO Validation | Validation Docs | VAO Monitor | VAO Home | NVO Feedback

*Click on "links to details" for more information

Current Error types for center: nao.ua

serviceId	shortname	ivoid	status	time ↑	serviceURL	runtest	type
links to details	description	registry entry	last test status		base url of service	run test	
9225	FONAC_Version2.0	ivo://nao.ua/scs/FONAC	pass	2013/09/21 05:07:32	url	Cone	Cone
9226	XPM_ConeSearch	ivo://nao.ua/scs/XPM	pass	2013/09/21 05:07:14	url	Cone	Cone
9210	ASCC-2.5_Search	ivo://nao.ua/scs/ASCC-2.5	pass	2013/09/21 05:03:46	url	Cone	Cone

Figure 8. Test results at the web site of the VAO (USA).

Other Astronomical Databases

Astronomers of the RI NAO carry out joint projects to apply technologies of virtual observatory for data storing and processing, which are currently not included in the UkrVO. In particular, they take part in three international projects to populate the following online catalogues and databases:

potentially hazardous asteroids (PHA) (http://newton. dm.unipi.it/neodys/index.php?pc=0);

optical meteors - Virtual Meteor Observatory (http://vmo .imo.net/);

Radio Meteor Observing Bulletin (http://www.rmob. org/index.php?lng=en).

The focus of the work is directed towards the electronic data processing such as: reduction of CCD observations of stars, the PHA, artificial Earth satellites, meteors. Obtain-ed results should be automatically submitted to the corres-ponding data center.

The RI NAO and other members of the Ukrainian net-work of optical stations carry out regular observations of the artificial Earth satellites. They all conduct the joint project to determine the orbital elements and to create online catalogue of the near-Earth objects.

The results of this work conducted in the RI NAO will be integrated with the UkrVO. The integration will empo-wer the UkrVO to provide users access to both historical and modern observations as well as the results of their reduction in a wide range of astronomical topics (Vavilova et al., 2010; Vavilova et al., 2011; Vavilova et al., 2012a; Vavilova et al., 2012b).

References

Mazhaev A.E., Protsyuk Yu.I.: 2010, *Izvestia GAO Pulkovo,* **219**, Issue 4, 185-188.

Fedorov P.N., Myznikov A.A., Akhmetov V.S.: 2009, *MNRAS*, **393**, Issue 1, 133-138.

Kharchenko N.V., Roeser S.: 2009, *VizieR Online Data Catalog: I/280B*.

Kislyuk V.S., Yatsenko A.I.: 2005, *Kinematika i Fizika Nebesnykh Tel*, **5**, 33-39.

Protsyuk Yu., Mazhaev A.: 2008, IAUS, **248**, 548-551.

Protsyuk Y., Pinigin G., Shulga A.: 2006, *Kinematika i Fizika Nebesnykh Tel*, **5**, 580-584.

Vavilova I.B., Pakuliak L.K., Protsyuk Yu.I. et al.: 2012a, *Baltic Astronomy*, **21**, 356-365.

Vavilova I.B., Pakulyak L.K., Shlyapnikov A.A. et al.: 2012b, *Kinematics and Physics of Celestial Bodies*, **28**, 85-102.

Vavilova I.B., Pakuliak L.K., Protsyuk Yu.I. et al.: 2011, *Kosmichna Nauka i Tekhnologiya,* **17**, 74-91.

Vavilova I.B., Pakuliak L.K., Protsyuk Yu.I.: 2010, *Kosmichna Nauka i Tekhnologiya,* **16,** 62-70.