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UkrVO ASTRONOMICAL WEB SERVICES

Ukraine Virtual Observatory (UkrVO) has been a member of the International Virtual Observatory Alliance (IVOA) since 2011. The virtual observatory (VO) is not a magic solution to all problems of data storing and processing, but it provides certain standards for building infrastructure of astronomical data center. The astronomical databases help data mining and offer to users an easy access to observation metadata, images within celestial sphere and results of image processing. The astronomical web services (AWS) of UkrVO give to users handy tools for data selection from large astronomical catalogues for a relatively small region of interest in the sky. Examples of the AWS usage are showed.

Keywords: database, web service, and virtual observatory.

INTRODUCTION

Ground-based and space telescopes have produced large volume of data over entire electromagnetic spectrum. In 2010, the Executive Committee of IVOA endorsed a note describing technical architecture to deal with all accumulated data resources [1]. Interoperability of computer systems is one of the main concepts behind the technical architecture to share and use astronomical data and metadata [2]. Fig. 1 illustrates the IVOA technical architecture consisting of three main layers, namely user layer, VO core layer, resource layer. The VO core as the middle layer provides quick and easy access to the resources wherever they are located. The AWS allow users to obtain access to the resources, distributed across five continents, thanks to the interoperability between different astronomical archives and data centers. Simple cone search (SCS) is one of many data access protocols, which provides the interoperability.

AWS FOR ASTRONOMICAL CATALOGUES

The AWS of UkrVO provide automated search and selection of required data in accordance with the SCS standard [3] for three astronomical catalogues compiled in Ukraine, namely ASCC [4], FONAC [5], XPM [6]. The structure of AWS web address consists of path to script and search options after the question mark (Table 1). We used PHP as the programming language to write the scripts. The search options consist of:

- right ascension and declination for a center of search in degrees of arc;
- radius of search in degrees of arc.

The user can search in different areas of the sky and retrieve data from the astrometric catalogues. If the user applies the search radius more than the largest possible value for a given catalogue, the script will display an error message in accordance with the SCS standard. Table 1 contains the main features of these three AWS.

We created the AWS at the end of 2012 for the first time in Ukraine [7]. Then we inscribed these web services into a register of the USA Virtual Astronomical Observatory (VAO). The register contains more than 17000 services. The high energy astrophysics science archive research center (HEASARC) validates each web service at least once per month. The HEASARC maintains a database with all validation results. For example,

Table 1.

The main features of AWS for three astrometric catalogues compiled in Ukraine

Catalogue name	# of records, million	AWS address	SR max, deg
ASCC	2.5	http://nao.db.ukr-vo.org/VOTable/ASCC/ASCCws.php?RA=3&DEC=2&SR=2	2.5
FONAC	2.0	http://nao.db.ukr-vo.org/VOTable/FONAC/FONACws.php?RA=3&DEC=2&SR=0.9	0.9
XPM	280	http://xpm.db.ukr-vo.org/XPMws.php?RA=3&DEC=2&SR=0.4	0.49

Table 2.

Validation results for the web service of XPM catalogue, obtained in 2012—2016 by HEASARC

Status	Type	Time	Status	Type	Time	Status	Type	Time
Fail	Cone	2016/08/24 05:31:18	Pass	Cone	2015/02/16 06:02:26	Pass	Cone	2013/11/03 06:03:55
Fail	Cone	2016/07/24 05:49:40	Pass	Cone	2015/01/18 06:04:19	Pass	Cone	2013/09/21 05:07:14
Fail	Cone	2016/06/24 16:10:58	Pass	Cone	2014/12/14 06:05:18	Pass	Cone	2013/08/16 05:09:50
Abort	Cone	2016/05/31 05:25:08	Pass	Cone	2014/11/11 17:13:57	Pass	Cone	2013/07/03 05:07:07
Pass	Cone	2016/03/12 06:03:55	Pass	Cone	2014/07/21 05:08:43	Pass	Cone	2013/05/31 05:04:39
Pass	Cone	2016/02/13 06:04:02	Pass	Cone	2014/06/15 05:06:24	Pass	Cone	2013/04/21 08:18:28
Pass	Cone	2016/01/12 06:01:40	Pass	Cone	2014/05/15 05:08:37	Pass	Cone	2013/03/19 08:18:41
Pass	Cone	2015/11/14 19:50:02	Pass	Cone	2014/04/15 05:07:44	Pass	Cone	2013/02/22 09:46:48
Pass	Cone	2015/10/17 18:51:46	Pass	Cone	2014/03/13 05:06:12	Pass	Cone	2013/01/25 16:08:41
Pass	Cone	2015/09/23 15:59:04	Pass	Cone	2014/02/15 06:03:41	Fail	Cone	2013/01/13 09:27:19
Pass	Cone	2015/08/29 05:02:11	Pass	Cone	2014/01/19 06:03:50	Pass	Cone	2012/12/03 10:11:27
Pass	Cone	2015/05/25 05:02:12	Pass	Cone	2013/12/28 06:06:40	Fail	Cone	2012/11/15 13:33:08
Abort	Cone	2015/03/27 05:11:07	Pass	Cone	2013/12/02 06:04:37			
http://heasarc.gsfc.nasa.gov/vo/validation/vresults.pl?show=oldtests&sid=9226&runid=721189								

table 2 contains all validation results, obtained in 2012—2016 years, for the web service of XPM catalogue. The AWS of UkrVO have successfully passed 30 regular checks out of 38 since November 2012. All failures were caused by communication errors between servers in the RI MAO (Ukraine) and the HEASARC (USA).

Fig. 2 illustrates a graphical user interface (GUI) and search results for XPM catalogue obtained by using Data Discovery Tool (DDT), which has been developed by the VAO. The DDT allows us to retrieve data from all archives, which are inscribed in the VAO register. The DDT found two competing records for the XPM catalogue (Fig. 2). The top part of the Fig. 2 shows the record of UkrVO web service for XPM catalogue. The bottom part of the Fig. 2 shows the VizieR record for XPM catalogue. The VizieR web service

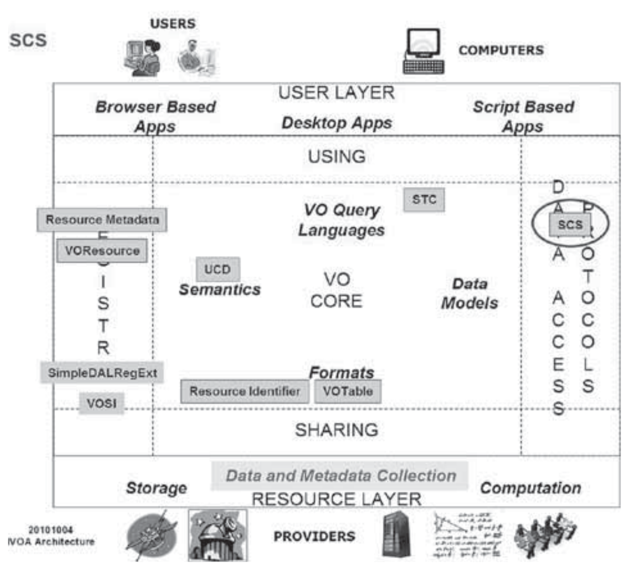

Fig. 1. The IVOA technical architecture consisting of user layer, VO core layer, resource layer

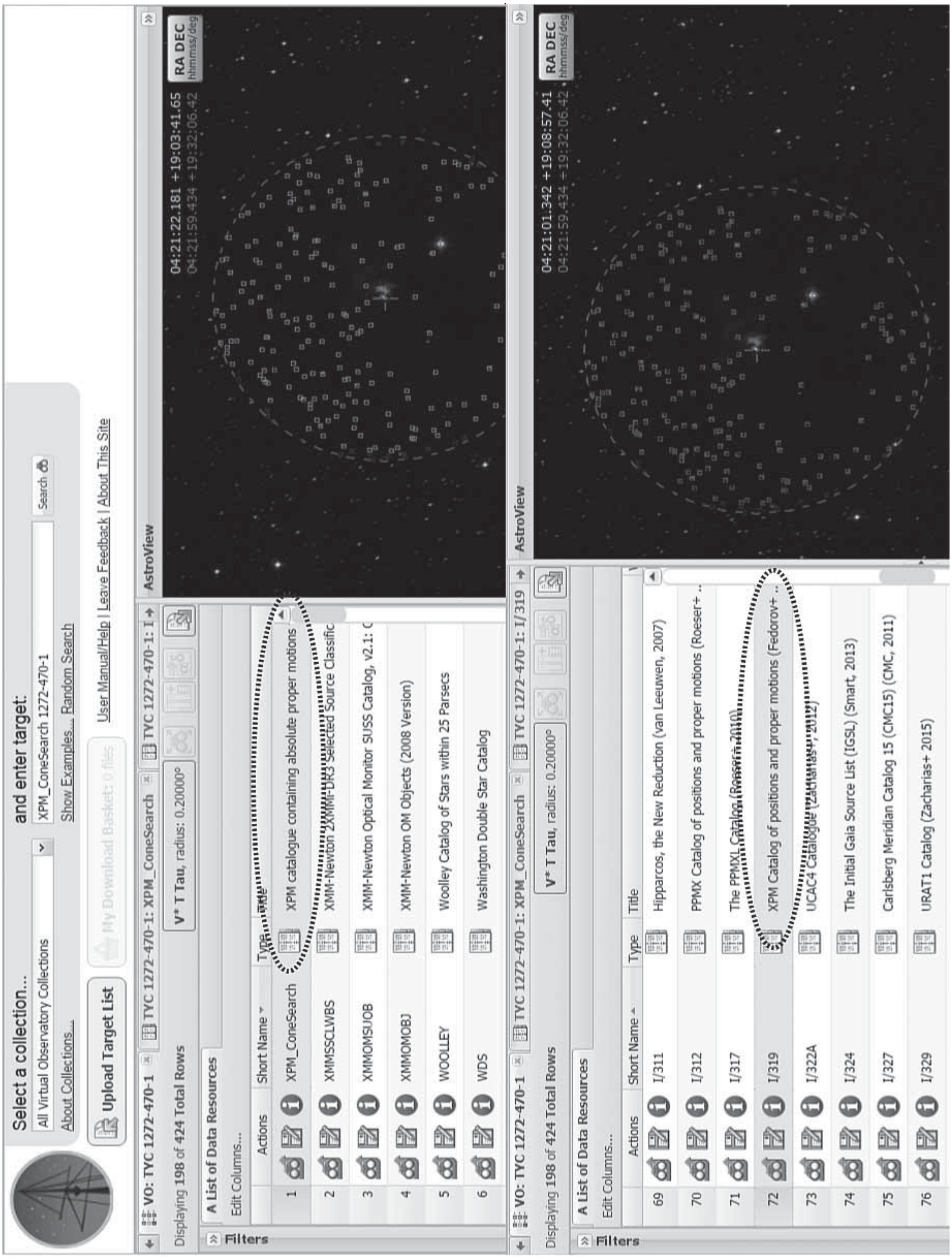

Fig. 2. The GUI and search results for XPM catalogue obtained by using Data Discovery Tool

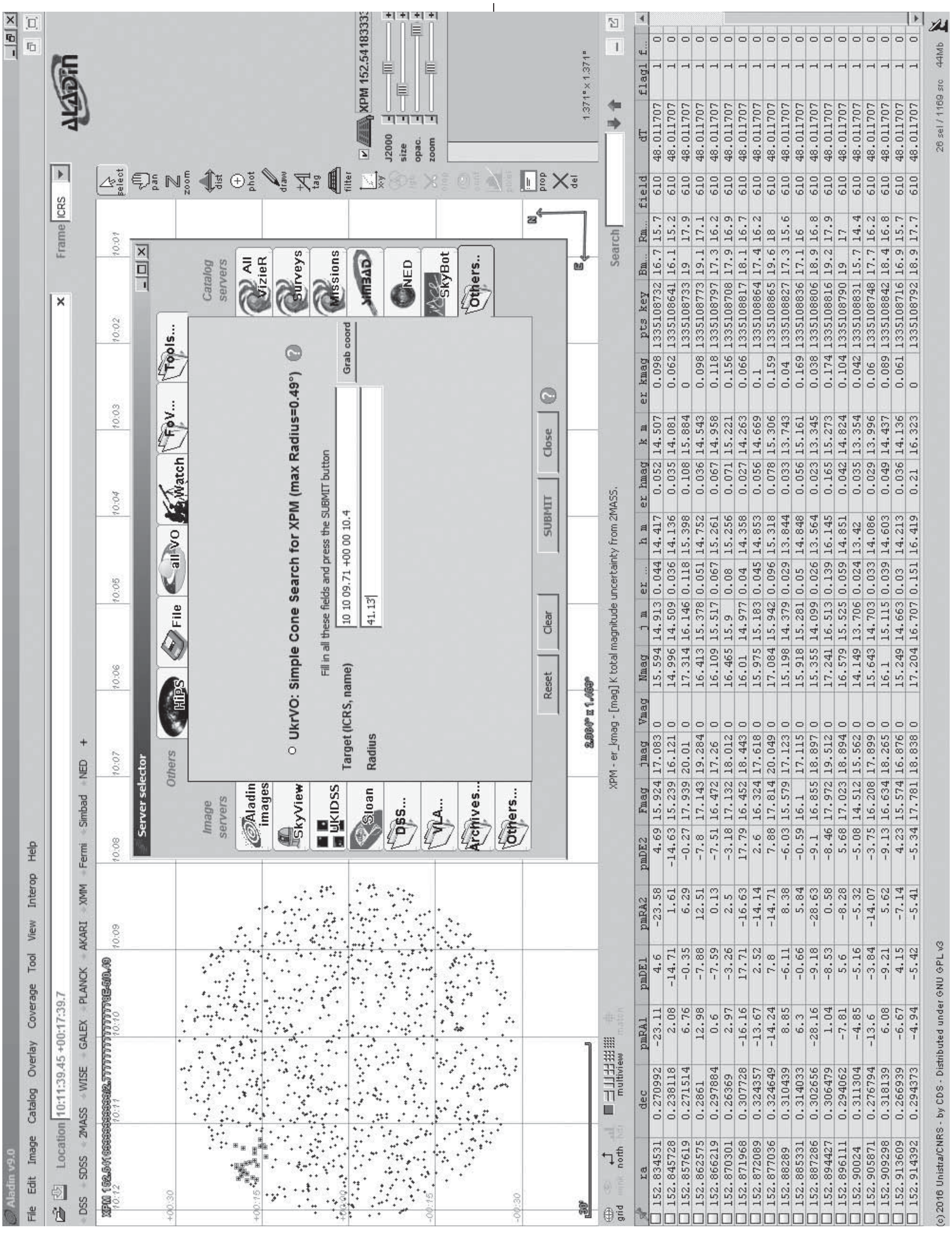

Fig. 3. The GUI and search results for XPM catalogue obtained by using Aladin

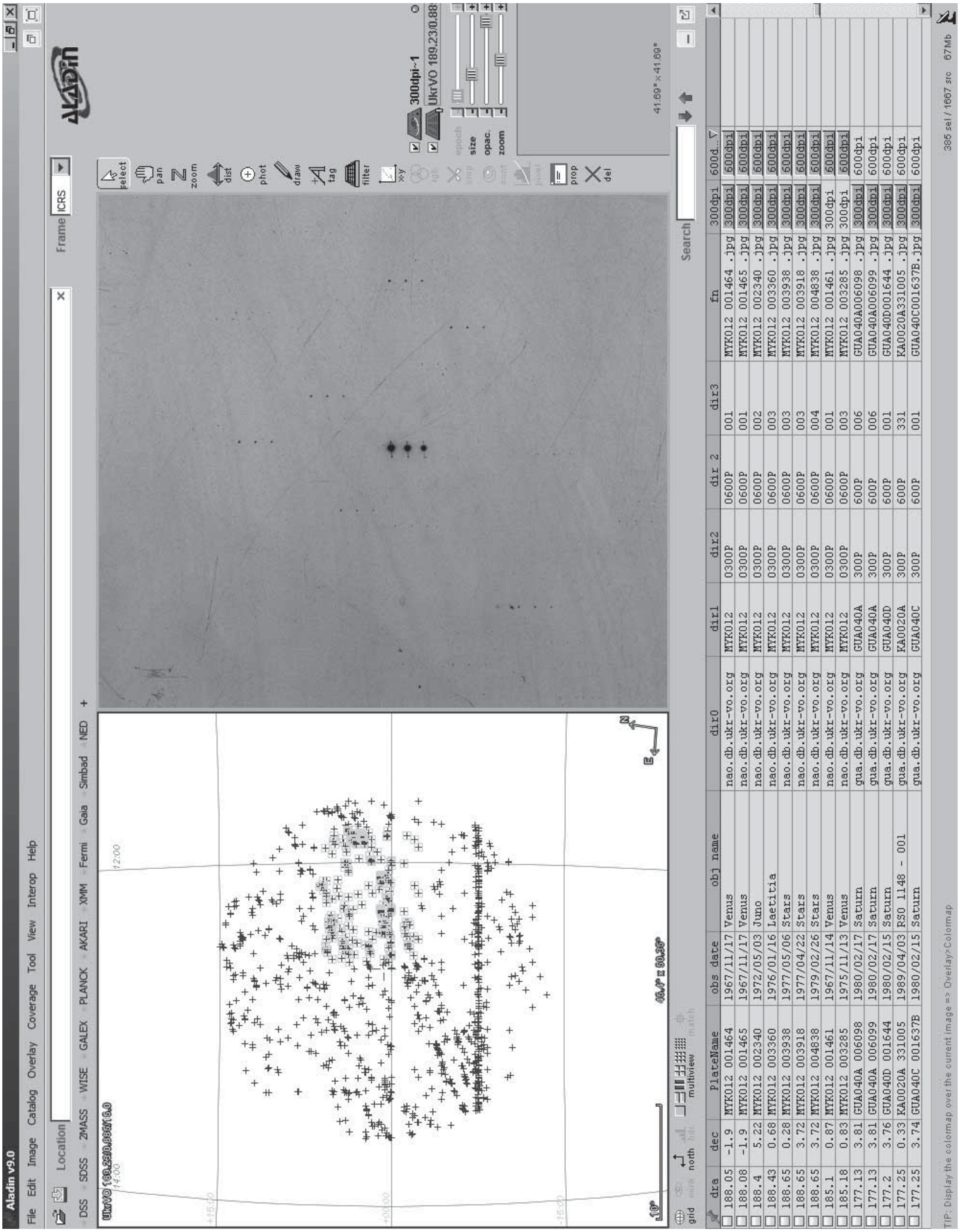

Fig. 4. The GUI and search results for DB of photo plates obtained by using Aladin

(Strasbourg, France) contains more than 15400 published astronomical catalogues including the XPM, and all these catalogues are available via the VAO registry.

One can choose any AWS address (Table 1) to request and to receive relevant information via the web browser. The user may save the retrieved data as an XML file and open the file for further data processing by using any software developed in accordance with the IVOA standards, such as Aladin [8]. The user can also copy the AWS address, paste it into the box titled Location, set the required parameters for search, send a request and get visualization of found results. Each retrieved record of star contains up to 30 values of parameters. Each parameter has a short description at the beginning of the XML file.

To obtain access for the AWS by using Aladin GUI, the user has to do the following steps:

- to download from the UkrVO site and to unzip the archive file named UkrVO.zip;
- to run the batch file named **UkrVO.bat** in case a computer is on Windows platform;
- to run the following command line in case a computer is on Linux platform: -java -Xmx512m -jar Aladin_7.exe -glufile = «UkrVO.txt»
- to edit and run the following command line in case the user needs to set up proxy parameters and size of cache memory: -java -Dhttp.proxyHost = 192.168.0.1 -Dhttp.proxyPort = 3128 -Xmx512m -jar Aladin.exe -glufile = «UkrVO.txt»
- to open a server selector and click on a button named **Others..** on the right side;
- to choose from the menu one of three catalogues: ASCC, FONAC, XPM.

Finally, the GUI is available for work with one of the AWS. Fig. 3 illustrates the GUI and search results for XPM catalogue obtained by using Aladin.

DATABASES OF OBSERVATIONS

To obtain access to two UkrVO databases (DB) of observations conducted with photo plates and CCD in the 20th and 21st centuries respectively, the user has to click on a button named **Others…** on the left side of server selector. Then he or she may select one of the UkrVO DB. Finally, the GUI is ready for work with the selected DB.

Fig. 4 illustrates the GUI and search results obtained by using Aladin for the DB of photo plates [9, 10, 11]. Using the search results within metadata window of Aladin (Fig. 4), one can download and visualize a preview image of a found photo plate by clicking a button titled 300 dpi or 600 dpi (dots per inch). The DB of photo plates deployed in Mykolaiv contains metadata for 40232 records. Two image servers in Kyiv and Mykolaiv store the preview images for about 7000 and 8750 plates, respectively. The preview images stored in Mykolaiv were presented with resolutions of 300 dpi and 600 dpi, and the preview images stored in Kyiv were presented with resolution of 300 dpi (Fig. 4).

The user may also choose the UkrVO DB of CCD observations, and get access to FITS images obtained at Mykolaiv observatory in 2001—2012.

CONCLUSIONS

The AWS of UkrVO have successfully passed 30 regular checks out of 38 since November 2012 (Table 2). All failures were caused by communication errors between servers in the RI MAO (Ukraine) and the HEASARC (USA).

The UkrVO image servers allow the user to get access via the Aladin search GUI to databases of observations by using specially written configuration file.

In future, Aladin window of image servers may contain permanent links to the UkrVO databases provided they give a complete set of metadata and images obtained in Ukraine. Using these databases, AWS for automated search of images by standard named simple image access may be created.

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АСТРОНОМІЧНІ
ВЕБ-СЕРВІСИ УкрВО

Українська віртуальна обсерваторія (УкрВО) є учасником Міжнародного альянсу віртуальних обсерваторій від 2011 року. Віртуальна обсерваторія не може вирішити всі проблеми зберігання і обробки даних, але вона надає користувачам стандарти для побудови інфраструктури астрономічних центрів даних. Астрономічні бази даних спрощують пошук даних і дають можливість вільного доступу до метаданих спостережень, зображень небесної сфери і результатів їх обробки та можливість зручного пошуку даних у великих астрономічних каталогах для відносно невеликої області на небесній сфері. Наведені приклади використання АВС.

Ключові слова: база даних, веб-сервіс, віртуальна обсерваторія.

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АСТРОНОМИЧЕСКИЕ
ВЕБ-СЕРВИСЫ УкрВО

Украинская виртуальная обсерватория (УкрВО) участвует в работе Международного альянса виртуальных обсерваторий с 2011 года. Виртуальная обсерватория не может решить все проблемы хранения и обработки данных, но она предоставляет пользователям стандарты для построения инфраструктуры астрономических центров данных. Астрономические базы данных упрощают поиск данных и дают возможность свободного доступа к метаданным наблюдений, изображениям небесной сферы и результатам их обработки и легко выбрать данные из больших астрономических каталогов для относительно небольшой области на небесной сфере. Приведены примеры использования АВС.

Ключевые слова: база данных, веб-сервис, виртуальная обсерватория.