SF2A 2009
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THE CONSTRUCTION OF THE LARGE QUASAR ASTROMETRIC CATALOGUE (LQAC)

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Abstract. We gather the 12 largest quasar catalogues (4 from radio interferometry programs, 8 from optical survey) and we carry out systematic cross-identifications of the objects to obtain their best position estimates, and providing physical information at both optical and radio wavelenghts. This catalogue compilation designated LQAC, give equatorial coordinates of 113 666 quasars with 9 photometry magnitude, 5 radio fluxes, redshift and absolute magnitude.

1 Scientific and technical objectives

The main scientific objective was to build an astrometric and Multi-wavelength catalogue gathering all QSO's named Large Quasar Astrometric Catalogue (LQAC). This catalogue was also usefull to help for the construction of the optical catalogue reference frame (LQRF - Andrei et al., 2009), to complete optical data for radio sources from the Second Realization of the International Celestial Reference Frame (Alan L. Fey et al., 2009) and for the preparation of an input QSO catalogue for GAIA mission. The creation of this catalogue was also interesting for studies like the link between QSO's radio position and optical positions, the analysis of QSO neighbourhood, their distribution in space and their color magnitude diagrams.
The main technical objective was to compile the largest QSO catalogues following the astrometric precision of each catalogue in descending order. For each QSO, its catalogue origin was kept and a specific processing was done to detect the right or wrong double identifications. To our compiled set of catalogues we added only QSO from Véron and Véron (2006) catalogue which were not identified. We added also magnitude from large star survey catalogues (2MASS, GSC 2.3, B1.0) to complete magnitude information whenever it was necessary. To control our procedures we worked with two differents softwares (home fortran programs and virtual observatory tools) and two differents teams working on the same catalogues taken one by one and with the same compilation strategy.

2 Results

The final catalogue LQAC was constructed with the compilation of 12 large QSO catalogues (optical and radio) and included 113 666 quasars, 5 radio fluxes (1.4 Ghz, 2.3 Ghz, 5.0 Ghz, 8.4 Ghz, 24 Ghz), 7 photometric magnitude visible (u, b, v, g, r, i, z), 2 infrared magnitude (j, k) and the redshift value.
The accuracy of QSO sources was at the level of the milliarcsecond for sources from ICRF and not worse than 2 arc seconds for sources from Hewitt and Burbidge catalogue and Véron and V́eron catalogue. In Fig. 1 (left) we show the accuracy of each catalogue and the radius choosen to make the cross-identification. In Fig. 1 (right) we show the accuracy of each catalogue after cross-identification. In Fig. 2 (left) we show the contribution in magnitude, fluxes and redshift of each individual catalogue (named from A to L letter) to the LQAC. After the construction of this catalogue, we have written an article on it in Astronomy and Astrophysics which has been published this year (Souchay, et al. 2009).

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Catalogue	Flag	Wavelength	No. quasars	Accuracy ″	Search radius ″
ICRF-Ext2	A	radio	717	0.001	1
VLBA	B	radio	3 357	0.001	1
VLA-015	C	radio	1 701	0.015	1
JVAS	D	radio	2 118	0.2	1
SDSS	E	optical	74 868	0.2	1
2QZ	F	optical	22 971	0.2	1
FIRST	G	radio	969	0.5	2
VLA+015	H	radio	157	0.2	2
HB	I	optical+radio	7 245	1.5	2-5-30*
2MASS	J	infrared	–	0.2	1
GSC2.3	K	optical	–	0.2	1
B1.0	L	optical	–	0.2	1
VV06	M	optical+radio	85 189	1.0	2-5-10*

* Three different search radii have been considered for the cross-identification.

	Mean (mas)		σ (mas)			
	$\Delta\alpha\cos\delta$	$\Delta\delta$	$\Delta\alpha\cos\delta$	$\Delta\delta$	N_1	N_2
VLBA	−0.010	0.039	0.767	0.585	94	4
JVAS	−0.054	−0.009	1.025	1.391	63	10
VLA	−3.287	−0.081	9.793	12.629	90	5
SDSS	1.210	−12.203	52.022	51.728	96	4
2QZ	86.242	45.991	193.667	181.214	98	3
FIRST	−30.282	0.010	286.750	319.342	96	3
HB	97.800	100.152	726.512	785.789	85	5
VV06	30.393	286.513	582.571	586.322	97	3

N_1 stands for the number of quasars remaining after a 3σ rejection threshold algorithm, and N_2 for the number of necessary iteration.

Fig. 1. Left: Accuracy of individual catalogue. Right: Accuracy after cross-identification.

	A	B	C	D	E	F	G	H	I	J	K	L	Total
u	0	0	0	0	74 861	20 912	0	0	570	0	0	0	**96 343**
b	0	0	0	0	0	22 965	966	0	836	0	69 355	2 131	**96 253**
v	0	0	0	0	0	0	0	0	6 949	0	41 517	0	**48 466**
g	0	0	0	0	74 862	0	0	0	0	0	0	0	**74 862**
r	0	0	0	0	74 861	20 305	413	0	0	0	3 502	455	**99 537**
i	0	0	0	0	74 861	0	0	0	0	0	7 517	3 765	**86 143**
z	0	0	0	0	74 861	0	0	0	0	0	0	0	**74 861**
J	0	0	0	0	0	0	0	0	0	13 647	0	0	**13 647**
K	0	0	0	0	0	0	0	0	0	13 647	0	0	**13 647**
1.4 GHz	0	0	730	0	0	0	937	144	0	0	0	0	**1 811**
2.3 GHz	0	3 234	0	0	0	0	0	0	0	0	0	0	**3 234**
5.0 GHz	0	0	821	0	0	0	0	41	0	0	0	0	**862**
8.4 GHz	0	3 225	46	570	0	0	0	17	0	0	0	0	**3 858**
24 GHz	0	0	61	0	0	0	0	0	0	0	0	0	**61**
redshift	0	0	0	0	74 866	20 912	413	0	5 344	0	0	0	**101 535**

Fig. 2. Contribution of individual catalogue

3 OV Tools used

The Virtual Observatory Tools used to construct the LQAC were Aladin freeware (from CDS see http://aladin.u-strasbg.fr/aladin) to visualize the catalogues orign. We can see in Fig. 3 (left) the LQAC vizualised by Aladin freeware on the sky. We used VizieR tools from CDS (see http://vizier.u-strasbg.fr/viz-bin/VizieR) to get the differents catalogues files. At last we used Topcat and Stilts (see http://www.starlinl.ac.uk/stilts and http:/www.star.bris.ac.uk/ mbt/topcat) to make cross matching and to construct the LQAC Data Base. We can see in Fig. 3 (right) our complete LQAC xml file with Topcat. We have written in our A&A article a section about the OV tools used to show the power of these new tools and also to recognize the good work of the provider of these free tools (Fig. 4, left). The LQAC is now accessible on the CDS web with the reference J/A+A/494/799 this VizieR Web Service. We can see in Fig. 4 (right) the LQAC xml file in Vizier.

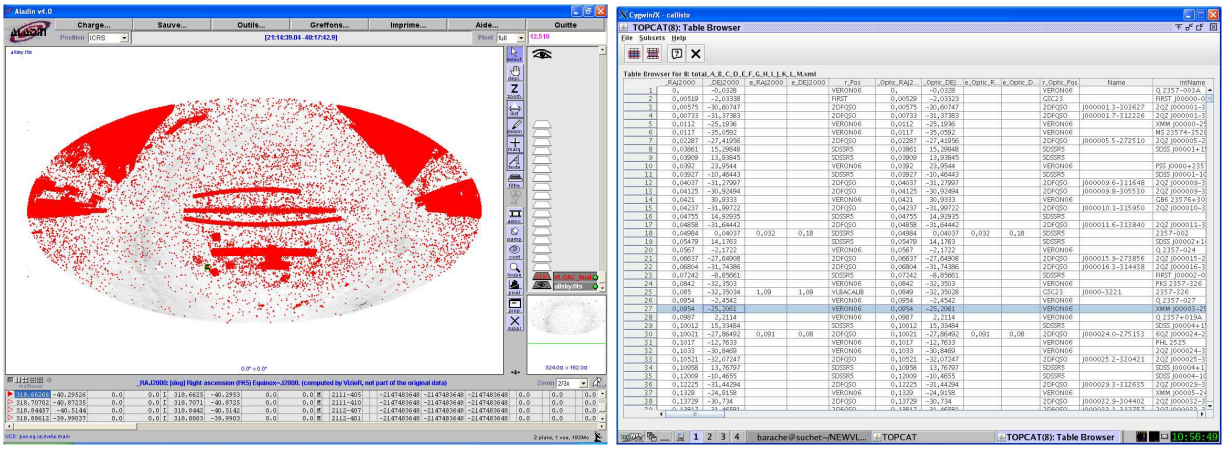

Fig. 3. Left: LQAC loaded with Aladin. Right: LQAC file loaded with topcat.

2.3. Virtual Observatory Input Data catalogues and manipulation tools

Most catalogues included in this compilation were extracted from the Centre de Données astronomiques de Strasbourg using the web tool Vizier (http://vizier.u-strasbg.fr/viz-bin/VizieR) and Votable format, as defined by the International Virtual Observatory Alliance (IVOA).

We made use of Aladin, a freeware tool provided by the CDS, to manipulate star or quasar catalogues and data imaging associated with these objects (see http://aladin.u-strasbg.fr/aladin.gml) for preliminary studies and for plotting the sky distribution of the quasars in the catalogues. To validate our tools and input data, two different software packages have been used for cross identification and data processing but dealing with the same parameters and strategy: (i) homemade FORTRAN programs, and (ii) scripts using Virtual Observatory tools named Stilts (see http://www.starlink.ac.uk/stilts) and Topcat (see http://www.star.bris.ac.uk/ mbt/topcat)

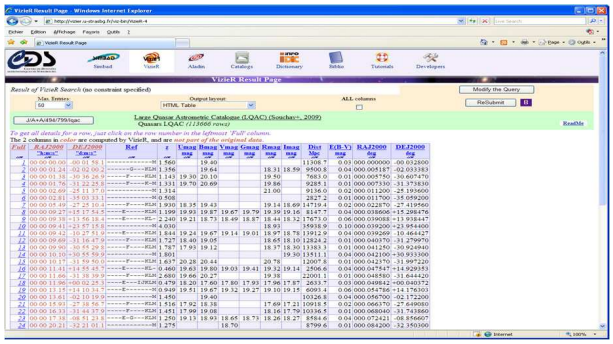

Fig. 4. Left: OV tools section of LQAC article. Right: LQAC file load by VizieR Web Service.

4 Conclusion

We are now preparing a new version of LQAC (LQAC 2.0) to improve the catalogue. We will resolve the wrong double QSO (300 pair of QSO's are in LQAC, their double status being doubtful). We will add some picture associated to each QSO and we will improve the homogeneity of magnitudes. We will also add a criterion of source geometry (for instance near star form than galaxy form).

The VO tools used for the LQAC were useful to get and study catalogue (Aladin, VizieR), to make cross-matching of sources (Topcat) and to manage, distribute the LQAC file catalogue easily (Topcat).
However, theses tools are a little limited for instance to get the data from very large catalogues, to make some complex cross-matching. Moreover we have found difficulties to get the magnitude system photometric used in the magnitude of sources in VO tables.

References

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