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A catalogue of quasars and active nuclei: 13th edition*

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ABSTRACT

Aims. This catalogue is aimed at presenting a compilation of all known AGN in a compact and convenient form, and we hope that it will be useful to all workers in this field.
Methods. Like the twelfth edition, it includes position and redshift as well as photometry (U, B, V) and 6 cm and 20 cm flux densities when available.
Results. The present version contains 133 336 quasars, 1 374 BL Lac objects and 34 231 active galaxies (including 16 517 Seyfert 1s), almost doubling the number listed in the 12^{th} edition. We also give a list of all known lensed and double quasars.

Key words. Quasars: general; galaxies: Seyfert; BL Lacertae objects: general.

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1. Introduction

The first catalogue of quasars was published in 1971 by De Veny et al. It contained 202 objects. The number of known quasars has since steadily increased until the year 2000 (see Table 1). The release of both the 2dF catalogue (Croom et al. 2001; 2004) and the first four data releases (Abazajian et al. 2003; 2004; 2005; Adelman-McCarthy et al. 2006) of the "Sloan Digital Sky Survey" (Fan et al. 1999) has dramatically increased the number of known quasars justifying the 10th, 11th and 12th editions of the present catalogue. The recent publication of the last three data releases (5th, 6th and 7th)(Adelman-McCarthy et al. 2007; 2008; Abazajian et al. 2009) of the SDSS, which has again almost doubled the number of known quasars, made a new edition timely.

Table 1. Increase with time of the number of known QSOs, BL Lacs and Seyfert 1s

QSO	BL Lac	Seyfert 1	reference
202			De Veny et al. 1971
2 251		190	Véron-Cetty & Véron 1984
2 835	73	236	Véron-Cetty & Véron 1985
3 473	84	258	Véron-Cetty & Véron 1987
4 169	117	358	Véron-Cetty & Véron 1989
6 225	162	575	Véron-Cetty & Véron 1991
7 383	171	695	Véron-Cetty & Véron 1993
8 609	220	888	Véron-Cetty & Véron 1996
11 358	357	1 111	Véron-Cetty & Véron 1998
13 214	462	1 711	Véron-Cetty & Véron 2000
23 760	608	2 765	Véron-Cetty & Véron 2001
48 921	876	6 762	Véron-Cetty & Véron 2003
85 221	1 122	9 628	Véron-Cetty & Véron 2006
133 336	1 374	16 517	Present edition

This edition contains quasars with measured redshift known to us prior to July 1^{st}, 2009. As in the preceding editions, we do not give any information about absorption lines or X-ray properties. But we give the absolute magnitude for each object and, when available, 20 and 6 cm flux densities.

This catalogue should not be used for any statistical analysis as it is not complete in any sense, except that it is, we hope, a complete survey of the literature.

2. Description of the catalogue

We have arbitrarily defined a quasar as a starlike object, or an object with a starlike nucleus, with broad emission

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* The catalogue (Table_QSO, Table_BL, Table_AGN and Table_reject) and the list of references are only available in electronic form at the Centre de Données Stellaires in Strasbourg (http://cdsweb.u-strasbg.fr/) or at the Observatoire de Haute Provence (http://www.obs-hp.fr/catalogues/veron2_13/veron2_13.html)

Table 1

Name	Alpha (J2000)	Delta (J2000)		S 6		S21		Z		V	B–V	U–B	Mabs	References			Alpha (B1950)	Delta (B1950)
FIRST J00000-0202	0 0 1.3	- 2 2 0	R			0.001	2530	1.356		19.64			-24.6			179	23 57 27.5	- 2 18 42
2QZ J000001-3036	0 0 1.4	-30 36 27	O					1.143		*20.10		-0.80	-23.7		539	539	23 57 27.4	-30 53 9
2QZ J000001-3122	0 0 1.7	-31 22 26	O					1.331		*20.69		-0.99	-23.5		539	539	23 57 27.7	-31 39 8
XMM J00000-2511	0 0 2.7	-25 11 37	O					1.314	S1	R21.			-22.6			751	23 57 28.8	-25 28 19
MS 23574-3520	0 0 2.8	-35 3 33	O		2242			0.508		O17.0			-25.0	1403		2242	23 57 28.8	-35 20 15
2QZ J000005-2725	0 0 5.6	-27 25 10	O					1.930		*19.43		-1.07	-25.5		537	537	23 57 31.6	-27 41 52
SDSS J00001+0030	0 0 6.6	0 30 55	O				2068	1.823		20.37	0.24	-0.88	-24.1		2068	2068	23 57 32.8	0 14 13
SDSS J00001+0016	0 0 8.2	0 16 35	O				2068	1.837		20.03	0.32	-0.79	-24.4		2068	2068	23 57 34.4	- 0 0 7
SDSS J00001+1517	0 0 9.3	15 17 54	O					1.199		19.65	0.35	-0.68	-23.9		3	3	23 57 35.6	15 1 12
SDSS J00001+1356	0 0 9.4	13 56 18	O					2.240		18.63	0.43	-0.56	-26.1		2068	2068	23 57 35.7	13 39 36
PSS J0000+2357	0 0 9.4	23 57 16						4.030		R18.93			-27.4			620	23 57 35.8	23 40 34
SDSS J00001-1027	0 0 9.4	-10 27 52	O					1.844		19.11	0.20	-0.65	-25.5		3	3	23 57 35.6	-10 44 34
2QZ J000009-3116	0 0 9.7	-31 16 48	O					1.727		*19.05		-0.65	-25.6		539	539	23 57 35.7	-31 33 30
2QZ J000009-3055	0 0 9.9	-30 55 30	O					1.787		*19.12		-1.19	-25.6		537	537	23 57 35.9	-31 12 12
GB6 23576+3039	0 0 10.1	30 56 0	R	0.049	883	0.086	483	1.801		I19.3			-24.5			1640	23 57 36.5	30 39 18
2QZ J000010-3159	0 0 10.2	-31 59 50	O					1.638		*20.44		-0.16	-24.1		537	537	23 57 36.2	-32 16 32
2QZ J000011-3138	0 0 11.7	-31 38 40	O					2.680		*20.27		-0.61	-25.6		539	539	23 57 37.7	-31 55 22
PB 5669	0 0 12.0	0 2 24	O					0.479		18.06	0.13	-0.58	-23.6		3	50	23 57 38.2	- 0 14 18
SDSS J00002-0032	0 0 12.3	- 0 32 20	O				2068	1.436		20.34	0.31	-0.88	-23.7		2068	2068	23 57 38.5	- 0 49 2
SDSS J00002+1410	0 0 13.2	14 10 34	O					0.949		19.29	0.24	-0.59	-23.9		3	3	23 57 39.5	13 53 52
Q 2357-024	0 0 13.6	- 2 10 20	O			0.002	483	*1.45		19.4			-25.0	2677		2677	23 57 39.8	- 2 27 2

Fig. 1. Sample page of the catalogue.

lines and brighter than absolute magnitude M_B=–22.25[1] (We shall described below the cosmology used). The quasars are listed in Table_QSO. A sample page is shown in Fig. 1. Clearly, some objects would move from Table_QSO to Table_AGN and vice versa if other values for H_o, q_o and the spectral index were used or if an accurate B apparent magnitude was available for all objects. The variability may have a similar effect, as well as the size of the diaphragm used for the measurement as the contribution of the underlying galaxy for low-z quasars may not be negligible.

In Table_BL, we list all confirmed, probable or possible BL Lac objects with or without a measured redshift, without consideration of their absolute magnitude. As better spectra are becoming available, broad emission lines have been detected in a number of objects formerly classified as BL Lac; they have usually been moved to Table_QSO.

Table_AGN lists "active galaxies" : Seyfert 1s, Seyfert 2s and Liners fainter than M_B=–22.25. A number of galaxies with a nuclear H II region are also included (167), the reason being that they have been called AGN in the past and later reclassified; we consider it useful to keep track of these reclassifications to avoid further confusion.

Seyfert 1s have broad Balmer and other permitted lines; Seyfert 2s have Balmer and forbidden lines of the same width. Osterbrock (1977, 1981) has divided the Seyfert 1s into five subgroups : Seyfert 1.0, 1.2, 1.5, 1.8 and 1.9 on the basis of the appearance of the Balmer lines. Seyfert 1.0s are "typical" members of the class, as described by Khachikian & Weedman (1971, 1974), while Seyfert 1.5s are objects intermediate between typical Seyfert 1s and Seyfert 2s, with an easily apparent narrow Hβ profile superimposed on broad wings. The classes Seyfert 1.2 and 1.8 are used to describe objects with relatively weaker and stronger narrow Hβ components, intermediate between Seyfert 1.0 and 1.5 and Seyfert 1.5 and 2 respectively. In Seyfert 1.9, although the broad Hα emission is clearly seen, broad Hβ cannot be detected with certainty by mere visual inspection of the spectra. We have adopted the more quantitative classification introduced by Winkler (1992) :

S1.0	5.0 $<$ R	
S1.2	2.0 $<$ R $<$ 5.0	
S1.5	0.33 $<$ R $<$ 2.0	
S1.8	R $<$ 0.33	broad component visible in Hα and Hβ
S1.9		broad component visible in Hα but not in Hβ
S2		no broad component visible

where R is the ratio of the total Hβ to the [OIII]λ5007 fluxes. Several objects have been found to show extreme spectral variability, changing from Seyfert 1.8 or 1.9 to Seyfert 1.0. In some cases these changes are consistent with changes of the reddening towards the BLR while, in others, they are probably due to real changes in ionizing flux (Goodrich 1989a, 1995; Tran et al. 1992b). In some Seyfert 2s, a broad Paβ line has been detected, indicating the presence of a highly reddened broad line region (Goodrich et al. 1994); we call these objects S1i. A number of Seyfert 2s have, in polarized light, the spectra of Seyfert 1s (Antonucci & Miller 1985; Miller & Goodrich 1990; Tran et al. 1992a); we call them S1h. Typical full widths at half-maximum of the Balmer lines in Seyfert 1s lie in the range 2 000-6 000 km s^{-1}; however, there is a group of active galactic nuclei with all the properties of Seyfert 1s, but with unusually narrow Balmer lines (Osterbrock & Pogge 1985; Goodrich 1989b); they are defined as having the broad component of the Balmer lines narrower than 2 000 km s^{-1} FWHM (Osterbrock 1987); we call them S1n. Liners (as defined by Heckman 1980)

[1] We use M_B=–22.25 instead of –23.0 as in the previous editions of this catalogue to take into account the change of the value of H_o used: 71 *vs* 50 km s^{-1} Mpc^{-1}

are called S3. If broad Balmer lines are observed, they are called S3b; if these broad Balmer lines are only seen in polarized light, they are called S3h.

Seyfert 1 galaxies and QSOs, when viewed through the absorbing dusty torus have the same optical appearance; however, they differ by their hard X-ray luminosity. It has become customary to call type 2 QSOs (or Q2s) rather than Seyfert 2 the high luminosity narrow line objects. Treister et al. (2005) call QSO2s narrow line objects with $L_{0.5-10keV}$ >10^{42} erg s^{-1} (H_o=70 km s^{-1} Mpc^{-1}) or >$10^{42.3}$ erg s^{-1} if H_o=50 km s^{-1} Mpc^{-1}, while Derry et al. (2003) have more conservatively defined QSO2s as having an intrinsic, hard (2-10 keV) X-ray luminosity larger than $10^{44.3}$ erg s^{-1} (for H_o=50 km s^{-1} Mpc^{-1}).

In Table_AGN, 9 887 objects have no classification. Most of them were originally classified as QSOs but turned out to be fainter than M_B=–22.25 and were therefore moved to this table. They should be called S1s.

Table_reject lists the objects which once were believed to be AGN and are now known to be either stars or normal galaxies.

Table_QSO contains 133 336 objects, Table_BL, 1 374, Table_AGN, 34 231 and Table_reject, 178. The catalogue is believed to contain all known quasars, BL Lac objects and Seyfert 1s. It should also contain all objects which have been unambiguously classified as Seyfert 2s, but the distiction betwen Syfert 2s, Liners, starbust galaxies and objects with composite spectra is sometimes difficult and therfore a number of these objects may have been omitted.

Table_QSO, Table_BL and Table_AGN give :

1) Cols. 1 and 2. The most common name of the object. For the meaning and the sources of the designations see Hewitt & Burbidge (1987), Fernandez et al. (1983) and Kesteven & Bridle (1977). For the sources discovered by the ROSAT X-ray satellite, we have used the following acronyms : RXS for the sources appearing in the All-Sky Bright Source Catalogue (Voges et al. 1999), 1WGA for the sources published in the WGACAT catalogue (White et al. 1994) and RX for the others.

When the name is preceded by an *, the object has not been explicitly associated with a radio source.

2) Cols. 3 to 10. The best available J2000 optical or radio coordinates. The J2000 positions have been converted from the B1950 positions using the matrix given by Aoki et al. (1983). An O or an R following the coordinates means that the position is either an optical or a radio position measured with an accuracy better than one arc sec. An A means that it is only an approximate position which may be wrong by several arc minutes. No reference is given for the source of the positions.

3) Cols. 11 to 14. The 6 and 20 cm flux densities (in Jy) with references to the literature. When several measurements are available we took one of them arbitrarily. When a reference is given for the 6 cm flux density but the value of the flux density itself is left blank and there is an * in column 1, only an upper limit is available and this upper limit is not much greater than 1 mJy; in case there is no * in column 1, the reference refers to a detection but at a wavelength other than 6 cm.

The 20 cm flux densities have been taken mainly from the NRAO VLA Sky Survey (NVSS) (Condon et al. 1998) and the FIRST survey (Becker et al. 1995; White et al. 1997). The NVSS covers the sky north of δ(J2000.0)=–40°. It contains 1 814 748 discrete sources stronger than S$\sim$2.5 mJy. The resolution was 45″ FWHM. The r.m.s. uncertainties in α and δ vary from $\leq$1″ for the sources stronger than 15 mJy to 7″ at the survey limit. The FIRST survey was carried out with the VLA. It covers an area of 9 033 deg^2 to a sensitivity limit of $\sim$1 mJy. It contains 811 118 sources. Source positions are good to better than 1″. The beam size was 5.″4.

4) Cols. 15 and 16. The redshift as published. An * in front of the redshift means that it has been estimated from a low dispersion slitless spectrum and is of lesser accuracy or even plainly wrong as the emission lines may easily have been misidentified. We have given only those values which are described as probable in the original sources and not the possible values.

5) Col. 17. In this column an attempt has been made to classify the objects as Q, Q2, Q?, S1, S1.0, S1.2, S1.5, S1.8, S1.9, S1i, S1h, S1n, S2, S3, S3b, S3h, S, S? or H2. Q is for quasars, while Q? indicates an object which has been classified as a quasar in one of the SDSS data release but whose nature appears quite uncertain upon visual inspection of the SDSS spectrum. Low redshift quasars are classified as S1 when a good spectrum shows that they are similar to Seyfert 1 galaxies.

In Table_BL, we find in this column :

BL	for a confirmed BL Lac object.
BL?	for a probable BL Lac
blank	for a possible BL Lac.
?	for a questionable BL Lac
HP	for a Highly Polarized object.

6) Cols. 18 to 21. The V, B–V and U–B photoelectric or photographic magnitude and colours when available (an * in front of the magnitude indicates that the colours and the magnitude are photographic). The column labelled "V" gives the V magnitude when B–V is also given; if this is not the case, this column usually gives the B magnitude unless it is preceded by a V, an R or an I, indicating a visible, a red or an infrared magnitude respectively. For a few objects the O magnitude, measured on the blue Palomar Sky Survey plates, or the UK Science Research Council SRC-J Survey plates, believed to be accurate within ± 0.2 mag., has been extracted from the APS database (Pennington et al. 1993). For a number of other objects we give the O magnitude, extracted from the USNO-A2 catalogue (Monet et al. 1996) or the Cambridge Automated Plate Measuring Machine (APM) catalogue (Irwin et al. 1994), recalibrated by E. Flesch (private communication); these magnitudes are flagged

with an O. The O and Johnson B magnitudes are related by B–O=–(0.27±0.06)×(B–V) (Evans, 1989).

For the SDSS objects we give V, B–V and U–B computed from u', g' and r' by the following equations[2] (Jester et al. 2005):

$V = g' - 0.52 \times (g' - r') - 0.03$

$B - V = 0.62 \times (g' - r') + 0.15$

$U - B = 0.75 \times (u' - g') - 0.81$

In the other cases, the magnitude given is an estimate as found in the original publications. These magnitudes are generally quite inaccurate and inhomogeneous; they are most often m_{pg} or B magnitudes instead of the Johnson V magnitude. Much care should be taken when using them for any purpose. Anyway, even when a photoelectric V magnitude is given, it is not very meaningful as most quasars are variable. On the other hand, the colours of quasars vary little, so the listed colours should be accurate[3]. Again, it should be noted that some of the colours listed are photographic and, therefore, less accurate; moreover, in each catalogue of photoelectric measurements, the faintest objects measured are affected by relatively large errors; this too should not be overlooked. For bright galaxies in Table_AGN, when photoelectric UBV photometry is available, we have chosen the magnitudes and colours measured in the smallest possible diaphragm (preferentially 16 arcsec) as we are interested in the nucleus rather than in the galaxy itself.

Fig. 2 is a plot of B–V and U–B *vs* z for 104 328 QSOs, most of them from the SDSS catalogue. There is a good correlation between these quantities, however there are a number of discrepant points; many of them are due to errors in the SDSS redshift or photometry. For example, the small cluster of points near z=3.3 and U–B=–0.5 is due to the misidentification of Mg II λ2800 for Lyα.

7) Col. 22. To compute the absolute magnitudes M_B, we have used a flat cosmology with H_o=71 km s^{-1} Mpc^{-1}, Ω_M=0.29 and Ω_Λ=0.71 (see for instance Perlmutter et al. 1999 or Riess et al. 2004), assuming an optical spectral index α (defined as $S \propto \nu^{-\alpha}$) equal to 0.3 (Francis et al. 1991)[4], as follows :

$$\mathrm{M_B} = \mathrm{B} + 5 - 5 \times log\mathrm{D} - \mathrm{k} + \Delta\mathrm{m(z)}$$

where D is the luminosity distance as defined by Riess et al. (2004):

$$D = c/H_o \times (1+z) \int_o^z [(1+z)^3 \times \Omega_M + \Omega_\Lambda]^{-0.5} dz$$

z is the redshift, $k = -2.5 \times log(1+z)^{1-\alpha}$ the k correction, Δm(z) is a correction to k taking into account the fact that the spectrum of quasars is not strictly a power law of the form $S \propto \nu^{-\alpha}$, but is affected by emission lines and by the Ly α forest depleting the continuum to the blue of Ly α (see Table 2 for the values of Δ m(z) for z<5.0; for larger values of z, we arbitrarily used Δm(z)=3.60). These corrections have been computed in a way similar to Wisotzky (2000) using the mean emission line strenghts available at the time (1986). These values are in reasonable agreement with those of this last author who gives these corrections for z<2.2.

[2] These relationships have been derived for QSOs with z<2.1. For larger redshift objects, the uncertainties on the computed colors are expected to be larger.

[3] Indeed this is only true if the measurements in the various colours are simultaneous or quasi simultaneous, but this is almost always the case

[4] Assuming α=0.3 may not give the best possible estimate of the k correction (Wisotzki 2000).

Table 2. Values of Δm(z) *vs* z used for z=0.0 to 5.0.

z	Δm(z)	z	Δm(z)	z	Δm(z)
0.0	0.00	1.7	−0.15	3.4	0.79
0.1	0.00	1.8	−0.15	3.5	0.93
0.2	0.00	1.9	−0.14	3.6	1.13
0.3	0.00	2.0	−0.12	3.7	1.15
0.4	−0.06	2.1	−0.14	3.8	1.17
0.5	−0.11	2.2	−0.20	3.9	1.35
0.6	−0.11	2.3	−0.02	4.0	1.50
0.7	−0.09	2.4	0.00	4.1	1.65
0.8	−0.04	2.5	0.04	4.2	1.80
0.9	0.00	2.6	0.09	4.3	1.95
1.0	−0.01	2.7	0.19	4.4	2.15
1.1	−0.04	2.8	0.27	4.5	2.45
1.2	−0.05	2.9	0.34	4.6	2.70
1.3	−0.05	3.0	0.40	4.7	2.95
1.4	−0.05	3.1	0.48	4.8	3.20
1.5	−0.09	3.2	0.57	4.9	3.40
1.6	−0.14	3.3	0.67	5.0	3.60

The O, V, R and I magnitudes have been transformed into the B system by using <B–O>=–0.11, <B–V>=0.40, <B–R>=0.57 and <B–I>=1.1 respectively for low z QSOs.

8) The next three columns (23 to 25) give the reference for the finding chart, the photometry and the redshift respectively. In many cases, the last reference in Table_AGN is that of the classification of the object (as a Seyfert or otherwise); in these cases the redshift can usually be found in Palumbo et al. (1983).

9) The B1950 position (cols. 26 to 32).

Since the discovery in 1979 by Walsh et al. of the first gravitationally lensed quasar, Q 0957+561, a number of such objects (88) and of physical pairs with separation less than 10" (47) have been found. They are listed in Tables 3 and 4 respectively. Mortlock et al. (1999) have stressed the difficulty sometimes encountered in distinguishing lensed quasars from physical pairs.

3. The large quasar astrometric catalogue(LQAC)

Souchay et al. (2009) have recently published a catalogue of 113 666 "quasars" by compiling a number of published optical and radio catalogues. As a result this is

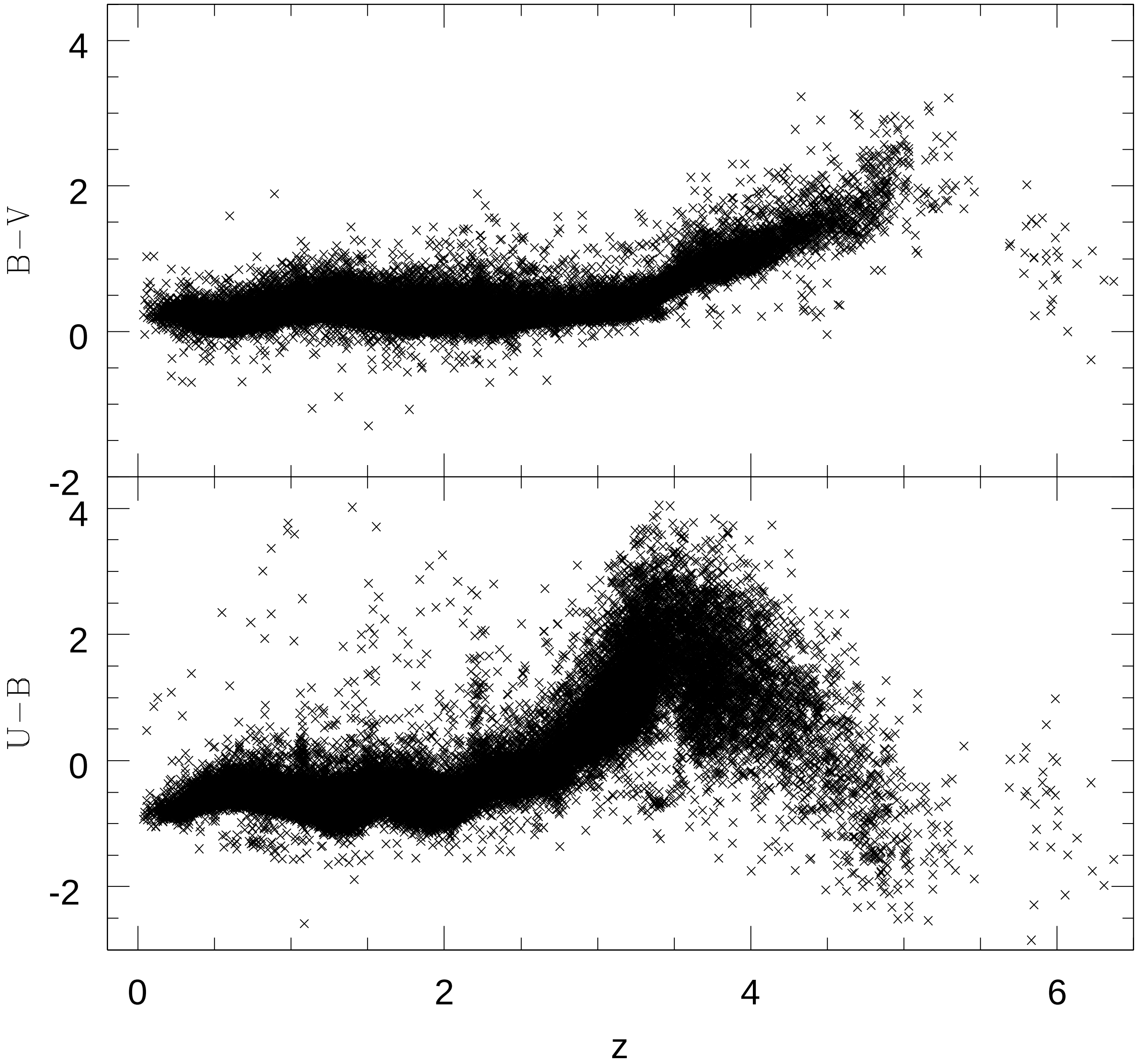

Fig. 2. Plot of B–V and U–B *vs* z for 104 328 QSOs, most of them from the SDSS catalogue.

not, strickly speaking, a quasar catalogue as a number of included objects (2 921) have no optical identification or measured redshift. The optical catalogues used are the first five data releases of the SDSS catalogue (Adelman-McCarthy et al. 2007) and the 2dF (Croom et al. 2004) and two compilations : HB (Hewitt & Burbidge 1993) and VV06 (Véron-Cetty & Véron 2006). The VV06 catalogue includes all HB quasars with, however, for many objects a more accurate optical position than those quoted in the much older HB. We have cross-correlated two sub-samples of the LQAC catalogue, one containing the objects included in HB, the other one those which do not appear in this catalogue, looking for pairs separated by less than 300″. We have found 1 011 such pairs with a redshift difference larger than 0.05 and 533 with a redshift difference smaller or equal to this value. The plot of the $\Delta\alpha$, $\Delta\delta$ values for the 1 011 pairs shows an almost uniform distribution suggesting that these pairs are mostly made of two distinct objects. On the other hand, a similar plot for the 533 pairs having nearly the same redshift shows a strong concentration toward the center of the plot indicating that most of them are in fact duplications of the same object at two different positions.

Table 3. Gravitationally lensed quasars. Col. 1 : name, col. 2 : short 1950 position, col. 3 : redshift of the quasar, col. 4 : redshift of the lens, col. 5 : separation in arc sec, col. 6 : references.

Name	Position	z_{quasar}	z_{lens}	sep(")	Ref.
HE 0047−1756	0047−17	1.67	0.408	1.44	78,87
PKS 0132−097	0132−09	2.216	0.764	0.7	14,18,68
UM 673	0142−10	2.719		2.2	60
CTQ 414	0156−43	1.294	0.317	1.2	46,101
B2 0218+35	0218+35	0.936		0.33	15
HE 0230−2130	0230−21	2.162	0.522	2.0	72,87
Q J0240−343	0238−34	1.406		6.1	62
SDSS J02465−0825	0244−08	1.684		1.04	85
PKS 0411+05	0411+05	2.639	0.958	2.2	34,64
HE 0435−1223	0435−12	1.689	0.456	2.6	73,80
HE 0512−3329	0512−33	1.565	0.931	0.6	12
B 0712+472	0712+47	1.339		1.27	8
SDSS J07402+2926	0737+29	0.980		2.6	84
SDSS J07468+4403	0743+44	1.998		1.08	89
MG 0751+2716	0748+27	3.200	0.350	0.8	64
SDSS J08063+2006	0803+20	1.540		1.50	13,102
HS 0810+25	0810+25	1.500		0.25	55
SDSS J08192+5356	0816+54	2.237	0.294	4.04	99
SDSS 08202+0812	0817+08	2.024	0.803	2.3	103
HS 0818+1227	0818+12	3.115		2.1	16
CLASS B0827+525	0827+52	2.064		2.8	31
APM 08279+5255	0827+52	3.87		0.4	35
SDSS J08322+0404	0829+04	1.115		2.0	94
SDSS 09035+5028	0900+50	3.584	0.388	2.8	28
RX J0911.4+0551	0908+06	2.800		0.8	1
SBS 0909+532	0909+53	1.377	0.830	1.11	30,39
1WGA J09212+4528	0917+45	1.66	0.31	6.93	51
SDSSp J09249+0219	0922+02	1.524	0.393	1.8	26,87,88
FBQS J0951+2635	0948+26	1.24		1.1	56
BRI 0952−01	0952−01	4.43		0.95	43
Q 0957+561	0957+56	1.414	0.355	6.1	11,65
SDSS J10014+5027	0958+50	1.838		2.86	83
FIRST J10044+1229	1001+12	2.65		1.54	32
RXS J10045+4112	1001+41	1.734	0.680	14.6	76,100
Q 1009−0252	1009−02	2.74	0.871	1.55	21,87
J 13.03	1015−20	2.55		0.84	61
SDSS J10211+4913	1018+49	1.720		1.14	74
IRAS F10214+4724	1021+47	2.286	0.896		57
SDSS J10292+2623	1026+26	2.197		22.5	92
B 1030+074	1030+07	1.535		1.56	8
SDSS J10353+0752	1032+08	1.215		2.7	84
HE 1104−1805	1104−18	2.303	0.729	3.0	37,70
PG 1115+080	1115+08	1.722	0.311	2.3	63,66
HE 113-0641	1113−06	1.235		0.67	97
SDSS J11202+6711	1117+67	1.494		1.5	84
UM 425	1120+01	1.465		6.5	44
SDSS J11249+5710	1122+57	2.311		2.2	84
1RXS J11319−1231	1129−12	0.658	0.295	4.2	58
SDSS J11381+6807	1135+68	0.769		2.6	84
SDSS J11380+0314	1135+03	2.442		1.44	100

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Table 3. (continued)

Name	Position	z_{quasar}	z_{lens}	sep(")	Ref.
TEX 1152+199	1152+19	1.019	0.439	1.6	52
SDSS J11552+6346	1152+64	2.89	0.176	1.8	75
CSO 1270	1203+43	1.789	0.748	2.90	83
Q 1208+1011	1208+10	3.803		0.45	41
SDSS J12167+3529	1214+35	2.012		1.5	94
SDSS J12261−0006	1223+00	1.121		1.24	100
SDSS J12511+2935	1248+29	0.802	0.410	1.79	95
SDSS J12543+2235	1251+22	3.626		1.56	99
SDSS J12583+1657	1255+17	2.701		1.28	99
SDSS J13139+5151	1311+52	1.875		1.24	96
SDSS J13226+1052	1320+11	1.716		2.0	94
SDSS J13323+0347	1329+04	1.445		1.14	90
Q 1333+0133	1333+01	1.577		1.6	81
SDSS J13531+1138	1350+11	1.629		1.41	13
87GB 1359+1527	1359+15	3.235		1.7	52
SDSS J14002+3134	1357+31	3.317		1.74	99
SDSS J14064+6126	1404+61	2.134		1.98	89
H 1413+117	1413+11	2.546		1.4	40
HST J14176+5226	1415+52	3.4		3.2	5
B 1422+231	1422+23	3.62	0.339	1.3	53,63
SDSS J15087+3328	1506+33	0.878		2.9	84
SBS 1520+530	1520+53	1.855	0.717	1.6	3,4
SDSS J15247+4409	1523+44	1.210		1.7	94
Q 1600+434	1600+43	1.61		1.38	27
PMN J1632-0033	1630−00	3.424		1.46	69
FIRST J1633+3134	1631+31	1.516		0.66	48
KP 1634.9+26.7	1634+26	1.961		3.8	59
SDSSp J16507+4251	1649+42	1.541		1.16	49
MC 1830−211	1830−21	2.507	0.885	0.60	36,38
TEX 1835−345	1835−34	2.78		1.0	67
MG 2019+1127	2016+11	3.273		3.4	33
WFI J2026-4536	2022−45	2.237		1.4	77
WFI J2033-4723	2030−47	1.661	0.658	2.5	77,87

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Table 3. (end)

Name	Position	z_{quasar}	z_{lens}	sep(")	Ref.
87GB 20451+2632	2045+26	1.28	0.867	1.9	9
Q 2138−431	2138−43	1.641		4.5	19
HE 2149-2745	2149−27	2.033		1.7	71
Q 2237+0305	2237+03	1.695	0.039	1.8	24
SDSS J23431-0050	2340−01	0.788		1.4	98

References:(1) Bade et al. 1997; (2) Brotherton et al. 1999; (3) Burud et al. 2002; (4) Chavushyan et al. 1997; (5) Crampton et al. 1996; (6) Crotts et al. 1994; (7) Djorgovski et al. 1987; (8) Fassnacht & Cohen, 1998; (9) Fassnacht et al. 1999; (10) Faure et al. 2003; (11) Garrett et al. 1992; (12) Gregg et al. 2000; (13) Inada et al. 2006; (14) Gregg et al. 2002; (15) Grundahl & Hjorth, 1995; (16) Hagen & Reimers 2000; (17) Hagen et al. 1996; (18) Hall et al. 2002; (19) Hawkins et al. 1997; (20) Hewett et al. 1989; (21) Hewett et al. 1994; (22) Hewett et al. 1998; (23) Hewitt et al. 1987; (24) Huchra et al. 1985; (25) Impey et al. 2002; (26) Inada et al. 2003; (27) Jackson et al. 1995; (28) Johnston et al. 2003. (29) Junkkarinen et al. 2001; (30) Kochanek et al. 1997; (31) Koopmans et al. 2000; (32) Lacy et al. 2002; (33) Lawrence et al. 1984; (34) Lawrence et al. 1995; (35) Ledoux et al. 1998; (36) Lidman et al. 1999; (37) Lidman et al. 2000; (38) Lovell et al. 1998; (39) Lubin et al. 2000; (40) Magain et al. 1988; (41) Magain et al. 1992; (42) Mason et al. 2000; (43) McMahon et al. 1992; (44) Meylan & Djorgovski 1989; (45) Meylan et al. 1990; (46) Morgan et al. 1999; (47) Morgan et al. 2000; (48) Morgan et al. 2001; (49) Morgan et al. 2003; (50) Muñoz et al. 1998; (51) Muñoz et al. 2001; (52) Myers et al. 1999; (53) Patnaïk et al. 1992; (54) Pelló et al. 1996; (55) Reimers et al. 2002; (56) Schechter et al. 1998; (57) Serjeant et al. 1995; (58) Sluse et al. 2003; (59) Steidel & Sargent, 1991; (60) Surdej et al. 1987; (61) Surdej et al. 1997; (62) Tinney, 1995; (63) Tonry, 1998; (64) Tonry & Kochanek, 1999; (65) Tytler & Fan 1992; (66) Weymann et al. 1980; (67) Winn et al. 2000; (68) Winn et al. 2002a; (69) Winn et al. 2002; (70) Wisotzki et al. 1993; (71) Wisotzki et al. 1996; (72) Wisotzki et al. 1999; (73) Wisotzki et al. 2002; (74) Pindor et al. 2006; (75) Pindor et al. 2004; (76) Inada et al. 2003; (77) Morgan et al. 2004; (78) Wisotzki et al. 2004; (79) Green et al. 2004; (80) Morgan et al. 2005; (81) Oguri et al. 2004; (82) Green et al. 2002; (83) Oguri et al. 2005; (84) Hennawi et al. 2006; (85) Inada et al. 2005; (86) Heidt et al. 2003; (87) Ofek et al. 2006; (88) Eigenbrod et al. 2006; (89) Inada et al. 2007; (90) Morokuma et al. 2007; (91) Djorgovski et al. 2007; (92) Inada et al. 2006; (93) Ellison et al. 2007; (94) Oguri et al. 2008; (95) Kayo et al. 2007; (96) Ofek et al. 2007; (97) Blackburne et al. 2008; (98) Jackson et al. 2008; (99) Inada et al. 2009; (100) Inada et al. 2008; (101) Faure et al. 2009; (102) Sluse et al. 2008; (103) Jackson et al. 2009; (104) Myers et al. 2008.

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Table 4. Quasar pairs. Col. 1 : name, col. 2 : short 1950 position, col. 3 : redshift of the quasar, col. 4 : separation in arc sec, col. 5 : references (see table 2).

Name	Position	z	sep(")	Ref.
LBQS 0015+02	0015+02	2.469	2.2	25
Q 0023+171	0023+17	0.945	4.8	23
SDSS J00480−1051	0045−11	1.557	3.6	84
CT 344	0103−27	0.848	0.3	29
PHL 1222	0151+04	1.910	3.3	45
SDSS J02451−0113	0242−01	2.46	4.5	84
SDSS J02483+0009	0245−00	1.645	6.9	84
CTQ 839	0250−33	2.24	2.1	47
PKS 0537-44	0537−44	0.89	4.0	86
SDSS J07479+4318	0744+43	0.50	9.2	84
SDSS J09591+5449	0955+55	1.95	3.9	84
SDSS J10287+3929	1025+39	1.89	7.5	84
SDSS J10348+0701	1032+07	1.25	3.1	84
2QZ J105644−0059	1054−00	2.13	7.2	84
SDSS J11161+4118	1113+41	1.98	13.0	93
SDSS J11202+6711	1117+67	1.494	1.5	74
Q 1145−071	1145−07	1.34	4.2	7
SDSS J11583+1235	1155+12	0.596	3.6	104
HS 1216+5032	1216+50	1.450	8.9	17,79
SDSS J12257+5644	1223+57	2.38	6.0	84
SDSS J12599+1241	1257+12	2.19	3.6	84
SDSS J13033+5100	1301+51	1.68	3.8	84
SDSS J1320+3056	1318+31	1.595	4.7	104
SDSS J13372+6012	1335+60	1.73	3.1	84
RRS IV 26,27	1343+26	2.030	9.5	6
SDSS J13494+1227	1347+12	1.72	3.0	84
SDSS J14050+4447	1403+45	2.23	7.4	84
SDSS J14098+3919	1407+39	2.08	6.8	84
SDSS J1418+2441	1416+24	0.572	4.5	104
SDSS J1426+0719	1423+07	1.312	4.3	104
SDSS J14279-0121	1425−01	2.30	6.2	84
SDSS J1430+0714	1427+07	1.246	5.4	104
Q 1429−008	1429−00	2.076	5.1	10,20,91
SDSS J1458+5448	1456+55	1.913	5.1	104
SDSS J15306+5304	1529+53	1.53	4.1	84
SDSS J16002+0000	1557+00	1.010	1.8	74
SDSS J1606+2900	1604+29	0.763	3.4	104
RX J16290+3724	1627+37	0.923	4.3	42
SDSS J1635+2911	1633+29	1.582	4.9	104
Q J1643+31	1641+32	0.586	2.3	2
SDSS J17232+5904	1722+59	1.60	3.7	84
SDSS J21289−0617	2126−06	2.07	8.3	84
Q 2153−2056	2153−20	1.845	7.8	22
SDSS J22144+1326	2212+13	2.00	5.8	84
MGC 2214+3550	2212+35	0.877	3.0	50
SDSS J23365−0107	2334−01	1.285	1.7	14
Q 2345+007	2345+00	2.15	7.1	54,82

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