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The Second Byurakan Survey: Faint Markarian Galaxies, AGN and QSOs

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Abstract. On the basis of the Second Byurakan Survey (SBS) we have produced the largest and most homogeneous new complete samples of faint Markarian Galaxies and bright QSOs. The volume of reliable investigation of UVX galaxies reaches to $\sim 200 - 250 Mpc$,– ten times deeper than the FBS.

New reliable data for the surface density of bright QSOs in mag. range $16.05 < B < 17.45$ and redshift $0.3 < z < 2.2$ are presented. The complete sample of bright($B < 17^m5$) SBS QSOs contains 93 QSOs in these ranges. The new data allow us to assume that bright QSOs fast evolution might be perhaps the result of a selection effect.

1. Introduction

The tremendous success of the Markarian survey has initiated a number of other extragalactic thin–prism surveys, initiatint a new direction in extragalactic astronomy–systematic searches for peculiar objects using low-dispersion spectroscopy. In 1974 we undertook the new survey – the Second Byurakan Survey(SBS). The primary goal of the SBS is to spread the Markarian survey as deep as possible to obtain a large, well–defined sample of AGNs and QSOs that are selected in a reasonably uniform fashion.

2. BYURAKAN SURVEYS (FBS and SBS).

The First Byurakan Survey (FBS). Begining in the mid–1960s and continuing through 1980, the first large-scale objective-prism survey for galaxies with blue and UVX in their continuum radiation was conducted by Markarian.

The 1500 Markarian galaxies contained in the FBS have provided the principal base from which the major types of AGNs have been discovered, classified, and studied in detail by numerous workers. FBS resulted in a complete sample of AGNs down to limiting magnitude 15^m2. Markarian galaxies comprise 10% of field galaxies and about 10% of Markarian galaxies turned out to be Sy galaxies, so 1% of field galaxies were found as Sy galaxies.

The Second Byurakan Survey (SBS). The SBS which is the continuation of the Markarian survey, aimed to reach fainter limiting magnitudes. First list of SBS objects was published in 1983 (Markarian & Stepanian 1983).Totally there are published seven lists (Stepanian 1994, and reference therein).

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SBS started in 1974, and plate searching was completed in 1991. A total area of 1000 deg^2 confined by the contiguous strip defined by $7^h40^m < \alpha < 17^h15^m$, $+49° < \delta < +61°$ has been observed. The SBS is being conducted with the same 40-52 inch Schmidt telescope, but with various objective prisms in combination with more modern(in 1974)IIIaJ and IIIaF emultions sensitized in heated nitrogen(Stepanian 1984). The use of both emulsions extends the wavelength range of sensitivity, increase the uniformity of discoveries, and permits the acquisition of spectra for AGNs down to $m_{pg} \sim 19^m5$. A selection of 1700 galaxies ($\sim$ 950 UVX and $\sim$ 750 ELG without significant UV excess) and 1800 stellar objects with an excess ultraviolet emission is the main result of the SBS survey.

So far, the nature of 464 new QSOs and Sy galaxies, 830 galaxies with narrow emission lines and 810 galactic stars, the vast majority of which are hot WD, have been confirmed. Hundreds of new close-binaries, and pairs of faint UVX galaxies were found. The present status of SBS survey is briefly illustrated in table 1.

Table 1. The Second Byurakan Survey. Present (1998) status.

Spectroscopy	∼ 2200	objects		photometry	∼ 400
Stellar objects:	∼ 1200	spectra;QSOs	- 355	stars	∼ 810
BALQSO	- 15	Radio sources	- 110	WD	∼ 300
DampQSO	- 5	X-ray sources	- 100	subdwarf	∼ 200
Ly forest	- 15	Gamma-ray	- 2	HBB+NHB	∼ 100
BLLac	- 5	BLAZAR	- 3	F/G	∼ 100
Abs-Line QSOs	- 35	IRAS	- ?	Continual	- 25
Grav. lenses	- 3			C2+dMe	- 45
Other	- 278			CV	- 25
				Composite	- 15
Galaxies	∼ 1000	slit spectra		Classified	∼ 500
Seyfert gal.	- 109	SBN	- 170	IRAS sources	∼ 520
Sy1	- 52	BCDG	- 130	Radio sources	∼ 200
Sy1.5	- 8	HII	- 50	X-ray	∼ 50
Sy2	- 49	ELG	- 480	Close-binaries	∼ 150
LINERS	- 41	Abs.gal.	- 20		

The redshift distribution of SBS and Markarian galaxies, QSOs and AGN for total and complete ($B < 17^m5$) samples, as well as the plots of number-counts for FBS, SBS and field galaxies, and $LogN(< B) - B$ are shown in fig.1.

3. The results and discussion:

SBS galaxies. The compilation of the surface densities of SBS, some other samples and field galaxies are given in table 2.

The completeness level of SBS galaxies, as seen from fig.1, is about $\sim$ 90% for $m \leq 16^m.5$ and $\sim$ 70% for $m \leq 17^m.0$ galaxies.

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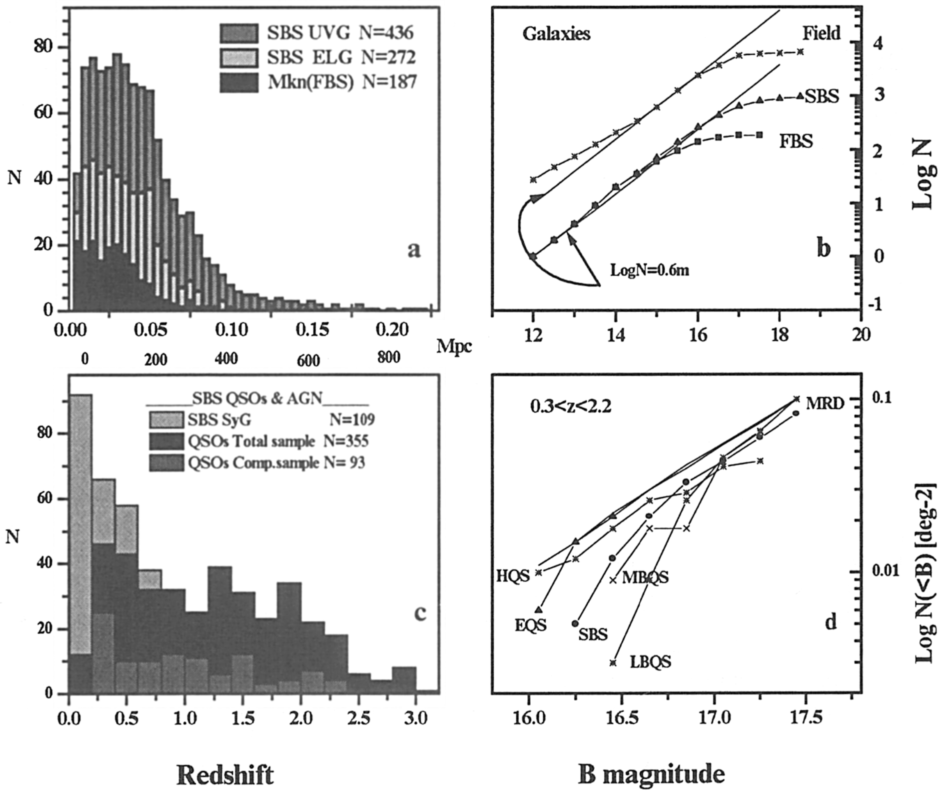

Figure 1. The redshift distribution of SBS and FBS galaxies(a); SBS QSOs and AGN, total and complete samples(c); the plots of number-counts for SBS and field galaxies(b); and $LogN(< B) - B$.(d).

Now it is well known, that the relative number of Sy and UVX galaxies among field galaxies consist of about 1% and 10% respectively. However, practically all these data were obtained by the use of the samples of nearby and accordingly bright objects in a space volume of about 100-120 Mpc. What is the relative number of Sy and UVX galaxies in a distance scale greater than 120 Mpc, is their nature, power, morphology changed?; what is the connection between the distant Sy galaxies and nearby QSOs?. Some of the mentioned questions may be answered on the base of SBS data.

1. The relative number of SBS AGN and the proportion of UVX galaxies among field galaxies in the volume of 200-250 Mpc consist of about 10-12%, which is the same as in FBS ($\sim$ 100 Mpc), but the number of QSOs and Liners is much higher.
2. About $\sim$ 30% of the total sample, and $\sim$ 50% of complete ($m < 16.5$) sample of SBS galaxies are IRAS sources. The proportion of IRAS galaxies among the field galaxies can be estimated no more than $\sim$ 30%. Radio sources among SBS galaxies consist of about $\sim$ 12%.

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Table 2. The surface density of SBS, other samples and field galaxies.

Name of sur.	Area	Number	15.0	15.5	16.0	16.5	17.0	Compl.
FBS	17000	1500	0.09					15.2
Tololo	1225	201	0.16					15.0
Wasilewski	825	96	0.12					15.0
UM	667	349	0.12			0.52		16.5
Case	184	161	0.12	0.23	0.30	0.47	0.72	16.5
SBS	1000	1700	0.12	0.25	0.49	0.79	1.10	16.5
FIELD	1000	10000	0.6	1.3	2.5	5.0	10.0	

3. Perhaps no voids exist in the distant scale of about 200 Mpc in SBS area ($\sim 1000\ deg^2$). The data of hundreds of bright ($\leq 15^m5$) and thousands of faint ($m \leq 17^m0$) galaxies doesnt exist in any database. This conclusion is made on the basis of "direct" selection on SBS objective prism plates. Field galaxies in SBS area consist of $\sim 5000(m < 16.5)$ and $\sim 10000(m < 17.0)$ galaxies. The redshifts are avialable for about $\sim 2500(m < 16.5)$ of them, the main part of which is SBS data. This data makes the size of known voids much smaller ($< 20Mpc$), which allow us to predict, that after obtaining redshifts for the remainder ~ 2500 ($m < 16.5$) galaxies, the voids may be filled.
4. The complete sample of faint Markarian galaxies from SBS gives a possibility to construct the first complete sample of faint $B \leq 17^m5$ AGN, to increase the volume of reliable investigation to 200-250 Mpc (ten times deeper than in FBS), and investigate the Large-scale structure of the Universe in a distant scale of about 400-500 Mpc.

Bright QSOs and the problem of completeness. The zero point of LogN-B is principal for any quasar evolution model. In the last years a number of papers have been published suggesting that the standard two power-law model of a pure luminosity evolution may not be an adequate representation of the data. The very steep number-magnitude relation which is important evidence for cosmological evolution of the QSO population comes mainly from BQS(Schmidt & Green 1983), and AAT survey(Boyle at al.1990) data. There is a significant difference between the published data for the bright end.It is worth noting that many workers transform the original Bj magnitudes to the standard Johnson B band by assuming B-V=0.3 for the QSOs and applying a mean transformation using the Blair & Gilmore color equation Bj=B-0.28(B-V) for stars.

To investigate this question, we undertake direct photometric CCD measurement for bright($b < 17^m5, 0.3 < z < 2.2$) QSOs in complete samples of surveys, the data of which as a rule are used for the bright end of $LogN(< B) - B$, and evolution models of QSOs. There are only a few of them: -BQS(Schmidt & Green 1983), MBQS(Mitchell et al.1984), LBQS(Hewett et al. 1995), and the new survey EQS(Goldshmidt et al. 1992). The BQS is well investigated, so we study the SBS and other three.

There are 8 objects in EQS, 26 in MBQS, 80 in LBQS and 93 in SBS. For SBS objects part of the photometic data are published (Chavushian et al. 1995), the next part including the LBQS, EQS and MBQS data are in preparation. The number of objects, the original and corrected data for integral surface density and the most reliable data(MRD) for bright ($B < 17.45$) QSOs in the redshift range $0.3 < z < 2.2$ are given in table 3. The CCD data of the recent survey HQS(Kohler et.al 1997) are also presented.

Table 3. The corrected integral surface density of bright QSOs.

$0.3 < z < 2.2$ $16.05 < B < 17.45$.

$< B$	EQS		MBQS		LBQS		HQS	SBS	MRD
	n orig.	corr.	n orig.	corr.	n orig.	corr.	n CCD	n CCD	
16.05	4 0.012	2 0.006	1 0.009				6 0.01	3 0.003	0.011
16.25	6 0.018	5 0.015	1 0.009				7 0.012	5 0.005	0.015
16.45	8 0.024	7 0.021	2 0.018	1 0.009	2 0.004	1 0.003	11 0.018	12 0.012	0.021
16.65			3 0.027	2 0.018	6 0.013	4 0.009	16 0.026	21 0.021	0.030
16.85			4 0.037	2 0.018	14 0.031	12 0.026	18 0.029	33 0.033	0.040
17.05			6 0.055	5 0.046	25 0.055	21 0.046	25 0.041	44 0.044	0.055
17.25			8 0.073	7 0.065	39 0.086	31 0.068	27 0.044	60 0.060	0.073
17.45					73 0.161	49 0.11		82 0.082	0.1

1. The "converted" B magnitudes used in EQS, MBQS and LBQS as a rule are brighter than standard Johnsons B magnitudes.
2. The gradient of LogN-B decrease from 0.98 to $\sim 0.67 \pm 0.04$. There is a flattening of the bright part of the QSO LF at low redshift. The models of the optical luminosity function for luminous QSOs need a smaller amount of cosmological evolution. The Baldwin effect clearly becomes to zero.

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References

Boyle,B.J.,Fong,R.,Shanks,T., Peterson,B.A.1990, MNRAS, 243, 1

Chavushian,V.H., Stepanian,J.A., Balayan,S.K., Vlasyuk,V.V. 1995, Astron.Letters. 21, 894

Goldshmidt,P, Miller L, La Franca,F,Cristiani, S.1992, MNRAS,256,65

Kohler,T., Grote,D., Reimers,D. & Wisotski.L. 1997, A&A.325,502

Hewett,P.C., Folz,C.B., Chaffee,F.H. 1995, AJ, 109, 1498

Mitchell K.J., Warnock A., Usher P.D. 1984, ApJ, 287, L3

Markarian,B.E., Stepanian,J.A. 1983, Astrofizika, 19, 639

Stepanian, J.A., 1994, Doctoral dissertation, Nizhnij Arkhys

Stepanian,J.A., Astron. Journal, XX, 1985, 62, 1211

Schmidt, M.R, Green, R.F. 1983, ApJ, 269, 352