

# Multiwavelength data for bright active galaxies

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**Abstract.** The spectral energy distribution (SED) gives a complete picture of the radiation of space objects and may result in correct classifications compared to those based only on optical (or other local) spectra. This is especially crucial for active galaxies, both AGN and Starbursts (SB). For this, multiwavelength (MW) data are needed taken from available surveys and catalogs. We have cross-correlated the Catalogue of quasars and active galaxies with all-sky or large-area MW catalogues, such as X-ray ROSAT (BSC and FSC), UV GALEX (MIS and AIS), optical APM, MAPS, USNO-B1.0, GSC 2.3.2, and SDSS DR8, NIR 2MASS, MIR/FIR WISE, IRAS (PSC and FSC) and AKARI (IRC and FIS), radio GB6, NVSS, FIRST, and WENSS. We have established accurate positions and photometry for a few thousands of objects that appeared in the catalog with poor data, as well as achieved the best astrometric and photometric data for all objects. This allowed correct cross-correlations and establishing correct MW data for these objects. As a result, we obtained 34 photometric points from X-rays to radio and using VO tools built SEDs for some 10,000 bright objects. Some data from other surveys were also used, such as Chandra, XMM, Spitzer, etc. All objects were grouped into several forms of SED and were compared to the known optical classes given in the catalog (QSO, BLL, Sy1, Sy1.2–1.9, Sy2, LINER, SB, and HII). This allowed reveal obscured AGN, as well as find previously misclassified objects. A homogeneous classification for these objects was established. The first part of this project is presented; establishment of accurate positions and photometry and cross-correlations with MW catalogs.

**Keywords.** catalogs, surveys, galaxies: active, galaxies: starburst

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## 1. The Catalogue of active galaxies and its statistical use

The Catalogue of quasars and active nuclei (13th edition; Veron-Cetty & Veron 2010; hereafter VCV-13) is the fullest collection of AGN (and other active galaxies). It contains 168,941 objects, including 133,336 QSO, 1,374 BL Lac objects, and 34,231 active galaxies (including 16,517 Sy1). Most of objects come from SDSS DR7 (Abazajian *et al.* 2009) and 2QZ/6QZ (Croom *et al.* 2004) surveys. The latest SDSS-based (SDSS-I and SDSS-II) QSO catalog was published by Schneider *et al.* (2010) and contains 105,783 spectroscopically confirmed QSOs over 9380 deg<sup>2</sup> surface. A Large quasar astrometric catalogue (LQAC) was recently built by Souchay *et al.* (2009) based on 12 optical and radio QSO catalogues. It contains 113,666 objects. In addition, Massaro *et al.* (2009) have published a multi-frequency catalogue of blazars with the fullest collection (3061 objects) of BL Lac and flat radio spectrum QSOs (last update: 1 July 2011). All these lists partially cover each other and for the users it is not easy to have a full set of data or even carry out cross-correlations between these catalogs (mainly, due to positional uncertainties).

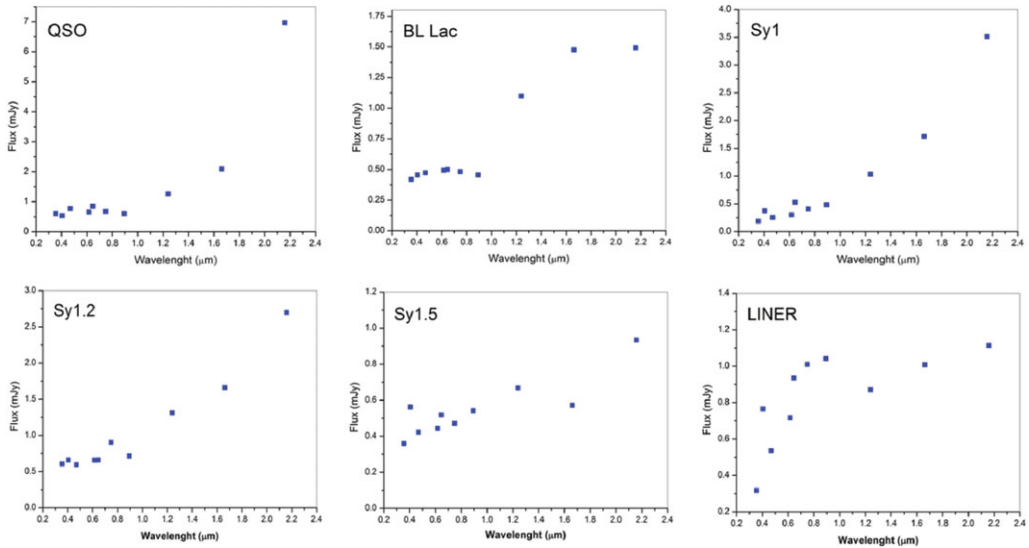
**Table 1.** All-sky / large area catalogues and their data.

Catalogs	Range	Area, surface	Accuracy	Sources	Release	Reference
ROSAT BSC	X-ray	All-sky	60 as	18806	1999-11-05	Voges <i>et al.</i> 1999
ROSAT FSC	X-ray	All-sky	60 as	105924	2000-05-26	Voges <i>et al.</i> 2000
GALEX MIS	UV	All-sky	2 as	12600000	2011-03-14	Bianchi <i>et al.</i> 2011
GALEX AIS	UV	All-sky	2 as	65300000	2011-03-14	Bianchi <i>et al.</i> 2011
APM	opt	$\delta > -33^\circ$ , $ b  > 20^\circ$	619 mas	166466987	2000-12-05	McMahon <i>et al.</i> 2000
MAPS	opt	$\delta > -33^\circ$ , $ b  > 20^\circ$	519 mas	89234404	2003-07-00	Cabanela <i>et al.</i> 2003
USNO-B1.0	opt	All-sky	387 mas	1045913669	2005-11-17	Monet <i>et al.</i> 2003
GSC 2.3.2	opt	All-sky	258 mas	945592683	2007-04-19	Lasker <i>et al.</i> 2008
2QZ/6QZ	opt	SGP/NGP,	338 mas	49425	2006-06-01	Croom <i>et al.</i> 2004
SDSS-II	opt	$\delta > 0^\circ$ , $ b  > 30^\circ$	67 mas	357175411	2009-06-03	Abazajian <i>et al.</i> 2009
2MASS	NIR	All-sky	479 mas	470992970	2003-06-10	Cutri <i>et al.</i> 2003
WISE	NIR/MIR	All-sky	500 mas	257310278	2011-04-14	Wright <i>et al.</i> 2010
IRAS PSC	MIR/FIR	All-sky	28 as	245889	1994-01-29	IRAS 1986
IRAS FSC	MIR/FIR	All-sky	13 as	173044	1993-02-24	Moshir <i>et al.</i> 1989
AKARI IRC	MIR	All-sky	300 mas	870973	2010-04-21	Ishihara <i>et al.</i> 2010
AKARI FIS	FIR	All-sky	800 mas	427071	2010-04-21	Yamamura <i>et al.</i> 2010
GB6	radio	$0^\circ < \delta < +75^\circ$	210 as	75162	1997-01-07	Gregory <i>et al.</i> 1996
NVSS	radio	$\delta > -40^\circ$ ,	45 as	1773484	2002-09-27	Condon <i>et al.</i> 1998
FIRST	radio	$\delta > 0^\circ$ , $ b  > 30^\circ$	5 as	811117	2011-04-03	Becker <i>et al.</i> 2003
WENSS	radio	$+28^\circ < \delta < +76^\circ$	54 as	229420	2004-05-14	de Bruyn <i>et al.</i> 1998

VCV-13 contains quasars with measured redshift known prior to July 1, 2009 (including SDSS DR7). As in the preceding editions, it does not give any information about absorption lines or X-ray/UV/IR properties. But absolute magnitudes and, when available, the 6 and 21 cm flux densities are given. The authors warn that the catalogue should not be used for any statistical analysis as it is not complete in any sense. One of the main problems is the absence of homogeneous accurate positional and photometric data: they are coming from the original papers and have extremely different accuracy and (in case of the magnitudes) bands (B, V, R, and other, making the magnitudes not useful for statistics). SDSS and 2QZ/6QZ provide reliable photometry, and in addition, homogeneous optical photometry is given in APM/MAPS/USNO/GSC catalogs measured from POSS1/POSS2. Absence of reliable photometry leads to misclassification of objects into QSO/Sy1 (as it is connected with the  $M_B = -22.25$  limit of the absolute magnitude), as well as impossibility of studies of luminosity functions, luminosity evolution, etc. Moreover, MW data for active galaxies would provide possibility to compare their properties, build MW SEDs, make up better classifications, and better understand their physics and evolution. Thus there is a need for cross-correlations of the AGN Catalogue with optical and MW data.

## 2. Cross-correlations of AGN catalogue with MW data

In general, cross-correlations lead to numerous misidentifications and doubtful associations. The problem arises due to selection of the search radius and final acceptance of found objects. Typically, a standard search radius is being given (like in Vizier and elsewhere) based on typical positional errors of the given catalog. We have developed a new method of calculation of the search radius based on  $3\sigma$  rms of individual objects/sources from each catalogue (Knyazyan *et al.* 2011). Such errors differ up to 10-15 times, so the traditional method leads to finding many associations out of  $3\sigma$  or losing many associations for objects with larger errors. Moreover, we use accurate rms values for optical catalogs to achieve the best matches (Mickaelian & Sinamyan 2010). Accurate coordinates and magnitudes were derived using our methods developed for APM/MAPS/USNO/GSC data (Mickaelian & Sinamyan 2010, Mickaelian *et al.* 2011).



**Figure 1.** SEDs of active galaxies in the optical and NIR ranges by means of SDSS, POSS, and 2MASS photometric data.

Cross-correlations of the catalog of Quasars and AGN (VCV-13) have been carried out with the following surveys and catalogues given in Table 1.

### 3. Results: MW data and SEDs for active galaxies

MW SEDs have been built as shown in our previous papers (Sargsyan 2009; Hovhannisyan *et al.* 2011; Sargsyan *et al.* 2011). For the beginning, we have correlated POSS1/POSS2 B and R, SDSS ugriz and 2MASS JHK magnitudes. Different activity type objects have been selected: QSO, BLL, Sy1, Sy1.2, Sy1.5, and LINER. The results are shown in Figure 1. Slight differences are present in SEDs, however, average SEDs will reveal significant changes in different activity types.

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