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THE QUASAR LUMINOSITY FUNCTION OF THE MILLIQUAS, MASTER AND 2QZ QUASAR CATALOGS

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ABSTRACT

Quasars are among the farthest and brightest objects known in the universe. Because quasars are mostly observed in the redshift range between 1 and 3, they can be used to study large scale structure in the universe, and its evolution over the past billion years. An important issue is the evolution of the quasar luminosity function, which has been investigated for relative small samples of the 2QZ catalog. Here we extend the study to 3 quasar samples, the most recent data of the Milliquas, Master and 2QZ quasar catalogs to determine the luminosity function of quasars and its evolution, using the Standard cosmological ΛCDM model with $\Omega_\Lambda = 0.73$, $\Omega_M = 0.27$, and $H_0 = 70kms^{-1}Mpc^{-1}$. For the purpose of this analysis we initially used 0.25-mag bins and approximately 0.180-redshift bins, then calculated the comoving distance and comoving volume for each bin of redshift and calculated the number of objects in each bin per unit volume, in order to find the number density per absolute magnitude bin. Our analysis on the basis of these new and much more complete datasets is largely in agreement with earlier studies of the luminosity evolution of quasars.

Key words: quasars: luminosity function: evolution

1. INTRODUCTION

Quasars, which were first detected during the 1960s while exploring the radio sky, are very bright objects with the sizes of stars and luminosities of galaxies. They are among the most distant and most luminous objects, with the highest observed redshifts known today. The optical luminosity function of QSOs and its evolution with redshift provides fundamental information on the demographics of the overall population of AGNs. It is an useful instrument to quantify the activity statistics of the AGNs Boyle et al. (2000). In addition, it provides a basis for determining the amount of matter in different forms in the universe Osmer et al. (2006). The optical luminosity function of QSOs as a function of redshift provides essential constraints on how the population characteristics of QSOs have changed with time, Koo and Kron (1988) and also provides constraints on the physical models of QSOs. Furthermore, it may provide information on models of structure formation in the early universe, Efstathiou and Rees (1988).

2. DATA

Three quasar catalogues were used for the present study of QSOs and their evolution Mohammadi (2013).

The million quasars (Milliquas) catalogue: Milliquas provides more than 1,223,884 objects in the redshift range z=0 to z=8 over the entire sky. These objects include quasars, AGNs and other quasar-like objects, with high luminosities. (heasarc.gsfc.nasa.gov/W3Browse/all/milliquas.html, Ver 3.0, 9th Sep. 2012)

The MASTER Optical Catalogue of Quasars: the MASTER catalog is a compilation of different surveys, with 501,761 objects, from z=5 to z=0, observed in the radio to X-rays, and including optically observed quasars. (http://quasars.org/Master-ReadMe.txt, June 2011)

2dF QSO Redshift Survey (2QZ): This survey is a low redshift survey with 49,425 objects, from z=4 to z=0. As for the galaxy redshift survey provided by 2dF, it is in two different slices in the north and south galactic regions and is different from the two other catalogs, in that it is observed only in the blue. (http://www.2dfquasar.org, June 2011)

3. ANALYSIS

Following the method of Meitei and Singh (2013) we used a binned estimator for the differential optical luminosity function with a 1/V estimator given by Page and Carrera (2000). The QSOs in the redshift range z = 0.613 to z = 2.014 were divided into seven intervals $0.613 < z < 0.763$, $0.763 < z < 0.928$, $0.928 < z < 1.108$, $1.108 < z < 1.306$, $1.306 < z < 1.521$, $1.521 < z < 1.757$ and $1.757 < z < 2.014$. Each red-

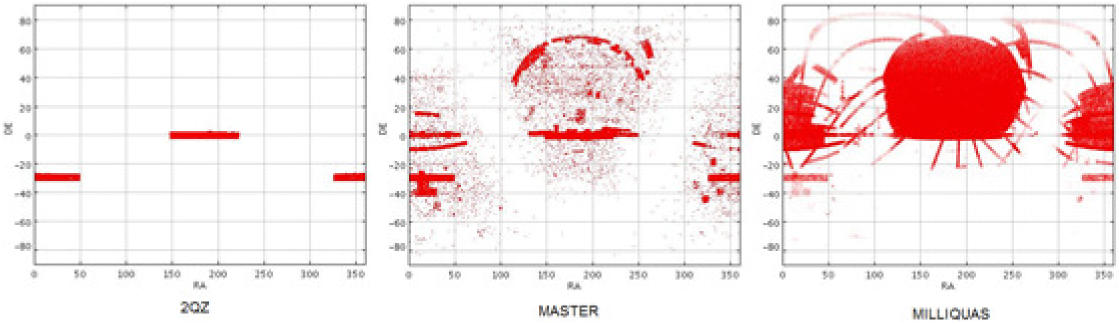

Figure 1. The 2QZ, Master and Milliquas quasar catalogs.

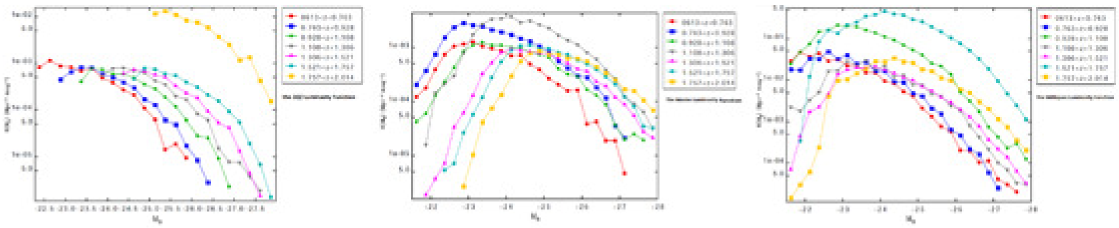

Figure 2. The quasar luminosity function of the 2QZ, Master and Milliquas quasar catalogs.

shift interval was divided into bins of absolute magnitude with a width of 0.25. Then the commoving distance was calculated, together with the commoving volume (Eq. 1) and the solid angle for each redshift.

$$V_c = \frac{4\pi c}{H_0} \int_0^z \frac{d_l^2 dz}{(1+z^2)\sqrt{(0.27(1+z)^3 + 0.73}} \qquad (1)$$

Next we found the number density of QSOs (Eq. 2). Finally we plotted the number density of QSOs vs. the absolute magnitude as shown below. We found it in good agreement with earlier studies, e.g. Osmer et al. (2006).

$$\Phi(M) = \frac{n}{\frac{\Delta\Omega}{4\pi} * V_c * \Delta mag} \qquad (2)$$

4. CONCLUSIONS

The observed luminosity functions of Milliquas and MASTER show the expected behavior; fast rising, barely visible in the 2QZ and decreasing with magnitude. At the redshift range of our analysis the Quasars are more luminous at higher redshifts in all 3 catalogs. The maximum of the luminosity function for the 2QZ catalog is

$z \approx 1.8$ and $M_b \approx -25.5$ For the MASTER catalog it is $z \approx 1.1$ and $M_b \approx -24$ and for the Milliquas catalog $z \approx 1.5$ and $M_b \approx -24$.

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