COUNTS OF QUASARS AT FAINT MAGNITUDES: A NEW COMPLETE SAMPLE*

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ABSTRACT. We present results on a new sample of optically selected quasar candidates. The "standard" multicolor technique for selecting quasar candidates has been applied to all the objects brighter than J = 22.0 in a field of 0.69 square degrees. Additional candidates have been selected from a search on grism plates obtained in the same area. Spectroscopy for all the candidates brighter than J = 20.9 has provided a sample of 22 confirmed quasars. The redshift distribution of these objects is essentially flat from z = 0.6 up to z = 2.8. Three out of the eight quasars with redshift larger than two were selected from the grism plates and were missed by our color selection. This result, although based on a small number of objects, suggests that the luminosity functions computed in this redshift range from samples which are only color selected might have to be increased by a factor up to 1.5. On the other hand, these possible losses of the multicolor search technique are negligible (of the order of 15% only) for the estimates of the integral number counts at magnitudes of the order 20-21.

1. INTRODUCTION

The study of the basic evolutionary properties of quasars requires the use of complete samples covering the largest possible regions of the magnitude - redshift plane. At relatively bright magnitudes (J < 20.0) various samples of UVX selected objects have recently become available (Schmidt and Green 1983; Mitchell, Warnock and Usher 1984; Marshall et al. 1984). These samples, together with the time honored AB sample (Braccesi, Formiggini and Gandolfi 1970), provide the basis for studies of the quasar luminosity function and its evolution for redshifts less

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than 2.2 (see, for example, Marshall 1985). At fainter magnitudes and higher redshifts the available information from complete samples is still scanty (Koo, Kron and Cudworth 1985; see also Boyle et al. 1986). For this reason, we started a program with the aim of selecting a sample of candidate quasars complete down to J = 22.0, for which we are now in the process of obtaining spectroscopic information.

2. THE SELECTION OF THE CANDIDATES

The observations and the data reduction are described in great detail in Marano, Zamorani and Zitelli 1985 and 1986 (Paper I and II). We have obtained various sets of deep exposures in the U(IIIaJ+UG1), J(IIIaJ+GG385) and F(IIIaF+GG495) bands at the prime focus of the ESO 3.6 m equipped with the triplet corrector. The whole useful field on six plates, two for each passband, was scanned with the ESO PDS microphotometer (50x50 micron aperture). The PDS scannings produced a working list of about 6000 objects complete to J = 22.0. After plates linearization and magnitude calibration, we have classified all the detected objects in three classes, "stellar", "intermediate" and "extended", on the basis of a shape parameter (see Paper I and II). For relatively bright magnitudes (J < 21.0) the "intermediate" objects would be commonly defined as "fuzzy". For each of the three classes we have then constructed the color - color diagrams (U-J vs. J-F), from which we have selected our quasar candidates following the "extended" color criterion suggested by Koo and Kron (1982).

In the same field we obtained also three grism plates at the ESO 3.6 m telescope. The wavelength range (3400 - 5300 A) is such that Lyα would not be detected at redshifts larger than about 3.3. The best two of these plates were visually inspected by us and additional quasar candidates from this inspection were added to the list of candidates selected by the color - color diagrams.

3. RESULTS OF SPECTROSCOPY

We have obtained slit spectroscopy for all the candidates brighter than J = 20.9. In the last spectroscopic run (November 1985) we have used the Eso Faint Object Spectrographic Camera which has become recently available at the ESO 3.6 m telescope (D'Odorico 1986). This camera allows to obtain in about 30 minutes good spectra (signal to noise of the order of 10) of objects in the magnitude range 20.5 - 21.0 (see Figure 1).

A summary of the results is as follows:

a) Down to J = 20.9 we have a sample of 22 confirmed quasars (broad emission lines objects). Ten of them are brighter than J = 20.0.

b) The redshift distribution is essentially flat in the redshift range 0.6 < z < 2.8, with eight objects with redshift larger than two.

c) Three of these 22 objects were selected only by the analysis of the grism plates. Each of them has a redshift larger than two. In order to select them also in the color - color diagram, it would have been

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necessary to include a relatively large number of blue subdwarf stars in the sample of candidates. To check this result we are currently obtaining new PDS scannings of our plates with a smaller window (20x20 micron). This will allow us to improve our magnitude measurements and to test with more accuracy the position of these three objects in the color - color diagram.

d) One of the three objects selected only from the grism plates is the only Broad Absorption Line quasar in our sample (see Figure 1).

e) Six further objects, in the redshift range 0.1 - 0.5, showed only narrow emission lines . Five of them were classified as "intermediate" (see above) and were the most ultraviolet objects in this class.

4. CONCLUSION

Having complete spectroscopic information for all the quasar candidates brighter than J = 20.9, and taking into account the additional candidates with 20.9 < J < 21.0, we estimate a surface density of 43 ± 8 quasars per square degree at J = 21.0. This number is in excellent

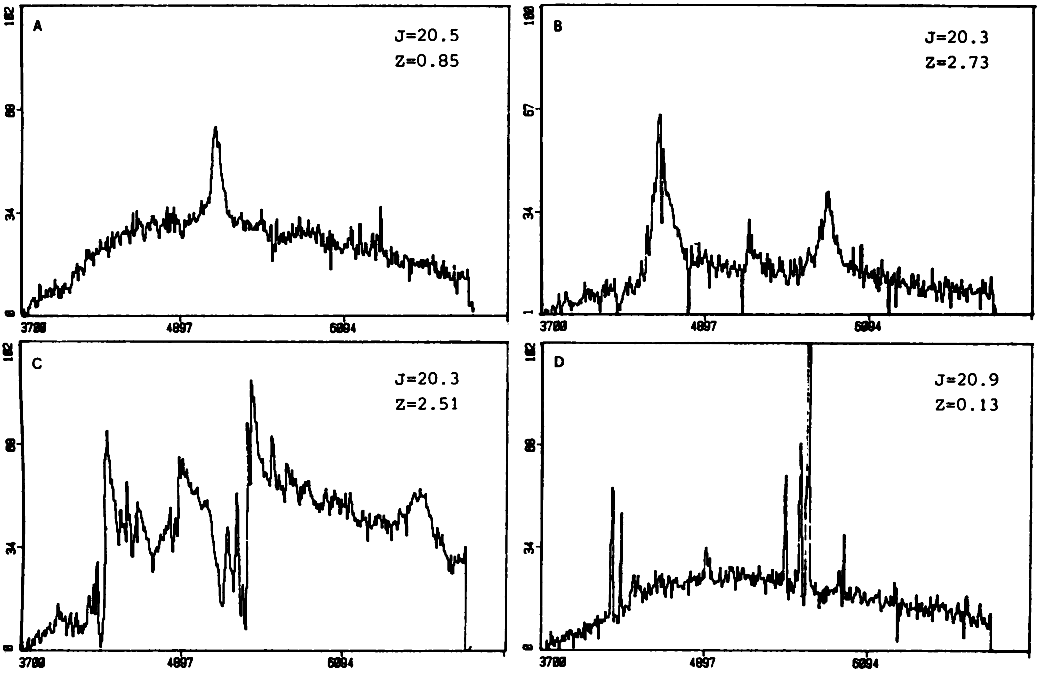

Figure 1. Spectra of four objects obtained with the EFOSC. The Y axis gives the sky subtracted intensity, not corrected for the instrumental response, in arbitrary units. Cosmic ray events have not been removed. Object c) is the only Broad Absorption Line quasar in our sample. Object d) is a low redshift Narrow Emission Line Object.

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agreement with the results of similar surveys (Koo, Kron and Cudworth 1985; Shanks at al. 1986).

Our spectroscopic results on the grism selected candidates suggest, although on the basis of a few objects, that quasar searches based exclusively on color - color diagrams may be somewhat incomplete. While this incompleteness has no significant impact on the estimates of the integral number counts, it can be significant for redshifts larger than two.

In our sample, as in similar surveys, we do not find very high redshift quasars. The highest redshift among the 22 confirmed quasars is 2.73. This gives additional evidence against the existence of a large number of high redshift, faint quasars (see Osmer 1986 for a comprehensive review of the subject).

At the other extreme of the redshift range, we do not find any broad emission line object with redshift smaller than 0.6. On the other hand, at least six objects with prominent narrow emission lines (but this sample is probably incomplete) have been found in the same redshift range. This suggests that our selection, which includes also objects with "intermediate" shape in the list of candidates, is not strongly biased against low redshift objects. If this is the case, the absence of broad emission line objects at low redshift may be taken as an indication of a flattening of their luminosity function for absolute magnitudes fainter than about $M_B = -23.0$ (but see the discussion on completeness of the multicolor selection in Paper I).

REFERENCES

Boyle,B.J., Fong,R., Shanks,T., and Peterson,B.A. 1986, in Structure and Evolution of Active Galactic Nuclei, G. Giuricin, F. Mardirossian, M. Mezzetti, and M. Ramella eds., (Dordrecht: Reidel).

Braccesi,A., Formiggini,L., and Gandolfi,E. 1970, Astr.Ap., **5**, 264.

D'Odorico,S. 1986, This Volume., p.57.

Koo,D.C., and Kron,R.G. 1982, Astr.Ap., **105**, 107.

Koo,D.C., Kron,R.G., and Cudworth,K.M. 1985, preprint.

Marano,B., Zamorani,G., and Zitelli V. **1986**, in Structure and Evolution of Active Galactic Nuclei, G. Giuricin, F. Mardirossian, M. Mezzetti, and M. Ramella eds., (Dordrecht: Reidel), in press.

Marano,B., Zamorani,G., and Zitelli V. **1985**, Proceedings of the Convegno Nazionale ASTRONET 1984-1985, 1985, Mem. Soc. Astr. It., in press.

Marshall,H.L. 1985, Ap.J., **299**, in press.

Marshall,H.L., Avni,Y., Braccesi,A., Huchra,J.P., Tananbaum,H., Zamorani,G., and Zitelli,V. 1984, Ap.J., **283**, 50.

Mitchell,K.J., Warnock III,A., and Usher,P.D. 1984, Ap.J.(Letters), **287**, L3.

Osmer,P.S. 1986, This Volume , p.447.

Schmidt,M., and Green,R.F. 1983, Ap.J., **269**, 352.

Shanks,T., Boyle,B.J., Fong,R., and Peterson,B.A. 1986, This Volume ,p.37.

https://doi.org/10.1017/S0074180900152180 Published online by Cambridge University Press