THE COSMIC EVOLUTION OF QUASARS AT HIGH REDSHIFTS

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ABSTRACT. The analysis of all published slitless quasar surveys suggests that the space density of quasars increases quickly with redshift up to $z \sim 2.45$, then drops abruptly by about a factor of five, increases again up to $z \sim 3.8$ at least to drop oneemore below the present day limit of sensitivity.

UV excess quasars ($z < 2.3$) are known to evolve quickly with cosmic time, their space density (or luminosity) being much smaller now than at $z = 2.3$ (see for instance Véron 1983). Weedman (1985) has shown that the quasar space density still increases at $z > 2.3$; however surveys of high redshift quasars suggest that a redshift cut-off exists either near or below $z = 3$ (Schmidt et al. 1986), or in the range $3.7 < z < 4.7$ (Osmer 1982).

A number of objective-prism or grism surveys have been carried out with the IIIaJ Kodak emulsion. These surveys are most efficient at picking out quasars with visible Ly α ($1.8 < z < 3.4$). The lower limit is set by the ultraviolet transmission of the atmosphere and the telescope optics between 3300 and 3600 Å; the upper limit is set by the Lyα + NV emission passing beyond the red limit of the IIIaJ emulsion at $\lambda \sim 5380$ Å.

These surveys belong to two groups : the Schmidt telescope (the Curtis Schmidt and the UK Schmidt) surveys, reaching a magnitude of ~ 18.5, and the large telescope (Kitt Peak and Cerro Tololo 4 m and CFHT 3.6 m) surveys reaching about two magnitude fainter. The two groups contain 232 and 331 Ly α quasars respectively.

Fig. 1 shows the histograms of the redshift distribution of the Ly α quasars separately for the Schmidt surveys and for the large telescope surveys. One of the important features of this figure is that the two redshift distributions are almost identical over the whole range covered. This indicates that the luminosity function is a power law ($N(>L) \propto L^{-n}$) in the absolute magnitude range of interest, the index n being independent of redshift. The fact that the surface density of quasars increases by a factor of ~ 20 when their apparent (or absolute) magnitude increases by 2.0 magnitudes indicates that $n \sim 1.6$.

The redshift distributions shown in Fig. 1 raise slowly by a factor of 2 between $z = 1.8$ and 2; this is due to the combine decline of sensitivity in the UV of the IIIaJ emulsion, of the atmosphere and of the telescope optics. The

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most important feature is the sharp drop (by a factor of ~ 5) of the quasar surface density at z = 2.45, followed by a flat wing extending up to the observational limit of z = 3.4. At z = 2.45, Ly α appears at 4200 Å; there is no obvious reason why the various surveys, should have a drop in sensitivity at this wavelength; the only feature common to all surveys is the use of the IIIaJ emulsion which has a wavelength sensitivity extending almost flat to λ 5300 Å. Therefore we believe that this drop is real rather than due to any observational effects.

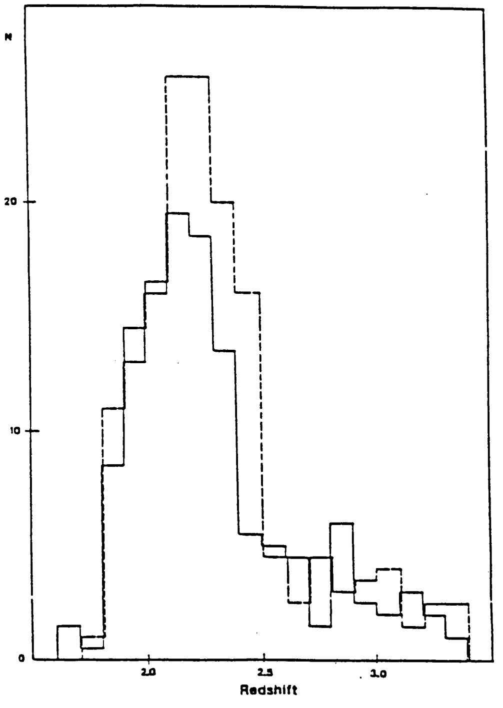

Fig. 1. The observed redshift distribution for Lyα quasars found in IIIaJ slitless surveys. (-) the Schmidt telescope surveys; (--) the large telescope surveys.

A number of surveys using other techniques sensitive to redshifts much larger than 3.4 have been published; they suggest that the wing of high redshift quasars may extend to z = 3.8. Until recently all efforts to find quasars at redshifts larger than this value have been vain suggesting that there was a cut-off at this limit. The announcement of the discovery of a quasar at z = 4.00 (Hewett, this conference) shows that this is probably not the case.

Knowing that the luminosity function is a power law, the redshift distribution can be easily used to determine the cosmic evolution of the quasar space density. It is found that the quasar space density increases quickly with redshift up to z ~ 2.45, drops by about a factor of 5 at this value, and then increases again at least up to z = 3.8.

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DISCUSSION

WINDHORST: This is a general question to all observers who have made QSO surveys using slitless techniques. If everyone would cut-off his sample more severely, e.g. at 1-1.5 mag brighter than they are currently doing would the redshift distributions then agree better? I realize that the numbers will be smaller, but the samples would be less biased.

VERON: There is no basic disagreement between the redshift distributions shown by various authors. Most of these distributions are based on very small samples and suggests a cut-off in the redshift range 2.5-3.5. My analysis, based on a large sample of more than 500 QSOs, shows clearly a drop at z ~ 2.45 which, if real, would certainly be acceptable by other authors. However it may be due to some as yet unrecognized observational bias.

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