THE EVOLUTION OF QUASARS SELECTED BY SLITLESS TECHNIQUE

Z. G. Deng
Department of Physics, Graduate School,
Academia Sinica, Beijing, China.
Y. Y. Zhou
Center for Astrophysics, University of Science and
Technology of China, Hefei, China.
Y. Z. Liu
Department of Physics, Graduate School,
Academia Sinica, Beijing, China.

ABSTRACT. After taking account of the selection effects in the identification of emission lines and choosing the sample within a narrow range of absolute magnitude, we can investigate the evolutionary function of quasars from their redshift distribution. From data given by slitless surveys with limiting apparent magnitude 19 .5, we find that the evolutionary function takes form of $\rho = \rho_o(1+z)^{6.5\pm1}$. The analysis has also showed that the observational redshift distribution of quasars is compatible with cosmological principle.

1. INTRODUCTION

Quasars have become a powerful tool to explore the space-time structure of the universe. To this end, an important task is determining their evolutionary function. Many authors have studied the evolution of quasars by different methods in various wavebands (Schmidt, 1968, 1974; Veron, 1983; Koo and Kron, 1982; Schmidt and Green, 1983). In order to obtain more reliable evolutionary function, we would consider the selection effects appearing in the identification of emission lines carefully.

In this work, we shall use the method developed before (Zhou, Deng, and Dai, 1985) and eliminate some other selection effects in the surveys to investigate the evolutionary function of quasars selected by slitless technique from their redshift distribution.

2. ANALYSES OF SELECTION EFFECTS

The observational redshift distribution of quasars can be expressed as

$$f(z) = P(z)R(z), \tag{1}$$

where, P(z) is the real redshift distribution of quasars and R(z) is a factor caused by selection effects depending on the redshift z. Under the standard model of the universe with $\Lambda = 0$, we have

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$$P(z) = \begin{cases} \dfrac{4\pi c^3}{H_0^3}\,\dfrac{[zq_0+(q_0-1)(-1+\sqrt{2q_0z+1})]^2}{q_0^4(1+z)^6(1+2q_0z)^{\frac{1}{2}}}\,n(z), & q_0 \neq 0, \\ \dfrac{4\pi c^3}{H_0^3}\,z^2(1+z/2)^2(1+z)^{-6}n(z), & q_0 = 0, \end{cases} \tag{2}$$

where, n(z) is a factor relating to the evolution of quasars. If quasars do not evolve, n(z) is proportional to $(1+z)^3$. If quasars evolve, then, under the assumption of power law evolution we can write

$$n(z) \propto (1+z)^{3+\gamma}, \tag{3}$$

where, γ is a parameter determining the evolution of quasars.

One of the selection effects is due to the existence of limiting apparent magnitude in each survey. This effect will lead to an extra inhomogeneity in the redshift distribution. If we restrict the quasars contained in our sample within a narrow range of absolute magnitude, we may avoid the influence of this selection effect.

Another important selection effect is that in the identification of emission lines. The factor R(z) caused by this selection effect can be expressed into (Zhou, Deng, and Dai, 1985)

$$R(z) = \sum_i R_i(z) + \sum_{i<j}\sum R_{ij}(z) + \sum_{i<j<k}\sum\sum R_{ijk}(z) + \ldots\ldots, \tag{4}$$

where, $R_i(z)$, $R_{ij}(z)$,... are the probability densities of finding a quasar with redshift z and including only the ith line, the ith and jth lines,... respectively. The R's depend on the optical window, the sensitivity of emulsion etc. If we use an approximate but reasonable assembly function $S(\lambda)$ as showed in fig.1, we may have

$$R_i(z) = \frac{N_i}{N}\,\frac{S[(1+z)\lambda_{oi}]}{\int P(z)S[(1+z)\lambda_{oi}]dz}, \tag{5}$$

$$R_{ij}(z) = \frac{N_{ij}}{N}\,\frac{S[(1+z)\lambda_{oi}]S[(1+z)\lambda_{oj}]}{\int P(z)S[(1+z)\lambda_{oi}]S[(1+z)\lambda_{oj}]dz}, \tag{6}$$

.... ,

where, N is the total number of quasars in the sample, and N_i, N_{ij},... are the numbers of quasars in which only the ith line, only the ith and ith lines,... are identified in the surveys, respectively.

The sample are chosen from surveys with limiting apparent magnitude about $19^m.5$ (Savage, et al, 1984; Osmer and Smith, 1980a,b; and Crampton, et al, 1985). If we take $q_o=0$ and $H_o=50$ km/s.Mpc, a quasar with apparent magnitude $19^m.5$ will have a absolute magnitude -28.5 at redshift 2.8. So, the sample will be limited to consist of quasars with absolute magnitude less than -28.5 and with redshifts less than 2.8.

Counting the N_i, N_{ij}, ..., and giving a series of values of γ, we can obtain the calculated the redshift distribution for each value of γ by using the $S(\lambda)$ given in fig.1. Comparing the calculated and observational redshift distribution by linear regression analysis, we can estimate the value of γ from the best fitting between the observational and calculated redshift distribution. We find that both of the largeat value of correlation coefficient and the least deviation are approximately at about $\gamma=3.5\pm1$. In fig.2, we present the observational redshift distribution and the calculated one for $\gamma=4.5$. The regression equation between them is

$$f_{ob}(z) = -0.82 + 1.1f_{cal}(z), \qquad (7)$$

and the correlation coefficient is 0.97.

4. CONCLUSIONS

1. When we consider any problem relating to the redshift of quasar, the selection effects muat be taken account of carefully.

2. The observational redshift distribution of quasars can be explained within the frame of cosmological principle provided the selection effects have been taken account of.

3. Our analysis gives an approximate evolutionary function of quasars selected by slitless technique $\rho=\rho_o(1+z)^{6.5\pm1}$.

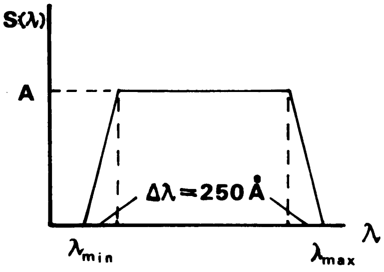

Figure 1. Sketch of the assembly response function $S(\lambda)$. λ_{min} and λ_{max} are the shortest and longest wavelengths of optical windows.

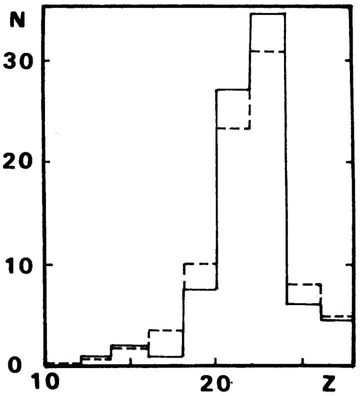

Figure 2. The observational redshift distribution (solid line) and the calculated distribution for $\gamma=4.5$ (dashed line).

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