Local Theory for Quasars

THE concentration of absorption and emission redshifts of quasars around a value of 1·95 (ref. 1), and a possible periodicity in the redshifts of quasars and other emission-line objects[2], have raised doubts about the cosmological origin of the redshifts. An alternative explanation is that they are comparatively local objects[3], though extragalactic[4], and that their redshifts arise mainly from some intrinsic property; gravitational, for example[5].

Provided that the redshift is independent of the distance of a source, it is possible to investigate the distribution in depth of a set of sources complete (or representative) down to some limiting flux-level.

Let the distance of a source of luminosity P be $D \ll c\tau_0$, where τ_0 is the Hubble time, and let the observed flux-density be S. The inverse square law gives

$$SD^2 = \frac{P}{J(z)} \tag{1}$$

where $J(z)$ takes account of the shift of the emitted spectrum across the waveband of the observer, and any other dimming caused by the redshift.

Now the r.h.s. of equation (1) depends only on intrinsic properties of the source, and so is constant for any particular class of source (of given P and z). This applies even if the luminosity is a function of redshift, as suggested by Hoyle and Burbidge[6].

Thus if $S_{\min}$ is the limiting flux-level, down to which we have a complete sample of sources, then the maximum distance at which this class of source is observable, $D_{\max}$, is given by

$$SD^2 = S_{\min} D^2_{\max} \tag{2}$$

If the distribution of the sources is uniform in space, the probability of finding a source at any particular distance is found by considering the corresponding volume of space, $\mathcal{V}(D)$ (ref. 7). If we define

$$x = \mathcal{V}(D)/\mathcal{V}(D_{\max}) \tag{3}$$

for any particular class of source, then x should be uniformly distributed in (0,1), with standard deviation $1/\sqrt{12}$.

Now if $D \ll c\tau_0$, $\mathcal{V}(D) = 4\pi D^3/3$

so

$$\left(\frac{D}{D_{\max}}\right)^3 = \left(\frac{S_{\min}}{S}\right)^{3/2} \tag{4}$$

from equations (2) and (3). Because quasars are affected by both radio and optical selection, the quantity which should be uniformly distributed in (0,1) for quasars is in fact

$$x = \max\ \{x_{\mathrm{rad}}, x_{\mathrm{opt}}\}$$

$$= \max\left\{\left(\frac{S_{\min}}{S}\right)^{3/2}_{\mathrm{rad}}, \left(\frac{S_{\min}}{S}\right)^{3/2}_{\mathrm{opt}}\right\}$$

and we compare $\sqrt{12N}\,(\bar{x} - 0{\cdot}5)$ with Student's t distribution.

We apply this to fifty-four quasars identified with 3C sources[8], for which $S_{\min} = 9$ flux units, and take

$$\left(\frac{S_{\min}}{S}\right)^{3/2}_{\mathrm{opt}} = 10^{0.6(V - V_{\lim})}$$

with $V_{\lim} = 19{\cdot}5\ (0{\cdot}5)\ 17{\cdot}5$. Table 1 gives N, $\bar{x}$, t and the corresponding probability for the different values of $V_{\lim}$. With a high degree of confidence we can assert that the quasars are not uniformly distributed locally. For each value of $V_{\lim}$, $\bar{x}$ is significantly greater than 0·5.

If we take $\mathcal{V} \propto S^{-a}$ instead of $S^{-3/2}$, then

$$\mu = \int_0^1 \frac{2a}{3} x^{2a/3} \mathrm{d}x = \frac{2a}{2a+3}$$

The identifications are probably complete down to $V = 18{\cdot}5$, so $\mu = 0{\cdot}6$ and $a = 2{\cdot}25$. Thus even if the quasars are "local", they show a strong departure from a uniform distribution in space, resembling the radio-galaxies[9] in this respect.

Because the number of sources is not very large it is not possible to test in detail to what extent this effect depends on direction in the sky. But when the area of sky covered by the 3C catalogue is divided into two ranges of declination, and two ranges of hour angle, the values of $\bar{x}$ are $> 0{\cdot}5$ for each portion of the sky, as shown in Table 1.

Table 1. LOCAL THEORY FOR QUASARS

$V_{\lim}$	19·5	19	18·5	18	17·5
Number of quasars	54	51	48	35	25
$\bar{x}$	0·58	0·57	0·61	0·61	0·70
t	3·0	2·5	3·7	2·6	3·5
Probability (per cent)	0·5	1·5	0·1	1	0·2
a (such that $\mathcal{V} \propto S^{-a}$)	2	2	2·5	2·5	3
R.A. $<$11 h.	$\bar{x}=$	0·56	0·62	0·60	0·80
R.A. $\geqslant$11 h	$\bar{x}=$	0·58	0·59	0·61	0·62
Dec. $\geqslant$30°	$\bar{x}=$	0·54	0·59	0·56	0·60
Dec. $<$30°	$\bar{x}=$	0·60	0·62	0·64	0·77

If we are in a "local" cluster of quasars, then we are in a special position, at the bottom of a density-well. The more natural inference is that the number-density or luminosity of these objects was greater in the past, ruling out the steady-state cosmology.

The discovery that the 0·095 redshift of $B264$ is almost certainly cosmological[10] does not settle the question whether the very large redshifts in many quasars are also cosmological.

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Variations of Small Quasar Components at 2,300 MHz

IN a previous article[1] we reported long-baseline interferometer measurements of several quasi-stellar radio sources using stations of the NASA/JPL Deep Space Network in Australia and California. Comparison of three sets of similar observations now shows evidence for secular variations in the apparent intensities of small-diameter components in several of these objects. The results are compatible with the theory of expanding synchrotron sources, but an apparent expansion velocity greater than that of light seems to be required for the recent outburst in 3C 273.

In our earlier article[1] we described our instrumental techniques and discussed a set of observations made in May 1968, using stations DSS 42 at Tidbinbilla, ACT, and DSS 14 at Goldstone, California, when we first found fringes over the trans-Pacific baseline of about 8×10^7 wavelengths. The observing frequency is 2,298 MHz, or a wavelength of 13·1 cm. We mentioned that a previous