The magnitude distribution of QSOs

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GENTLEMEN,—

In a recent paper, Zotov and Davidson[1] attempt to show that pure density evolution as postulated by Schmidt[2] does not explain the observations of QSOs. They base their statistics on distributions of QSO identifications from various Parkes catalogues[3–6] and they conclude that there is a marked disagreement between the predicted numbers based on Schmidt's models and the numbers actually found. However, the authors did not quote statistical errors. I have recently repeated their statistics, as follows.

As a first step I used identifications[3–5, 7–9] from the Parkes Catalogue in the range 0° to −20°. It should be noted here that the sample used[1], *i.e.* all QSO identifications with $S_{1410} \geqslant 0{\cdot}8$ flux unit, is by no means complete. The reason for this is, of course, that the survey frequency was 408 MHz and that it is possible to define a complete sample only at the survey frequency. In this particular case, assuming a spectral index distribution as adopted by Schmidt, the lower limits at 408 MHz corresponding to $S_{1410} \geqslant 0{\cdot}8$ f.u. are:

$\langle\alpha\rangle$	*Percentage of QSOs*	S_{408}
−0·30	30	⩾1·2
−0·75	40	⩾2·0
−1·00	30	⩾2·8

Taking into account that the Parkes Catalogue is only complete for $S_{408} \geqslant 3{\cdot}5$ f.u., the sample used[1] may be very incomplete indeed. We have therefore considered only those QSO identifications for which $S_{408} \geqslant 3{\cdot}5$ f.u. They number 37.

They are grouped in magnitude intervals of 15·5–16·5, 16·5–17·5 and so on. Those QSOs for which magnitudes of 16·5, 17·5 and so on were quoted were distributed equally over the adjoining intervals: this is necessary as generally magnitudes for the Parkes identifications are determined to the nearest half-magnitude.

A comparison of Schmidt's models with the observations (scaled to whole-sky numbers) then yields the following distribution.

m_V	16	17	18	19	20
$S(i)$	15	31	80	107	41
$S(ii)$	16	45	81	76	36
P_{408}	13±9(2)	47±18(7)	121±29(17)	27±13(4)	47±18(7)

in which $S(i)$ is the Schmidt model[6] with $\rho \propto (1+z)$, and $S(ii)$ is the model with $\rho \propto 10^{5\tau}$. P_{408} is the observed distribution taken from the Parkes catalogue as described.

The errors quoted are formal sample size errors, computed from the observed number of objects in brackets. It can be seen that the agreement between predicted and observed numbers is good. Only for $m = 19$ is the difference larger than 3 r.m.s. errors. This may be at least partly due to errors in the magnitude determination.

As a second step, the statistics for the two sets of the 2700 MHz data were repeated using the method described above, with the following results.

$S_{2700} \geqslant 0{\cdot}35$ f.u.

The total number of sources in the sample is 76.

m_V	16	17	18	19	20
$S(i)$	35	107	300	597	694
$S(ii)$	35	147	392	620	617
P	$34\pm24(2)$	$224\pm62(13)$	$500\pm92(29)$	$413\pm84(24)$	$138\pm49(8)$

$S_{2700} \geqslant 0{\cdot}1$ f.u.

The total number of sources in the sample is 29.

m_V	16	17	18	19	20
$S(i)$	64	246	929	2325	3526
$S(ii)$	58	321	1182	2621	3916
P	$167\pm167(1)$	$501\pm289(3)$	$668\pm334(4)$	$2505\pm646(15)$	$1002\pm409(6)$

There are some differences between our results and those of Zotov and Davidson. The largest discrepancy occurs at $m_V = 20$ where we find twice as many objects[1]. This must be due to a different distribution over magnitude intervals.

It can be seen that including statistical errors is extremely illuminating, if only to show the 50 per cent shortfall[1] of the predictions for $m_V \geqslant 17{\cdot}5$ to be statistically insignificant. Any slight systematic effect may be explained in at least three different ways:

(*a*) Not all QSO identifications are, in fact, quasars. (For most of the tentative QSO identifications from the 2700 MHz surveys no confirming optical spectra are available as yet.)

(*b*) The adopted spectral index distribution is incorrect. Since the finding frequency is so different from the frequency at which the spectral index distribution is defined, this is quite likely to be the case.

(*c*) The adopted $G(>R)$ function[10] is incorrect: it has been noted[10] by Fanti *et al.* that the $G(>R)$ function may be redshift-dependent.

There remains some discrepancy for faint magnitudes but it is not nearly so serious as that of Zotov and Davidson. This discrepancy, which only becomes significant at $m_V = 20$, may at least partly be due to incompleteness of the identifications. Summing up, I conclude that there is certainly no very *marked* disagreement between Schmidt's model and the Parkes data. Luminosity evolution may enter the discussion (point *c*) but then only as one of a number of possibilities to explain one not-very-significant discrepancy.

I am, Gentlemen, Yours faithfully,

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1973 July 9.

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References

(1) N. V. Zotov and W. Davidson, *M.N.*, **162**, 127, 1973.
(2) M. Schmidt, *Ap. J.*, **176**, 273, 1972.
(3) J. G. Bolton and J. Ekers, *Austr. J. Phys.*, **19**, 559, 1966.
(4) J. G. Bolton and J. Ekers, *Austr. J. Phys.*, **19**, 713, 1966.
(5) J. G. Bolton and J. Ekers, *Austr. J. Phys.*, **20**, 109, 1967.
(6) J. V. Wall, A. J. Shimmins and J. K. Merkelijn, *Austr. J. Phys. Astrophys. Suppl.*, **19**, 1, 1968.
(7) J. G. Bolton, A. J. Shimmins and J. K. Merkelijn, *Austr. J. Phys.*, **21**, 81, 1968.
(8) J. K. Merkelijn, *Austr. J. Phys.*, **22**, 237, 1969.
(9) J. K. Merkelijn, *Austr. J. Phys.*, **25**, 451, 1972.
(10) R. Fanti, L. Formiggini, C. Lari, L. Padrielli, J. K. Katgert-Merkelijn and P. Katgert, *A. & A.*, **23**, 161, 1973.