then it is possible to calculate the number of sources in this sample, which would lie at a given separation from stars having $m_{pg} \lesssim 20$. The results are plotted in Fig. 2, together with the actual separations between the radio and optical positions for the five compact sources. It can be seen that, even with the fairly small positional discrepancies given in Table 1, the number of associations is no more than can be attributed to chance.

It must therefore be concluded that while it will never be possible to exclude the hypothesis that certain radio sources are identified with galactic stars, there is now no evidence to support it. The more accurate radio positions for these seven sources do not, however, enable any alternative identifications to be made with other objects visible on the *Sky Survey Prints*.

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[1] Wlerick, G., and Véron, P., *Ann. Astrophys.*, **30**, 341 (1967).
[2] Elsmore, B., Kenderdine, S., and Ryle, M., *Mon. Not. Roy. Astro. Soc.*, **134**, 87 (1966).
[3] Macdonald, G. H., Kenderdine, S., and Neville, A. C., *Mon. Not. Roy. Astro. Soc.* (in the press).
[4] Wyndham, J. D., *Ap. J.*, **144**, 459 (1966).

Absorption Lines in Quasi-stellar Objects

GAMOW[1] has attempted to explain the lack of correlation between apparent brightness and red-shift of quasi-stellar objects[2,3] as being caused by the fact that the red-shifts are measured from absorption spectra which he has argued are caused by galaxies intercepting the light from more distant quasti-stellar objects. In this case, no correlations could reasonably be expected because the apparent magnitude would refer to one object and the red-shift to another.

Gamow's conclusion, however, is based on a misinterpretation of the observational data. All the red-shifts which have been used in the analysis by Longair and Scheuer[3] are emission-line red-shifts[4,5] which cannot arise in anything other than the quasi-stellar object itself.

It is true that some quasi-stellar objects do have absorption lines in their spectra in addition to the emission lines, and we have summarized all the data now available on the red-shifts of the absorption lines[6]. Only about twenty quasi-stellar objects out of the 104 with known red-shifts do in fact show absorption features. The absorption-line red-shifts, z_{abs}, are found either to be approximately equal to the emission-line red-shifts, z_{em}, or to have a "standard" value of about 1·95. In cases where $z_{abs} \approx z_{em}$ there is no question but that the emission lines and the absorption lines all arise in the quasi-stellar object. In cases where $z_{abs} \approx 1{\cdot}95$, often $z_{em} > z_{abs}$, or $z_{em} \approx z_{abs}$, but there is at least one case where $z_{abs} > z_{em}$ by a small amount. Spectroscopic arguments[7,8] strongly suggest that in these cases, also, the regions producing the absorption lines are very close to the source of radiation in the quasi-stellar object. This, together with the fact that a "standard" red-shift seems to have been found, led us to the conclusion that these red-shifts are largely intrinsic and not cosmological. Shklovsky[9], however, has argued that the "standard" absorption spectrum, $z_{abs} \approx 1{\cdot}95$, is caused by galaxies all at this (cosmological) red-shift, an idea which forces one to the conclusion that a cosmological model of the Lemaitre type is required. But in no case do the data support the idea that the absorption is taking place in galaxies with a wide range of red-shifts.

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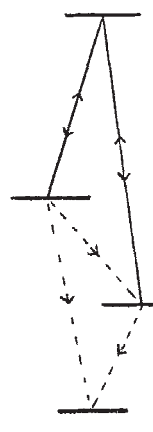
[1] Gamow, G., *Nature*, **216**, 461 (1967).
[2] Hoyle, F., and Burbidge, G. R., *Nature*, **210**, 1346 (1966).
[3] Longair, M., and Scheuer, P. A. G., *Nature*, **215**, 919 (1967).
[4] Burbidge, E. M., *Ann. Rev. Astro. and Astrophys.*, **5**, 399 (1967).
[5] Burbidge, G. R., and Burbidge, E. M., in *Quasi-Stellar Objects* (W. H. Freeman, San Francisco, 1967).
[6] Burbidge, G. R., and Burbidge, E. M., *Astrophys. J. Lett.*, **148**, L 107 (1967).
[7] Bahcall, J. N., and Salpeter, E. E., *Ap. J.*, **144**, 847 (1966).
[8] Bahcall, J. N., *Astrophys. J. Lett.*, **149**, L 7 (1967).
[9] Shklovsky, I. S., *Astrophys. J. Lett.*, **150**, L 1 (1967).

Emission of [O II] and [O III] Forbidden Transitions by Quasi-stellar Objects

THE observation of forbidden transitions in the emission spectra of quasi-stellar objects[1,2] has led previous authors to deduce limiting values for the electron density in relevant regions of these sources (for example, ref. 1). In this report I shall show that significant limits must be set on the ultraviolet radiation intensity in the emitting region, and thus on the size of the region, if the observations of certain [O II] transitions are to be explained even at low electron densities.

The level scheme relevant to both O II and O III is shown in Fig. 1. I consider the alteration in the forbidden line intensities produced by photoexcitation to levels connected by allowed transitions to both the metastable states, 1 and 2. For simplicity, only the nearest such excited level, 3, is considered. The collisional depopulation of levels 1 and 2 is neglected in comparison with radiative processes, because my interest is in conditions where forbidden transitions are emitted strongly. Spontaneous radiative transitions are assumed to be the only significant processes depopulating level 3. Photoexcitation to levels connected to a single metastable leve by allowed transitions can be ignored, because the eventual return of the electron to the original level implies that the forbidden line intensity is unchanged. Levels 1 and 2 are also populated at rates P_1 and P_2 by processes other than photoexcitation from either level and subsequent decay—the rates P_1 and P_2 need not be specified in detail in what follows, and may include either collisional excitation or radiative cascade. The ratio of the inten-



Level	O II	O III
3	$2s2p^4\ ^2D$	$2s2p^3\ ^1P^0$
2	$2p^3\ ^2P^0$	$2p^2\ ^1S$
1	$2p^3\ ^2D^0$	$2p^2\ ^1D$
0	$2p^3\ ^4S^0$	$2p^2\ ^3P$

Fig. 1. Level scheme. ——, Allowed transitions; - - - -, forbidden transitions.