Note on a Comment by Edward L. Wright

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In a recent paper Edward L. Wright (1994) has criticized both a paper of ours and the Monthly Notices which published it (Hoyle, et al. 1994) on the original grounds that neither we nor the journal took adequate notice of his views! He is concerned with Sections 3 and 4 of our second paper in the series in which we have developed the quasi-steady state cosmological model and have shown that it is a viable alternative to the popular big bang model. We believe that his criticisms of our Section 3 have already been discussed adequately in our paper and we have nothing further to add. His discussion of our Section 4, while not seeming to differ significantly from our calculations technically, differs in relation to a radiosource survey by Allington-Smith (1982).

In that survey, Allington-Smith attempted identifications of 59 sources with flux values between 1 and 2 \textit{Jy} taken over a limited strip of the sky from the Bologna survey at 408 MHz. We were concerned in our paper with radiogalaxies, and of these 59 sources about 32 would be expected to be radiogalaxies. Our paper predicted about 8 should show identifications at magnitudes of $\sim +20$ to $+21$, and the remaining 24 would show identifications at about magnitude $+25$. Since Allington-Smith’s attempted identifications went down to $r$ magnitude about $+23$, our expectation was that the 24 cases would be found as so-called empty fields. But things turned out the opposite way round, about 8 empty fields and 24 rather clear-cut identifications at magnitudes typically around $+20$.

We had been aware of this survey, at the time of our paper, but had discounted it, partly because of the small number of sources involved, about 32 radiogalaxies out of 5000 or more with $F \geq 1$\textit{Jy} over the whole sky, and partly because there seemed to be an incompleteness in its redshift content (McCarthy 1993) Wright’s view however, is that the survey should be considered to give a complete sample of all 408 MHz sources with $1 \leq F/2 \leq \textit{Jy}$. If this view is accepted, then the question of whether our theory can match the observed source counts as a function of $F$ requires further consideration. We show in what follows that the issue is a tactical one, in no way involving the basic properties of our cosmological model.

The form in which we consider the quasi steady-state model had a scale function

$$S(t) = \exp\left(\frac{t}{P} \left(1 + 0.75 \cos\frac{2\pi t}{Q}\right)\right)$$

in the metric.

$$ds^2 = dt^2 - \frac{S^2(t)}{S^2(t_o)} \left[dr^2 + r^2(d\theta^2 + \sin^2\theta d\phi^2)\right].$$

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where $t_o$ is the present moment of time. The characteristic period of oscillation of the second factor of (1) was taken as $Q = 40 \times 10^9$ years, while $P \gg Q$. The model has a slow expansion due to the factor $\exp t/P$ superposed on the oscillations. Numerical values were given in former papers subject to the choice $T_o = 0.85Q$, or $t_o = 0.85$ when $Q$ is used as the unit of time.

We took the occurrence of radio sources to be always proportional to the cosmological density, while here we modify this extremely simple postulate by requiring the occurrence of powerful sources to be concentrated in the half of each cycle centered around the minima of $S(t)$. This accords with the view we have expressed on several occasions more recently than our Monthly Notices paper cited above, namely that violent activity in our model tends to be centered around the minima of the oscillatory cycles. On this view we expect sources of very high radio luminosity to be more concentrated towards the minima than sources of comparatively low luminosity.

Explicitly, we now consider a rather simple situation in which there are just three luminosities:

I sources with $L = 10^{26} WHz^{-1}$,

II sources with $L = 10^{27} WHz^{-1}$,

III sources with $L = 10^{29} WHz^{-1}$.

A fourth class with $L = 10^{28} WHz^{-1}$ could be included and would give extra scope to the model. But since such a fourth class is not essential we omit it for simplicity.

Sources of Type I we consider to occur uniformly at all times, as in our former discussion. Sources of Type II are to occur uniformly as before for $0.22 \leq t \leq 0.78$ but not for $t \geq 0.78$, and sources of Type III occur uniformly as before for $0.30 \leq t \leq 0.70$ but not for $t \geq 0.70$. And the relative occurrence rates at times when all three types occur as given by I:II:III = 5000:1000:1. Very powerful sources are thus infrequent. The resulting integral source counts as a function of flux $F$ are given by the points of Figure 1, which may be compared with the observed counts shown in Figure 2 (Fig 2 of Hoyle et al. 1994a). Only sources from the present half-cycle $0.5 \leq t \leq 0.8$ contribute effectively to Figure 1 and all have redshifts. Integral source counts have been used in Figure 1, otherwise the approximation of sources of Type II and III being assumed to begin abruptly at $t \leq 0.78$ and $t \leq 0.70$ respectively (rather than as continuous transitions) would lead to artificial distortions.

Only types I and II contribute down to the level of the 3CR catalog at $F = 10 Jy$, in a ratio of about 3:1. The Type I sources have low redshifts of $\sim 0.03$, while the Type III sources have redshifts of $\sim 1.4$. At $F \approx 1 Jy$, however, the count is dominated by Type II sources with redshifts of $\sim 0.5$. These are the cause of the notorious rise of the counts as $F$ decreases from $10 Jy$ to $\sim 1 Jy$.

If it be said that the above model is analogous to the way in which Big-Bang cosmology seeks to grapple with the source count problem, our reply is that our choice of parameters can be understood in relation to the phases of the oscillatory cycles in $S(t)$, whereas there is no similar
situation in Big-Bang cosmology, where radio sources are required to change their behavior quite drastically just about now. Subsequent to the synthesis of the light elements in Big-Bang cosmology, the density of the Universe is supposed to have fallen by some thirty powers of ten. And yet radio source evolution is required to have occurred in the last decline of the density by a factor only \( \sim 2 \). Why?

In his concluding remarks Wright appears to have been completely carried away (as he was in his original referee’s report). He states that “the data disprove the QSSC”.

As we have said elsewhere the QSSC is based on a fundamentally new idea involving matter creation in an oscillatory mode imposed on an expanding universe (Hoyle et al. 1993, 1994a,b). The exact values of the free parameters of the theory are not known. The points in dispute are related to the numerical values we have chosen when we compare with observational details. Suitable choices can and do make the theory compatible with the observations, i.e. it is obvious that the theory is not disproved by Wright’s analysis of the data.

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Figure Captions

Fig 1  Theoretical curve based on the model described here for the counts of radio sources.

Fig 2  Observed counts of radio sources at 408 MHz and 1.4 GHz, with the latter restricted to flux values greater than \( \sim 10^{-2}\) Jy, redrawn from Kellermann & Wall (1987). The counts are normalized to a uniformly filled static Euclidean universe.