QUASAR COUNTS AND THE LAGGING CORE MODEL ('WHITE HOLES')

Y. NE'EMAN

University of Tel-Aviv, Tel Aviv, Israel, and University of Texas, Austin, Tex., U.S.A.

Abstract. The lagging core model for quasars (i.e., 'white holes') is shown to impose a negative exponential for the number of quasars at any given time as measured from the start of the cosmological expansion. Models in which quasars and other dense cores result from collapse yield a different behavior. A recent observational count appears to fit a negative exponential.

The morphological study of quasars lends plausibility to the following characteristics:

(a) quasars possess very dense cores (Greenstein and Schmidt, 1964);

(b) quasars are at cosmological distances (Bahcall and Bahcall, 1970; Gunn, 1971);

(c) they seem to fit in a general class of objects with dense nuclei (Burbidge, 1970); and

(d) their space distribution displays an evolutionary effect, their number appearing to follow an exponential decrease (Schmidt, 1970).

We would like to point out that the observation (d) reinforces the arguments for quasars as lagging cores of the original expansion (Ne'eman, 1965; Novikov, 1964) and would be difficult to reconcile with any other model.

Dense nuclei can be created in two ways:

(A) through the gravitational collapse of matter in a galaxy or a protogalaxy. In this case it can have the following history.

(1) it continues to collect matter and to grow; and

(2) at a certain point it undergoes further collapse and generates a black hole. In this case it either vanishes and thus has a finite lifetime, or it may go into a stationary state and is then equivalent to case (1).

(B) dense nuclei represent lagging – as yet unexpanded – cores ('white holes' in presently fashionable nomenclature). At some stage in their history they finally expand and turn into 'normal' distributions of matter – galaxies etc. Members of this class of objects are thus only recognized as quasars in their initial stage.

In case A1, the number of quasars (and similar objects) should grow with time. The evolutionary effect should thus be the inverse of observation (d).

In case A2, with a finite lifetime for collapsed nuclei due to the formation of black holes, the number of quasars and dense nuclei should have at least reached a steady state at some early stage in the formation of galaxies; alternatively, we would have some growth with time, though less than in case A1. Again, negative exponential behavior does not fit this picture.

Now for case B. We assume that the total amount of matter in the universe is fixed, with much of it in unexpanded cores. Assuming a fixed probability λ for any single core to start upon the final stages of its expansion in any given unit of time, we find

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for N the number of quasars at time t

$$N(t) = N_0 e^{-\lambda t}.$$

The time coordinate t here corresponds to some external observer, e.g., an observer linked to a universal space-averaged reference frame. We know that the expansion occurs very fast in the lagging core's own reference frame, but is extremely slow with respect to an outside observer. With the difference between the two frames becoming very large, it is natural to take a probabilistic view with respect to the occurrence of the final expansion for the outside time-coordinate.

Summing up, we see that observation (d) fits very well with the lagging core model.

References

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DISCUSSION

Van Horn: I am not a general relativist, but insofar as I understand the problem I believe that the total mass of the universe is directly connected with the deceleration parameter q_0. If that is so, the limitations that can be placed upon the range of possible values of q_0 from existing observational data can be used to place restrictions on the amount of mass in the universe that has not yet become observable, in the model you have described. What sort of restrictions on the amount of such 'unborn' mass does this give?

Ne'eman: I think we are as yet far from seriously influencing the overall density ϱ. The conventional value of $\varrho \sim 10^{-29}$ g cm^{-3} is indeed connected to the Hubble constant $H = \dot{Q}/Q$ for the case of Euclidean three-space $k = 0$ and deceleration $q_0 = 0.5$ by the equation

$$\varrho = \frac{3H^2.}{8\pi G}$$

This is the density which makes the universe close upon a Schwarzschild radius c/H, i.e. the universe just fills out its observational bubble. In the $k = +1$ case, at present favored by Sandage's estimates of q_0 from counts, ϱ has to be even larger than the above figure. Now to get this value of ϱ, we require some 10^{55} to 10^{56} g in the Universe, i.e. about 10^{22}–10^{23} solar masses. If the number of quasars is of the order of 10^5, this would still allow us to put in as much as 10^{16} solar masses, i.e. up to a million galaxies, without modifying the situation by more than 10%.