Zeitschrift: Helvetica Physica Acta

Band: 29 (1956)

Heft: [4]: Supplementum 4. Fünfzig Jahre Relativitätstheorie = Cinquantenaire de la Théorie de la Relativité = Jubilee of Relativity Theory

Artikel: Observational tests in cosmology

Autor: Hoyle, F.

DOI: https://doi.org/10.5169/seals-112735

Observational Tests in Cosmology

by F. HOYLE (Cambridge)

I should like to follow Dr. BAADE and Dr. ROBERTSON in discussing the relation of observation to theoretical cosmology. It is convenient to divide my remarks into two categories, one relating to cosmological observations, and the other to cosmogonic developments. The cosmological observations can be subdivided within themselves, first into observations that refer to a significantly different time to the present – where we are looking back so far along the light cone that the time of transit of the light from the object in question is a significant fraction of HUBBLE's constant (which Dr. BAADE gave as about $5{\cdot}4 \times 10^9$ years). In this subdivision we may include the determination of HUBBLE's constant itself and the problem of nebular counts. These issues have been so fully dealt with by Dr. BAADE and Dr. ROBERTSON that I shall pass them by with just one remark. The extreme difficulty of making accurate nebular counts by optical methods has been emphasized. It is perhaps worth noting that the counting of discrete sources of radio emission may turn out to be a considerably easier matter. And if, as seems likely, the majority of these discrete sources correspond to a special class of galaxy, then it may prove possible to derive valuable cosmological information from 'radio counts'.

Now let us consider an example of the second subdivision of the cosmological type of observation, the subdivision corresponding to observations that relate to times that do not differ appreciably from the present. It seems probable that our Local Group is not expanding, that it is a bound cluster of galaxies. It seems to me a fair inference from this that the average density of matter in the universe must be less than the mean density within the Local Group. I would expect that any cosmological theory would explain the non-expansion of the Local Group in these terms – i.e. that the Local Group is non-expanding because the density of matter within it exceeds the average for the universe. Now the mean density within the Local Group can be estimated with quite good accuracy. It is in the neighbourhood of 5×10^{-29} gm/cm³. It therefore seems unlikely that the average density of matter throughout space can exceed this value.

I now come to my second main division, to the cosmogonic type of development. This may include cosmogonic theory as well as observation. Let me consider one important example. The observed colour-magnitude diagrams of the Type II stars, together with the theory of stellar structure, are sufficient for a quite precise estimate to be made of the ages of the Type II stars. And since these are the oldest stars we presumably get thereby an estimate for the age of our Galaxy. Although present investigations are clearly susceptible of much improvement we already know sufficient to say that the answer cannot be much different from five or six thousand million years. If we combine this with Dr. BAADE's value of $5{\cdot}4 \times 10^9$ years for the expansion constant we arrive at a rather crucial statement: that we cannot accept any point-source cosmology in which there has been an appreciable slowing down of the expansion of the universe – we must confine our attention to the markedly hyperbolic cases.

Cosmogonic considerations of this sort are capable of further development. It should eventually be possible to deduce the ages of Type II stars in other galaxies with nearly the same accuracy that we can for our own galaxy. Then it will be possible to decide such important cosmological questions as whether all galaxies are of nearly the same ages, or of widely different ages.

My impression is that our knowledge of cosmology is likely to advance as much from cosmogonic considerations as it is from the more widely known cosmological type of observation.

Diskussion – Discussion

G. JÄRNEFELT: Wäre es nicht sehr wünschenswert diejenigen Beobachtungstatsachen, die zu der Behauptung, daß die mittlere Dichte im Weltraum etwa $5 \cdot 10^{-29}$ g/cm^3 ist, irgendwann möglichst explizit darzustellen?