28. COMMISSION DES NEBULEUSES EXTRAGALACTIQUES

PRÉSIDENT: M. HUBBLE†

SECRÉTAIRE: M. N. U. MAYALL.

MEMBRES: MM. Baade, Bondi, Carpenter, Coutrez, Holmberg, Humason, Knox-Shaw, Lemaître, Lindblad Lundmark, McVittie, Madwar, Oort, Page, Paraskevopoulos†, Randers, Reynolds†, Samaha, Seyfert, H. Shapley, V M. Slipher, Whitrow, Zwicky.

Report of meeting

PRESIDENT: Dr W BAADE.

SECRETARY: M. F. HOYLE.

In his opening remarks Dr Baade pointed out that although in the past instrumental opportunities for the study of extragalactic problems had been extremely limited, there was now hope that several large telescopes would soon become available. In particular, Dr Baade referred to the progress that had been made with the new reflector at the Lick Observatory. In answer to a query concerning the present position of this reflector, Dr Shane said that, while the dome was already completed, he thought that something like three more years should be allowed for the completion of the mounting, the figuring of the mirror, and for final testing.

Dr Baade then went on to describe several results of great cosmological significance. He pointed out that, in the course of his work on the two stellar populations in M 31, it had become more and more clear that either the zero-point of the classical cepheids or the zero-point of the cluster variables must be in error. Data obtained recently—Sandage's colour-magnitude diagram of M 3—supported the view that the error lay with the zero-point of the classical cepheids, not with the cluster variables. Moreover, the error must be such that our previous estimates of extragalactic distances—not distances within our own Galaxy—were too small by as much as a factor 2. Many notable implications followed immediately from the corrected distances: the globular clusters in M 31 and in our own Galaxy now come out to have closely similar luminosities; and our Galaxy may now come out to be somewhat smaller than M 31. Above all, Hubble's characteristic time scale for the Universe must now be increased from about $1{\cdot}8 \times 10^9$ years to about $3{\cdot}6 \times 10^9$ years.

In reference to recent work by Dr Hubble, Dr Baade said that re-determinations of red-shifts were being carried out up to a limit of 90,000 km./sec. Dr Hubble was also carrying out further investigations on the distribution of nebulae in depth, using the 200-inch telescope.

Dr Thackeray reported that results obtained from the study of the Magellanic Clouds fitted very well with the suggestion that the old zero-point of the classical cepheids was in error by about 1 magnitude.

Work at Pretoria has led to the discovery of three cluster-type variables in NGC 121 which most probably is one of the globular clusters of the SMC. Instead of being of apparent magnitude 17·5, as one would expect according to the present zero-point for the classical cepheids (type I), they are of apparent magnitude 19. Commenting on Thackeray's result Baade stressed the point that the search for cluster-type variables in the Magellanic Clouds should be extended to, say, magnitude 20, in order to settle the question whether cluster-type variables occur in the LMC or whether they are absent. He also stated that the present discrepancy in the zero-points of the classical cepheids on the one hand and of the cluster-type variables on the other could be most easily checked in the Magellanic Clouds. If cluster-type variables could be discovered in a very few globular clusters of the Clouds (two would be sufficient), we could be certain that we are dealing with members of the Clouds and not with foreground objects. A comparison of their magnitudes with that of classical cepheids of a given period would then immediately reveal the present discrepancy in the two zero-points and would determine the error numerically.

Prof. Oort added that the distances given by the modified zero-point of the classical cepheids had also cleared up the radius discrepancy of η Aql, as found by Stebbins and Whitford.

Dr Shane described preliminary results that have been obtained by the Lick Survey of nebulae, using the 20-inch telescope. He said that, so far, 1246 plates have been taken, covering nine separate areas. On the average between 60 and 70 nebulae per square degree are being counted: with perhaps a counting error of about 13%. The fluctuations revealed in the counts are about four times greater than would be expected from purely random fluctuations. This indicated a marked clustering tendency among the nebulae. Indeed, present results are consistent with the assumption that *all* nebulae belong to clusters, although of course this consistency does not establish the ultimate validity of the assumption. The final results of the Lick Survey would be published in two forms: in addition to maps showing contours of equal nebular densities, the straight counts would also be given.

Prof. Shapley then pointed out that his earlier investigations required the occurrence of irregularities in nebular density on a scale even larger than the clusters. Mr Bondi emphasized the importance to cosmological theory of Prof. Shapley's remark, and Mr Gold asked Prof. Shapley whether he could offer an estimate of the maximum size of the irregularities of distribution. To this Prof. Shapley replied that irregularities certainly existed up to dimensions of the order of 20 million light years. Prof. Shapley then asked Dr Baade if he could describe in a little more detail how he (Dr Baade) had arrived at the error in the zero-point of the classical cepheids. Dr Baade offered two arguments in support of his conclusion:

First argument. According to the present zero-points we should expect to find the cluster-type variables of the Andromeda nebula at $m_{pg}=22{\cdot}4$ since the distance modulus of this system, derived from classical cepheids, is $m-M=22{\cdot}4$. The very first exposures on M31, taken at the 200-inch telescope, showed at once that something was wrong. Tests had shown that we reach with this instrument, using the $f/3{\cdot}7$ correcting lens, stars of $m_{pg}=22{\cdot}4$ in an exposure of 30 min. Hence we should just reach in such an exposure the cluster-type variables in M31, at least in their maximum phases. Actually we reach only the brightest stars of population II in M31 with such an exposure. Since, according to the latest colour-magnitude diagrams of globular clusters, the brightest stars of the population II are photographically about 1·5 mag. brighter than the cluster-type variables we must conclude that the latter are to be found in M31 at $m_{pg}=23{\cdot}9\pm$, and not at $m_{pg}=22{\cdot}4$ as predicted on the basis of our present zero-points.

We have also convincing proof that the brightest stars of population II in M31 are properly identified because when they emerge above the plate limit the globular clusters of M31 begin to be resolved into stars.

Second argument. Since the observations just mentioned were made in the central lens of the Andromeda nebula one might object that the relatively dense, unresolved background could introduce serious photometric errors. In order to avoid this objection the photographic magnitude of the brightest stars in the outer parts of NGC 205, the elliptical companion of M31, was determined. Again, the same value as in M31 was found, i.e. $m_{pg}=22{\cdot}4\pm$ for the brightest stars of the population II; hence, with $m_{pg}=-1{\cdot}5$ for their absolute magnitude, $m_{pg}=23{\cdot}9\pm$ for the cluster-type variables. The assumption made in this case that the population II of NGC 205 can be substituted for the population II of M31 is fully confirmed for the area where the outlying stars of the two systems intermingle. They are completely indistinguishable from one another.

It should be emphasized that these are rough first data indicating the order of the corrections which the present constants require.

Dr Whitrow asked what was the position regarding the existence of intergalactic material. Prof. Oort remarked that he had just received a letter from Dr Zwicky, who referred to threads that occasionally could be observed to run from one galaxy to another. Prof. Oort added that, of course, such threads might be stars and not diffuse material.

Dr Dufay pointed out that the change in the scale of extragalactic distance had an interesting application so far as the sizes of gaseous emission nebulae were concerned. Formerly there had been systematic differences of size between such nebulae in the Galaxy and both the Magellanic Clouds and NGC 6822. The changed distance scale now equalized the sizes.

Dr Dufay then went on to say that at one time it was thought that the smallest galaxies were closely comparable in luminosity with the brightest globular clusters. Then the work of Holmberg and Bigay on integrated galactic magnitudes had shown that the faintest galaxies were about 1 mag. brighter than the globular clusters. Would the new distances increase this gap still further?

Dr Baade replied that indeed the gap between the faintest galaxies and the brightest clusters is now widened to about 2 magnitudes.

F. HOYLE, *Secretary*

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