

is intricate, and not one in which it is easy to excite interest in a general audience. It is, therefore, much to the lecturer's credit that he succeeded in making the subject not only intelligible, but also interesting. He discussed first Froude's theory of the screw, and then showed how the various factors in the resulting equations had been checked by experimental work both in the wind-channel and on the "rotating arm" apparatus. Incidentally, he referred to the flapping flight of birds, showed how difficult it would be to imitate this, and doubted whether true progress lay in this direction. Mankind had made much use of the wheel in mechanism; evolution had led to the introduction of no such element in animal life, in spite of its proved efficiency in its many human applications. This afforded an argument that man had here beaten uninstructed Nature. The only flying animal which approached the aeroplane in design was perhaps the beetle, which possibly used its horny wing-covers as stationary planes and its wings as a means of propulsion.

The Parallaxes of Globular Clusters and Spiral Nebulæ.

IT may be remembered that Dr. Charlier expressed doubt as to the correctness of the enormous distances for globular clusters announced by Dr. Harlow Shapley. Mr. Knut Lundmark, of Upsala Observatory, undertook a re-examination of the question, taking different lines of evidence from those used by Dr. Shapley. His work is published in *Kungl. Svenska Vetenskapsakademiens Handlingar*, Band 60, No. 8. His data are avowedly of a much less precise character than those used by Dr. Shapley, but they lead to results of the same order of magnitude:—

(1) The discussion of the proper motion of those clusters for which data are available indicates a value not exceeding 1" per century. Accepting this maximum value, and combining it with the mean radial velocity of clusters found by Prof. Slipher, Mr. Lundmark finds the distance 3000 parsecs, one-fifth of Dr. Shapley's value.

(2) Use is made of Kapteyn's luminosity law. Van Schöuten has already applied this method to the clusters M₃, 5, 11, and 13, obtaining distances that are, in the mean, twenty-eight times those of Dr. Charlier and one-eighth of those of Dr. Shapley. His work is here revised, estimation being made of the spectral type of the stars from Dr. Shapley's observed colour-indices. The mean of several independent estimations gives 6000 parsecs for the distance of M₃ and M₁₃.

(3) A rough estimate of distance is made from the observed mean absolute magnitudes of stars of different spectral types. Various assumptions are made as regards the mean spectral type of the stars employed. In the mean the distances found are about eighty times those of Dr. Charlier, or one-third of those of Dr. Shapley.

(4) Holetschek has investigated the apparent magnitudes of several clusters regarded as single objects. Mr. Lundmark shows that his values are about $\frac{7}{8}$ magnitudes brighter than Dr. Shapley's mean values of the twenty-five brightest stars in the respective clusters, this difference being very nearly constant.

It follows that the assumption that the absolute magnitude of a cluster is constant will lead to relative distances of the different clusters proportional to those deduced by Dr. Shapley.

The four lines of evidence outlined above, though

individually weak, have cumulative force, and tend to increase confidence in the accuracy of Dr. Shapley's work.

Mr. Lundmark uses Prof. Slipher's radial velocities of clusters to determine the sun's motion with regard to them. He finds that its velocity is 381 km./sec. towards R.A. 320°, N. decl. 74°. He notes that both the R.A. and declination of the solar apex as determined from stars tend to increase as fainter stars are used. This is explained by a larger proportion of the stars being outside the local cluster. He suggests that his value is the limit to which the others are tending.

Mr. Lundmark passes on to consider the parallaxes of the spiral nebulæ.

(1) Beginning with the Andromeda nebula, he quotes all the directly observed measures of its parallax. They are discordant, but their mean is near zero.

(2) The star density increases towards the middle of the Andromeda nebula, in spite of the nebulosity tending to veil them. It is concluded that the nebula is more distant than the non-nebulous faint stars in the region. A combination of the results of many workers indicates a distance of 3000 parsecs for these faint stars.

(3) A combination of measured angular rotation of spirals with the values of the linear rotational speed given by the spectroscopy has led to estimates of distance somewhat greater than the last, say 4000 parsecs. It is further shown that the mass necessary to control the rotation is $10^9 \times$ sun, of the same order as the estimated mass of the stellar system.

(4) Making the rather doubtful assumption that the dark curves in various nebulæ have the same absolute dimensions as the similar dark regions in the galaxy, Wolf finds distances for various spirals ranging from 10,000 to 200,000 parsecs.

(5) Comparisons of the light curves of novæ in spirals with those in the galaxy, while they involve several rather doubtful assumptions, give very large distances for the spirals, 200,000 parsecs being found for the Andromeda nebula. Bullialdus noted that the Andromeda nebula was exceptionally bright in the year 1664. It is conjectured that a nova of magnitude 5 or 6 may have appeared in it at that time.

From the above and other considerations Mr. Lundmark locates the spiral nebulæ far beyond the galactic limits, but inclines to the view that they are the star-producing mechanisms of Mr. Jeans's theory rather than counterparts of the galaxy. Their linear dimensions appear to be much inferior to the latter, of which our ideas have lately been enlarged by Dr. Shapley's and other researches.

The Forestry Commission.

WE are informed that the Forestry Commissioners who were appointed on November 29 last at once proceeded with the planting programme for 1919-20. The shortage of forest-tree seed has been met to a great extent by purchases in Austria and elsewhere and by gifts from the United States and Canada. About 34,000 acres of afforestable land are in course of acquisition by purchase or on lease, in some cases below the market value and in others as free gifts from landowners. Rather more than 10,000 acres are in England, of which 3500 are in Suffolk, 2760 in Devon, 1150 in Cumberland, and 1800 in Northamptonshire and Bedfordshire. More than 5000 acres are in Ireland, of which 2000 are in Tyrone, 1500 in County Galway, 1500 in King's County, and