sary; (6) the right of any qualified teacher to teach in any capacity in any State-aided school; (7) no class in any type of school to exceed thirty on the roll, and each class to have its own qualified teacher; and (8) the curriculum of the primary school should be liberal and non-vocational, with the aim of promoting true citizenship and high personal character. It was also suggested that the attention of public opinion and of organisations representing parents of elementary-school children should be directed to the powers now possessed by persons interested in education to secure substantial improvements in the educational facilities provided in their localities by means of representations on the schemes prepared by local education authorities under the Act of 1918, where such schemes fail to attain the standard set up in the foregoing proposals, and that county and local teachers' associations should stimulate the demand for the full benefits of the Act of 1918 in each locality.

A further important topic discussed at the conference was "The Supply and Training of Teachers." The scheme submitted was approved by the conference, and included the following main requirements: (1) All intending candidates should have completed a satisfactory course of higher education, and show by adequate tests their fitness for the profession; (2) the admission to the graduate course should be the standard of matriculation; (3) the course of study should include "Education" as a principal subject for the degree, and the course be followed in association with other students entering for other professions; (4) a period of one year should, as a rule, be devoted to the acquisition of skill in teaching, the existing training colleges (which should be recognised as colleges of the university) being utilised for this purpose alone, whilst education research work should be a distinct feature of the college staff and students; (5) on the completion of the academic and professional training the teacher should be eligible for recognition by the Board of Education for service in any approved school; and (6) the teachers of special subjects should be required to take a course of higher education and of professional training.

Aeronautics at the Imperial College.

SIR RICHARD GLAZEBROOK, the occupant of the Zaharoff chair of aeronautics at the Imperial College of Science and Technology, completed on March 24 the series of five lectures which initiate the new course of study. It will be remembered that Sir Basil Zaharoff founded similar chairs in Paris and in Petrograd. The London chair has been chosen by the Government as the nucleus around which to organise a central school of aeronautics—a scheme in which the new professor's long experience as Director of the National Physical Laboratory, chairman of the Advisory Committee for Aeronautics, and, latterly, chairman of the Government Committee on Education and Research in Aeronautics, will be of immense help. In the years to come the courses of instruction so provided will doubtless prove of service to officers of the Royal Air Force selected by the Air Ministry for higher technical training, in addition to such numbers of other students as the then position of civil aviation may inspire to join this new and adventurous profession.

The attendance at this initial course of lectures must have been encouraging to the lecturer, if only as an indication of a widespread general interest in the subject. In the circumstances, the lectures were, naturally and rightly, of a simple character, only the last one, on air-screws, being at all technical.

Sir Richard Glazebrook in his first lecture paid a tribute to the munificence of the founder of his chair, and proceeded to a description of the experimental wind-channels and of full-scale experiments on aircraft. He was able to show how, on Lord Rayleigh's law of similarity, the measurements made by the one method could be compared with the other. The agreement in most cases was reasonably satisfactory, though enough anomalies had been found to provide an ample field for future research work. This was followed by a lecture on the principles of automatic and inherent stability. The former is achieved by the use of auxiliary apparatus, whether mechanical or aerodynamic, to operate the controls of the machine; and the latter by providing, in the original design, such sizes and positions for the aerodynamic surfaces that any departure of the machine from its normal position brings into play forces which tend to restore it to that position, and create a "damping" couple sufficient to prevent the continuance of such oscillations. Inherent stability can, as experience has amply shown, be provided for by careful design, so that automatic apparatus for the purpose is quite unnecessary. Commercial machines should be decidedly stable, fighting machines only just stable. Sir Richard Glazebrook was able to show (with Mr. Nayler's assistance) a number of mica models in flight, and so to illustrate the various forms and degrees of stability and instability.

The third lecture was concerned with the instruments essential to flight, and included the air-speed indicator, the engine-revolution indicator, the altimeter, the clinometer (to indicate side slip), the statoscope (to show the rate of climb), and the turn indicator. The statoscope measures the rate of air leakage through a small hole in a vessel kept at a constant temperature. Turn indicators are of two forms, the static head type and the precessional gyro type; these are later inventions than the other instruments mentioned.

Among the most important measurements made on an aeroplane are the determinations of oscillation in yaw, roll, and pitch; for such experiments use can conveniently be made of the sun as a fixed point, since the motion of a shadow of some part of an aeroplane on the rest of the machine can be employed to obtain a photographic trace of the oscillations. This work, however, is really only just beginning.

In view of the enormous inertia forces which come on a machine when "stunting," it is essential to obtain a continuous record of their amount during all parts of the flight-path concerned. For this purpose a stiff fibre acted as an acceleration index, and some most valuable records were obtained. On occasion the force on the wings of the machine might be three, or even four, times the weight of the aeroplane.

This naturally led in the fourth lecture to a consideration of the strength of the wing structure and to statements of the load factors necessary in design. The load factor is the ratio of the breaking load to the normal load corresponding to horizontal straight flight at the designed speed. Another important coefficient is the factor of safety, and this is the ratio of the breaking load to the loading incurred during some specified operation, *e.g.* a vertical nose-dive. The load factor needs to be fixed at a higher figure for machines which, like fighting machines, have to "stunt."

Sir Richard Glazebrook's fifth and last lecture was of special interest. The subject, "Air-Screws,"

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 Schouten 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 ⅞ 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-nebular 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 spectroscope 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