WE have received a copy of the first issue—that for 1903—of *Mimir*, which is wholly concerned with Iceland and Icelandic institutions. The annual publication is intended to help Icelandic research, to keep the people of Iceland and the foreign student informed of the progress of this research, and to promote the proper development of the island and its people. Among the interesting contents we notice the account of institutions in Iceland, the addresses of foreign students of Old-Northern letters, and numerous notes on Icelandic matters of general interest. *Mimir* is printed in English, and is published by Martius Truelsen, of Copenhagen.

THE tables relating to the output of coal and other minerals and the number of persons employed at mines worked under the Coal and Metalliferous Mines Regulation Acts during the year 1903 have now been printed. The tables have been prepared by direction of the Home Secretary from returns furnished by H.M. Inspectors of Mines; and they form part of the general report and statistics for 1903 of mines and quarries. The output of coal from mines under the Coal Mines Regulation Act, which was 227,084,871 tons in 1902, was 230,323,391 in 1903, showing an increase of 3,238,520 tons. The number of persons employed at these mines in 1903 was 842,066, an increase of 17,275.

Two new general methods of preparing aldehydes are given in the current number of the *Comptes rendus*. The first of these, by M. E. E. Blaise, consists in the conversion of the acid through its bromine derivative into the corresponding α-hydroxy-acid, which by the action of heat is first converted into a lactide, and this on distillation splits up into carbon monoxide and the aldehyde of the next lower acid. The yields are very good, from 50 to 60 per cent. of the acid employed, and from the results obtained would appear to be generally applicable to the higher fatty acids. The second method, published by M. F. Bodroux, is based upon the action of magnesium alkyl compounds in toluene solution upon ethyl orthoformate. Here again the reaction gives good yields—from 55 to 75 per cent. of the theoretical—and the examples given by the author include members of both the fatty and aromatic series.

THE Geneva *Archives des Sciences* for January contain an important article on the theory of nickel steels, by M. Guillaume, of the Bureau international des Poids et Mesures. One of the most important properties of these alloys is their low coefficient of expansion, which becomes zero at about 36 per cent. of nickel. It is pointed out that the conversion, below 890° C., of the hard, non-magnetic γ variety of iron into soft, magnetic α iron is accompanied by an expansion of 3 mm. in a rod a metre long. The addition of nickel lowers the transition temperature until in presence of 20 per cent. of nickel magnetic properties only appear when the alloy has been cooled below 200°, whilst (owing to a kind of thermal hysteresis) the magnetic properties do not disappear again until the alloy has been heated to 600° C. In the non-expansive alloys the transition temperature appears to have been brought down to atmospheric temperatures, and the constancy of length is attributed to the same change in structure as that which causes the abrupt expansion in pure iron when cooled below 890°. A striking proof of the correctness of this view was obtained by cooling a metre rod in liquid air, when it suffered a permanent expansion of 3·9 mm., and subsequently showed the high coefficient of expansion characteristic of α iron in place of the lower coefficient characteristic of γ iron.

THE additions to the Zoological Society's Gardens during the past week include a Green Monkey (*Cercopithecus callitrichus*) from West Africa, presented by Mrs. L. A. Moline; a Vervet Monkey (*Cercopithecus lalandii*) from South Africa, presented by Captain Campbell; two Eastern Sarus Cranes (*Grus antigone*) from Northern India, presented by Lieut.-Colonel H. H. Smyth; a Greater Sulphur-crested Cockatoo (*Cacatua galerita*) from Australia, presented by Mr. C. Hammett; a Hybrid Pheasant (between *Phasianus reevesi* and *Euplocamus nycthemerus*), presented by the Earl of Ducie; two Ring-tailed Lemurs (*Lemur catta*) from Madagascar, an Azara's Opossum (*Didelphys azaroe*) from South America, a Blue-necked Cassowary (*Casuarius intensus*) from New Guinea, four Dusky Francolins (*Pternistes infuscatus*), two Jackson's Francolins (*Francolinus jacksoni*), two Schueth's Francolins (*Francolinus schuethi*) from East Africa, two Hybrid Parrakeets (between *Platycercus semitorquatus* and *P. barnardi*) from Australia, deposited. In additions in last week's issue (p 473), Snow Leopard presented by Major Cox should read Major Mackintosh.

OUR ASTRONOMICAL COLUMN.

VARIATIONS OF THE MARTIAN CANALS.—During the 1903 opposition of Mars, Mr. Lowell observed changes in the canals which he believes were the results of artificial interference. Among the canals mapped by Schiaparelli in 1877 were three, situated on the eastern edge of the Syrtis Major, which met at a common point, the Lacus Tritonis, and which he named Thoth, Triton and Nepenthes respectively. In 1882 and 1884 Thoth appeared double, but was undoubtedly seen, and in 1884 Nepenthes was also distinctly double.

At the commencement of Mr. Lowell's observations in 1894 he was surprised to find no trace of these three canals, or of the Lacus Moeris, a widening of Nepenthes, although other well known but smaller features were plainly visible. Instead of Thoth another canal, which he named Amenthes, appeared, running from Syrtis Minor to the Aquæ Calidæ, nearly parallel to the earlier recorded directions of Thoth and Triton. During the oppositions of 1896–7 and 1901 this continued as an easily seen object, and Mr. Lowell concluded that it was really Thoth which had been wrongly placed on the earlier drawings. During February and March, 1903, Amenthes was still visible but less distinct, and on April 19 it was accompanied by Thoth in exactly the position shown on Schiaparelli's earlier map; on April 20 Thoth alone was visible. Suddenly, on May 29, the Lacus Moeris, which had long been given up, appeared and became a noticeable feature of that region of the planet's surface. In July Amenthes reappeared alongside Thoth and Triton, and thus settled the question of the presence of *two* canals.

These changes are entirely independent of the seasonal changes, and whilst the two "visibility" curves of Thoth and Amenthes vary inversely, the curve derived from the summation of them agrees very closely with that of a "mean" canal, for which only the seasonal changes have as yet been observed.

From these phenomena Mr. Lowell reasons that owing to the small amount of water on Mars it becomes necessary to irrigate the surface in sections, and for this purpose the canals are artificially regulated, Thoth and Amenthes being allowed to fill up and irrigate the regions surrounding them alternately (Lowell Observatory *Bulletin*, No. 8).

PROF. BURNHAM'S MEASURES OF DOUBLE STARS.—One of the *Decennial Publications* (vol. viii.) of the Chicago University is devoted to a record of the measures of double stars made by Prof. S. W. Burnham with the Yerkes 40-inch refractor during 1900 and 1901. The systems which have been measured are those which have been long neglected and are little known, and those which, from the few early measures or the uncertainty of their results, could not be classified as to their motion or otherwise. Most of the pairs were selected from the Herschel and South catalogues, whilst some of the rejected Struve stars have also been measured.

Eighteen new pairs discovered by Burnham are also included. The pairs are arranged in order of R.A., and the coordinates (for 1880·0), the number in the original catalogue, and the measures of position angle and distance are given.

ORIGIN OF AURORÆ.—In a lengthy communication to the Société Française de Physique (*Bulletin* No. 3, 1903), M. Ch. Nordmann discusses the causes which produce auroræ. After reviewing the various observations of the phenomena attending auroræ, and discussing in detail the theories of Arrhenius and Birkeland, he formulates his own theory in the following words:—"I think that the Auroræ Boreales are luminous phenomena produced in the upper atmosphere by the Hertzian waves emanating from the Sun."

In support of this belief he discusses each of the phenomena attending the appearance of auroræ, and shows that the forms and orientation, the extension, the frequency, the height, the spectrum and the diurnal, annual and undecennial periodicities may all be explained by the application of his theory. In discussing the relations between auroræ, solar disturbances and magnetic storms, he states that the emission of the Hertzian waves becomes more intense in the regions of spots and faculæ at the period of maximum solar activity, and quotes the observed fact that it is only the rapidly moving auroræ (*i.e.* those due to the greater disturbances) which apparently affect the magnetic needles.

ASTRONOMICAL DETERMINATION OF LATITUDE AND AZIMUTH.—In a recent publication of the Royal Geodetic Commission of Italy, Prof. V. Reina gives the details and the results of the astronomical determination of the latitude and azimuth of five selected stations situated near to the meridian of Rome. The main object of this determination was to study the action of the local attraction on these two coordinates. A number of circum-meridian observations of certain fundamental stars were made at each station, and the results are given separately. Auwers's correction to the astronomically determined position is then applied, and the final results are embodied in a table, which also shows the reduction of each position to the "mean pole," the effects of local attraction, and the differences between the results of the astronomical and geodetical determinations.

THEORIES OF THE RESOLVING POWER OF A MICROSCOPE.[1]

GEOMETRICAL optics in its relation to instruments has been studied to great advantage abroad; we in England have of recent years somewhat neglected the subject, with the result that only a small share in the recent advance in lens construction has been ours. The books and papers under review tell us of the advance.

It was in 1878, in his report on the London International Exhibition of Scientific Apparatus, that Prof. Abbe first directed attention to the fact that the further perfection of the microscope as an optical instrument depended on the advance of the art of glass making. With the glasses then at their disposal it was not possible for opticians to get rid of the secondary spectrum of their object glasses; while a glass could be made achromatic for two wave-lengths, the differences in the relative dispersion of the two ends of the spectrum were such that there was an outstanding amount of colour which prevented the attainment of the highest perfection of the image. It was to this fact that the establishment of the now celebrated firm of Schott and Company was due, and the results of Abbe's own work on microscope lenses are summed up in the first volume of his collected papers, which has recently appeared.

The well-known paper, "Contributions to the Theory of the Microscope and of Microscopic Perception," which forms the basis of his work, is here reprinted, and it will be interesting to consider some of the points it raises.

But first let us contrast what is now possible so far as achromatic correction is concerned with what was possible, say twenty years ago. In those days the ordinary flint and crown glasses only were available. In the case of a telescope object glass with a focal length of one metre for the D line, the variation in focal length will, with such glasses, amount to 1·4 millimetres for A′ and 2·2 millimetres for G′. In an object glass using modern glass, such as that designed by Mr. H. D. Taylor, these errors are reduced respectively to −0·1 millimetre and +0·3 millimetre.

These figures are enough to show how much the optician owes to the art of the glass maker.

Turning now to some theoretical matters connected with the microscope which are dealt with by Abbe in his papers, let us consider first the term numerical aperture in its relation to the resolving power of the instrument. We owe to Abbe the introduction of this term, and the realisation of its importance as defining, in certain circumstances, the resolving power of the instrument. By numerical aperture is meant the value of the quantity $\mu \sin \alpha$, where μ is the refractive index of the medium in which the object is placed, 2α the vertical angle of the cone subtended at the object glass by the point in which the axis of the instrument meets the object. Let us suppose, then, that an object is on the stage viewed by transmitted light, and to simplify matters let us suppose the source of light at some distance.

Then, according to Abbe[1] and his followers, in considering the image formed in the focal plane of the eye-piece we are not to start from the object as a self-luminous source and consider where the image of such a source would be if formed by the laws of geometrical optics; we are to start from the source itself, to consider its image formed in the focal plane of the object glass, and to treat this image as a self-luminous source of light in the microscope tube from which arises the image we see.

If the object be small, the focal image will be modified by diffraction due to the object, and according to the views enunciated in the paper before us, it is on the nature of the diffraction images and the number of them which are formed that the definition depends.

We will return later to the question whether it is necessary thus to consider our problem.

At present let us develop it and examine whether it affords us a satisfactory solution of the problem of resolving power.

Suppose, now, the microscope has been focused on some object on the stage and then this object has been removed; the parallel rays from the source are brought to a focus in the focal plane of the object glass, forming there a circular patch of light; rays diverge from each point of this, and reaching the eye produce the sensation of a uniform luminous field.

Now let the field in the focal plane be limited by diaphragms pierced with a series of small apertures. The distribution of light in the focal plane of the eye lens, the view plane, will be no longer uniform; we shall see the diffraction pattern formed there by the apertures.

If, for example, there be but one aperture, a single narrow slit, the field will still be uniform; light diverges from the slit uniformly in all directions, and no structure is seen.

If we have a number of equidistant slits the view plane will be crossed by a series of equidistant dark and light bars. The distance between these bars and the distribution of light between them will depend on the distance between the slits of the diaphragm and the distribution of luminosity among the slits. If this be known, the distribution of light in the view plane can be calculated. If, for example, the distance between the slits be doubled, the distance between the maxima in the view plane will be halved, that is to say, the number of bright bars in a given interval will be doubled. The distribution in the view plane depends on that in the focal plane, and can be calculated from it; this is quite certain.

1 "Gesammelte Abhandlungen" Von Ernst Abbe.
"Das Zeisswerk und die Karl Zeiss-Stiftung in Jena."
"Zur Theorie der Mikroskopischen Bild-erzeugung." By Victor Grunberg.
"The Helmholtz Theory of the Microscope." By J. W. Gordon.
"The Theory of Optical Images." By Lord Rayleigh (*Journal* of Royal Microscopical Society, 1903).

1 It was stated recently by Dr. Czapski (*Proc.* Royal Microscopical Society, August, 1903, p. 569) that it would be a mistake to suppose that Prof. Abbe had merely given a grating theory of the microscope; he has treated the matter more fully.