

it invariably crystallises out upon cooling in the form of graphite of density about 2; but that when the operation is performed under increased pressure the density and hardness of the carbon which eventually separates are augmented, and black diamonds are produced in considerable quantity. A modification of the original form of these pressure experiments is now described, which results in the production of small but perfectly transparent and colourless diamonds similar to those found naturally. The former experiments were made with iron and silver as solvents for the carbon, the mixture of metal and excess of charcoal being heated in the arc of the electric furnace under pressure until most of the charcoal was dissolved in the white-hot metal, after which the hot crucible was thrown into a tank of water to effect sudden cooling. Bismuth has since been tried as a solvent but is not found suitable, as a violent explosion is caused when the fused mass is projected into water, probably owing to the sudden decomposition of a carbide of bismuth. Iron is therefore used, and the cooling is effected by pouring the contents of the crucible into a bath of just melted lead. The solution of carbon in molten iron, being lighter than liquid lead, rises to the surface in spherical globules; the smaller spheres solidify before reaching the surface of the lead, but the larger ones are still liquid and are still so hot that they cause the lead at the surface to burn in contact with the air, incandescent particles of metal and oxide being projected out, and torrents of fumes of litharge produced. Upon removing the globules floating at the surface of the lead, dissolving their leaden coating in nitric acid, and subsequently removing the iron by suitable solvents, as previously described by M. Moissan, the transparent diamonds are readily isolated. They frequently exhibit well-defined crystal faces, which are usually curved and striated and etched with cubical markings exactly like those of natural diamonds. They possess the same wonderful limpidity, high refractive power, hardness, and density (3.5) as native diamonds, and exhibit many of the properties, such as anomalous polarisation and occasional spontaneous disruption, owing to their state of strain resulting from their formation under high pressure, which are characteristic of some Cape diamonds. The hemihedral forms of the cubic system appear to predominate in the crystals examined. They scratch rubies, and resist the action of a mixture of potassium chlorate and fuming nitric acid, but burn in oxygen at a temperature of about 900° with formation of pure carbon dioxide.

NOTES from the Marine Biological Station, Plymouth.—During the past fortnight the alga *Halosphaera viridis* has frequently been present in the tow-nettings. The proportion of Mollusc, Polychæte, and Cirrhipede larvæ to the rest of the floating fauna has become still greater. The medusa *Phialidium variabile* is obtainable in about the same numbers as previously, and a few *Obelia* medusæ have made their first appearance for the year; but, strange to say, *Rathkea octopunctata* has not been observed, and even the ephyræ of *Aurelia*, although numerous in the open Channel, have been scarce within the Sound. No Echinoderm larvæ have been yet observed. The Hydroids *Tubularia indivisa*, *Eudendrium ramosum*, and *Sertularia argentea*, and the Molluscs *Nassa reticulata*, *Lamellaria perspicua* and *Lamellidoris pusilla* are now breeding.

THE additions to the Zoological Society's Gardens during the past week include two Mozambique Monkeys (*Cercopithecus pygerythrus*, ♂♂) from East Africa, presented by Lt.-Gen. Owen L. C. Williams; a Hooded Crow (*Corvus cornix*) from Norway, presented by Mrs. Wroughton; a Puff Adder (*Vipera arietans*), a Hoary Snake (*Coronella cana*) from South Africa, presented by Mr. B. Matcham; a Hairy Porcupine (*Sphingurus villosus*) from Brazil, deposited.

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OUR ASTRONOMICAL COLUMN.

A LARGE SUN-SPOT.—During the foggy days of last week, when the brightness of the sun was not too great to permit direct observation, a sun-spot, which was very plainly visible to the naked eye, attracted general attention. It was first seen in the south-east quadrant on February 19, and will probably pass off the visible disc about March 2. It has been somewhat remarkable for its relatively large penumbra and the scattered character of the umbra; a very distinct nucleus was also observed. In the course of an interview, Mr. Maunder stated that the spot was at a maximum on February 20, when it was about 48,000 by 46,000 miles, and the area 1870 millions of square miles. It was therefore much smaller than the great spot of February 1892. Though the magnetic disturbances have not been so great as in the case of the 1892 spot, a marked effect on the Greenwich recording magnets was noticed at 3.15 p.m. on February 20, the disturbance lasting about twenty-seven hours. After an interval of about twenty-four hours, another and more intense storm commenced, and reached a maximum at 3 p.m. on February 23. In the case of the spot of February 1892, the violent magnetic storms occurred after the spot had passed the central meridian; but in the present instance, the disturbances seem to have preceded the central transit of the spot.

ANDERSON'S VARIABLE IN ANDROMEDA.—Prof. E. C. Pickering announces in *Astronomische Nachrichten* (No. 3213) that an examination by Mrs. M. Fleming of photographs taken at the Harvard College Observatory confirms the variability of the star in the constellation Andromeda (R.A. oh. 14m. 48s. Decl. +26° 10' 3") observed by Dr. Anderson (*NATURE*, Nov. 30, 1893). The observations, and those quoted by Dr. Anderson, as having been made at Bonn and Cambridge, indicate that the period of the variable is 281 days, and that the next maximum will occur on March 30. A determination of the form of the light curve led to the interesting result that during the three months following a maximum, the diminution in light is at the uniform rate of one magnitude in twenty-five days; for the three months preceding the maximum the increase is also uniform, and at the rate of one magnitude in twenty-six days. Prof. Pickering points out that this great uniformity in the variation in light of the star appears less extraordinary if a similar uniformity in the diminution of the light of Nova Aurigæ is considered. From March 7 to March 31, 1892, the light of this star diminished from magnitude 6.3 to 13.3 with almost perfect regularity at the rate of three-tenths of a magnitude per day.

Following Prof. Pickering's note is one in which Dr. E. Hartwig gives observations to show that the next maximum of the variable under consideration will occur on March 10, and that the period of variability is 74.4 days.

A BRIGHT METEOR.—Mr. Andrew Greig writes to us as follows:—"A very bright meteor was seen at Dundee at 7h. 13.3m. p.m. on Wednesday, February 21. It was a little to the east of south, and midway between Sirius and Orion's belt. It was falling in a westerly direction, or parallel to a line joining the stars Betelgeux and Rigel. It was visible for about three seconds. There was a slight haze above both southern and northern horizons at the time, but Vega could easily be seen low down in the north. The portion of the sky around Jupiter and the Pleiades was quite clear. 'Streamers' were observed in the north for about three minutes afterwards."

This meteor was also seen in North Lincolnshire. To an observer in that district it appeared in the north-west by northern part of the sky, and fell in a westerly direction. Among other places in which the object was observed are Colwyn Bay, Whitby, Howden, and Sandal; but no details as to the path it traversed, or the times of observation, have reached us from these places. An explosion was heard at Colwyn Bay, but no sound is mentioned by other observers.

THE BAKERIAN LECTURE.

AN investigation on the internal friction of liquids, carried out by Prof. T. E. Thorpe, F.R.S., and Mr. J. W. Rodger, formed the subject of the Bakerian Lecture delivered at the Royal Society on February 22. The following is an abstract of the communication:—

The purpose of this paper is to throw light upon the relations between the viscosity of homogeneous liquids and their chemical nature.

The first of the three parts into which the paper is divided contains a summary of the attempts which have been made, more particularly by Poiseuille, Graham, Rellstab, Guerout, Pribram and Handl, and Gartenmeister, to elucidate this question. Although it is evident from the investigations of these physicists that relationships of the kind under consideration do exist, it must be admitted that they are as yet not very precisely defined mainly for the reason that the conditions by which truly comparable results can alone be obtained have received but scant consideration.

For example, it seems futile to expect that any definite stoichiometric relations would become evident by comparing observations taken at one and the same temperature. Practically, nothing is known of a quantitative character concerning the influence of temperature on viscosity.

From the time which a liquid takes to flow through a capillary tube under certain conditions, which are set out at length in the paper, a measure of the viscosity of the liquid can be obtained.

An apparatus was, therefore, designed on this principle which admitted of the determination in absolute measure of the viscosity, and for a temperature range extending from 0° up to the ordinary boiling point of the liquid examined.

Full details of the conditions determining the dimensions of the apparatus and of the modes of estimating these dimensions, together with the methods of conducting the observations, are given in the paper, and the corrections to be applied to the direct results are discussed.

The question of the mathematical expression of the relation of viscosity of liquids to temperature is considered, and reasons are given for preferring the formula of Slotte—

$$\eta = c/(1 + bt)^n$$

η is here the coefficient of viscosity in dynes per square centimetre, and c , b , and n are constants varying with the liquid.

With a view of testing the conclusions set out at length in the historical section of the paper, and, in particular, of tracing the influence of homology, substitution, isomerism, and, generally speaking, of changes in the composition and constitution of chemical compounds upon viscosity, a scheme of work was arranged which involved the determination, in absolute measure, of the viscosity of some seventy liquids, at all temperatures between 0° (except where the liquid solidified at that temperature) and their respective boiling points.

Part ii. of the memoir is concerned with the origin and modes of establishing the purity of the several liquids; it contains the details of the measurements of the viscosity coefficients, together with the data required to express the relation of viscosity coefficients to temperature by means of Slotte's formula, and tables are given showing the agreement between the observed and calculated values.

In Part iii. the results are discussed. In the outset the factors upon which the magnitude of the viscosity probably depends are dealt with. The influence of possible molecular aggregations, as indicated by observations of vapour densities, boiling points, and critical densities, and, more especially, by measurements of surface energy, made by Eötvös in 1886, and more recently by Ramsay and Shields, are taken note of.

The deductions which may be made by considering the graphical representation of the results, showing the variations of viscosity coefficients with temperature, are then set forth.

For liquids which probably contain simple molecules, or for which there is little evidence of association of molecules at any temperature, the following conclusions may be drawn:—

(1) In homologous series the coefficient of viscosity is greater, the greater the molecular weight.

(2) An iso-compound has always a smaller viscosity coefficient than the corresponding normal compound.

(3) An allyl compound has, in general, a coefficient which is greater than that of the corresponding isopropyl compound, but less than that of the normal propyl compound.

(4) Substitution of halogen for hydrogen raises the viscosity coefficient by an amount which is greater, the greater the atomic weight of the halogen; successive substitutions of hydrogen by chlorine in the same molecule bring about different increments in the viscosity coefficients.

(5) In some cases, as in those of the dichlorethanes, substitution exerts a marked influence on the viscosity, and in the case of the dibromides and benzene, it may be so large that the compound of higher molecular weight has the smaller viscosity.

(6) Certain liquids, which probably contain molecular com-

plexes, do not obey these rules. Formic and acetic acids are exceptions to Rule 1. The alcohols at some temperatures, but not at all, are exceptions to Rule 2; at no temperatures do they conform to Rule 3.

(7) Liquids containing molecular complexes have, in general, large values of $d\eta/dt$.

(8) In both classes of liquids the behaviour of the initial members of homologous series, such as formic acid and benzene, is in some cases exceptional when compared with that of higher homologues.

As regards the influence of temperature on viscosity, it is found that the best results given by Slotte's formula are in cases where the slope of the curve varies but little with the temperature. From the mode in which the values of the constants n and b are derived, it cannot be expected that their magnitudes will be related in any simple manner to chemical nature. With the exception of certain liquids, such as water and the alcohols, which are characterised by large temperature coefficients, and in which there is reason to expect the existence of molecular aggregates, the formula

$$\eta = c/(1 + \beta t + \gamma t^2),$$

obtained from Slotte's expression by neglecting terms in the denominator involving higher powers of t than t^2 , gives a close agreement with the observed results, and in this formula the magnitude of β and γ are definitely related to the chemical nature of the substances.

In order to obtain quantitative relationships between viscosity and chemical nature, and to compare one group of substances with another, it is necessary to fix upon particular temperatures at which the liquids may be taken as being in comparable conditions as regards viscosity, and to compare the values of the viscosities at those temperatures.

The first comparable temperature which suggested itself was the boiling point.

A second comparable temperature was obtained by calculating values of corresponding temperatures by the method of van der Waals with such data as could be obtained.

The third basis of comparison consisted in using temperatures of equal slope, *i.e.* temperatures at which the rate of change of the viscosity coefficient is the same for all liquids.

At each of the different conditions of comparisons, the experimental results have been expressed according to the same system, in order to show at a glance relationships between the magnitudes of the viscosity constants and the chemical nature of the substances. The liquids are arranged so that chemically related substances are grouped together. Tables are constructed which give the values of the three different magnitudes derivable from measurements of the viscosity of the substances.

(1) Values of viscosity coefficients (η).

(2) Values of $\eta \times$ molecular area, *i.e.* molecular viscosity.

(3) Values of $\eta \times$ molecular volume, *i.e.* molecular viscosity work.

The coefficient η is the force in dynes which has to be exerted per unit-area of a liquid surface in order to maintain its velocity relative to that of another parallel surface at unit distance equal to unity. It seemed, however, that relations between viscosity and chemical nature would best be brought to light if, instead of adopting merely unit-areas, areas were selected upon which there might be assumed to be the same number of molecules. The *molecular viscosity* is proportional to the force exerted on a liquid molecule in order to maintain its velocity equal to unity under the unit conditions above defined. With the units chosen it is the force in dynes exerted on the molecular area in square centimetres under unit conditions. The *molecular viscosity work* may be regarded as proportional to the work spent in moving a molecule through the average distance between two adjacent molecules under unit conditions. In ordinary units it is the work in ergs required to move a surface equal to the molecular area in square centimetres through the molecular length in centimetres.

In the case of the comparison of the viscosity coefficients at the boiling point, it is found:

(1) As an homologous series is ascended, in a few cases the viscosity coefficient remains practically the same, but in the greater number of series the coefficients diminish. In one series the coefficients increase; in the case of the alcohols the coefficients vary irregularly with ascent of the series.

(2) Of corresponding compounds, the one having the highest molecular weight has in general the highest coefficient (the

aliphatic acids, and to a much greater extent the alcohols, do not conform with this rule).

(3) Normal propyl compounds have, as a rule, slightly higher values than allyl compounds; in the case of the alcohols, propyl compounds have much the higher value.

(4) The effect of molecular weight in some cases may be more than counterbalanced by that of constitution, or of complexity.

(5) The lowest members of homologous series frequently exhibit deviations from the regularity shown by higher members.

(6) An iso-compound has in general a larger coefficient than a normal compound, and the differences reach their maximum in the case of the alcohols.

(7) In the case of other metameric substances, branching in the atomic chain and the symmetry of the molecule influence the magnitudes of the coefficients; the ortho-position, in the case of aromatic compounds, appears to have a more marked effect on the coefficient than either the meta- or para-position. Acetone and ether have coefficients that are less than half the values given by the isomeric alcohols.

(8) One of the most striking points thus brought to light is the peculiar behaviour of the alcohols, and to some extent of the acids, as contrasted with that of other liquids.

Comparisons of molecular viscosity at the boiling point show—

(1) That, with the exception of the alcohols, dibromides, and the lowest members of homologous series, an increment of CH_2 in chemical composition corresponds with an increase in molecular viscosity.

(2) With the above exceptions, it is also apparent that the corresponding compound having the highest molecular weight has the highest molecular viscosity: the difference in molecular viscosity between the corresponding members of two correlated series is fairly constant.

(3) The relationships shown in the other tables are substantially of the same nature as those given by the viscosity coefficients.

The comparisons which give the largest deviation from regularity contain those substances which, as already shown, exhibit a peculiar behaviour, namely, the alcohols, acids, propylene dibromide, ethylene dichloride, &c.

In order to indicate how molecular viscosity at the boiling point is quantitatively connected with chemical nature, attempts were made to calculate the probable partial effects of the atoms on the molecular viscosity. Values were also assigned to the effects of the iso-grouping of atoms, the double linkage of carbon atoms, and the ring grouping.

Tables are given which show the concordance between the observed molecular viscosity and those calculated by means of these constants. In the case of forty-five liquids the difference between the observed and calculated values rarely exceeds 5 per cent. In the case of the isomeric ketones and aromatic hydrocarbons, the differences are in part due to constitutive influences, which cannot at present be allowed for in obtaining the calculated values.

In a second table are given those substances for which the differences exceed this 5 per cent. limit. These may be roughly classed as unsaturated hydrocarbons, polyhalogen compounds, formic and acetic acids, benzene, water, and the alcohols.

Similar fundamental constants for molecular viscosity work at the boiling point have also been deduced, and tables are also given showing the comparison between the observed and calculated numbers, the substances being classified into two groups, as in the case of molecular viscosity, according as the differences are less or greater than about 5 per cent.

On taking a general survey of the comparisons at the boiling point, it is evident that for the majority of the substances examined—the paraffins and their monohalogen derivatives, the sulphides, the ketones, the oxides, and most of the acids and the aromatic hydrocarbons—molecular viscosity and molecular viscosity work may be quantitatively connected with chemical nature. The remaining substances—unsaturated hydrocarbons, di- and poly-halogen compounds, formic acid, benzene, water, and the alcohols—present marked exceptions to the foregoing regularities.

As regards the comparison of the viscosity magnitudes at the corresponding temperature, it is found that, although the critical data are too unsatisfactory to warrant us in laying any particular stress on the relationships obtained under this condition of comparison, these relationships are similar to, even if less definite

than, those obtained at the boiling point. For a property like viscosity, which alters so rapidly with temperature, a corresponding temperature is no better as a condition of comparison than the boiling point.

The third series of comparisons was made at temperatures at which $d\eta/dt$ is the same for the different liquids. Or, graphically, the temperatures may be defined as those corresponding with points on the viscosity curves at which tangents are equally inclined to the axes of coordinates. The temperatures are therefore those at which temperature is exercising the same effect on viscosity, and for shortness may be termed *temperatures of equal slope*. The temperatures were obtained by means of Slotte's formula.

It was apparent from the shape of the curves that all the liquids could not be compared at any one value of the slope, because the effect of temperature on the slope varied so much from substance to substance. In some cases—the whole of the alcohols for example—the slope at the boiling point was considerably greater than that at 0° in the case of some of the less viscous liquids. A slope was, therefore, selected at which as many liquids as possible could be compared. Another slope was then obtained at which the outstanding liquids could be compared with as many as possible of the liquids used at the original value of the slope. The relationships between the magnitudes of the viscosities of these liquids which could be compared at the two slopes were then found to be the *same at either slope*, so that general conclusions regarding the behaviour of all the liquids could be deduced. These are as follows:—

(1) Temperatures of equal slope tend to reveal much more definite relationships between the values of viscosity coefficients and the chemical nature of substances than are obtained at the boiling point.

(2) In all homologous series, with the exception of those of the alcohols, acids, and dichlorides, the effect of CH_2 on the value of the coefficient is positive, and tends to diminish as the series is ascended.

(3) Of corresponding compounds the one of highest molecular weight has the highest coefficient.

(4) Normal propyl compounds have slightly larger coefficients than the corresponding allyl compounds.

(5) An iso-compound has invariably a larger coefficient than a normal compound.

(6) In the case of other isomers the orientation of the molecule and branching of the atomic chain influence the magnitudes of the coefficients. Similar effects of constitution are also exhibited on comparing saturated and unsaturated hydrocarbons, and the variable effects produced by successive substitution of halogen for hydrogen.

(7) The alcohols, and to some extent the acids, still give results which are peculiar when compared with other substances.

As regards molecular viscosity at equal slope the following conclusions may be drawn:—

(1) For the great majority of the substances molecular viscosity at equal slope can be calculated from fundamental constants which express not only the partial effects of the atoms existing in the molecule, but also those due to different atomic arrangements.

The large effects which can be attributed to the ring-grouping of atoms, to the iso-linkage, to double-linkage, and to changes in the condition of oxygen in its compounds, as well as the smaller effects due to the accumulation of atoms of halogen in a molecule, render evident the quantitative influence of constitution.

(2) Of the remaining substances the chlormethanes, tetrachlorethylene, ethylidene chloride and carbon bisulphide give deviations from the calculated values on account of constitutive influences not allowed for in obtaining the fundamental constants.

(3) The alcohols and water exhibit no agreement with the calculated values. The mode in which deviations vary indicates, in the case of the alcohols, that the disturbing factor is related to their chemical nature.

The results obtained from the consideration of molecular viscosity work at equal slope, are of precisely the same nature as those discussed under molecular viscosity.

The substances which give deviations from the calculated values fall into two classes. In the first the deviations are to be attributed to chemical constitution, inasmuch as similar disturbing effects may be detected in the magnitudes of other

physical properties which afford no evidence of being influenced by molecular complexity.

In the second are substances like the acids, water, and the alcohols, for which the disturbing factor is, no doubt, molecular complexity.

The question of the generality of the results obtained is next discussed. It is evident :

(1) That over such temperature ranges as the observations extend the results obtained at a particular value of the slope may be regarded as general for all liquids, with the exception of the alcohols, for which the relationships vary slightly as the slope alters. A general expression connecting the viscosity coefficient with the slope is given.

(2) It is further indicated, from comparisons made by the use of slopes which varied from liquid to liquid, and which were chosen according to definite systems, that in the present state of the question equal slope is the most suitable condition at which to compare the viscosities of different liquids.

With respect to the relationships existing between the magnitudes of the comparable temperatures of equal slope, it appears :—

(1) That these vary in a regular way with the chemical nature of the substances, except in the case of liquids like benzene and propylene dibromide, giving viscosity curves which are abnormal when compared with those of their homologues.

(2) The temperature relationships may also be regarded as general and thus independent of the value of the slope, except in the case of the alcohols, which, in this respect, as in that of viscosity at equal slope, are anomalous.

The rest of the memoir is concerned with the discussion of certain general conclusions regarding physicochemical comparisons ; and it finally deals with other possible methods of obtaining and comparing viscosity magnitudes.

THE DYNAMICS OF THE ATMOSPHERE.

UNDER this title a series of articles appeared in the *Meteorologische Zeitschrift* for May, August, and September, 1893, from the pen of Prof. M. Möller, of Brunswick, which treat of many of the important processes that are at work in our atmosphere.

The principal feature in these discussions is that the author treats the various phenomena as the result of complicated processes, and inquires into their character separately, prior to attempting to draw conclusions from them, so that some relations are presented in a new form.

With regard to the part which aqueous vapour plays in the atmosphere, it is usually stated that the heat set free in condensation during the formation of clouds greatly favours the origin of ascending air-currents, but Möller takes another view of the matter. Two columns of air have usually been compared with each other, having at their base similar initial temperature, but in which the decrease of temperature with height proceeds in a different manner, as one column is supposed to contain dry air, that is very cold at the upper end, and the other moist air warmed by condensation. But the author considers that this difference of temperature does not actually occur in this manner, and that all theories based upon this assumption must lead to erroneous results. He states that as the air of the upper strata has risen up previously, it has consequently gone through the process of warming by condensation, so that the increase of heat caused by condensation cannot produce by itself a higher temperature in the ascending current than that possessed by the surrounding air, hence the cause of the upward impulse, which has been attributed to the aqueous vapour of the air, disappears. If it is wished to produce a circulation of the air in two vertical tubes in communication at both ends, the air in the bottom part of the one tube must be warmed, while that in the upper part of the other tube is cooled ; but if the source of heat is applied at the top, a condition of stable equilibrium and rest takes place. In the same way the condensation of the aqueous vapour causes a warming of the upper strata of air, the effect of which is generally to produce a condition of stable equilibrium, contrary to the theory which assumes that the condensation of the vapour favours the ascending current, and consequently gives rise to depressions. The author attributes the chief cause of the origin of cyclones to horizontal differences of temperature in the earth's atmosphere, to the

steep gradients of the upper strata caused by them, and the consequent strong movements of the air in those regions. He agrees in the main with the views of Ferrel, but attributes greater importance to the effect of friction against the rough surface of the earth. The air which rises at the equator, and moves in the upper regions towards the pole, takes, according to the law of the preservation of the moments of rotation, a west to east velocity, whose right-handed deflective force in the northern hemisphere is opposed to the poleward motive effect of the upper gradient.

According to Prof. Möller, this right-handed force over the dry zone, in the belts of high pressure, on both sides of the tropics, and in higher latitudes, becomes so great that a condition of equilibrium of the forces is produced in the direction of the meridians. Apart from local disturbances, the upper wind here follows the parallels of latitude, unless owing to friction, or the mixing of the upper and lower strata, a diminution of the upper current occurs, whereby the meridional deflecting force of the upper gradients gains the mastery over the decreased right-handed deflective force arising from the centrifugal effect. Only then, and in proportion as this diminution of the upper current occurs, does the upper current follow the meridional upper gradient. In this case a part of the energy gained in the upper currents of the atmosphere is transferred to the lower strata, so that there the velocities which are directed from west to east increase. The atmosphere, therefore, in the temperate and polar zones is like a caloric machine, which first produces by meridional gradients of temperature the upper gradients of pressure, and consequently an air current from west to east at a great height, whose transference to the lower strata of air depends upon opportunities of friction or mixture of masses of air. The meridional advance of air in the upper air-current is checked by the centrifugal force ; for the advance to the pole increases the velocity of the west wind, and thus the centrifugal right-handed deflective force whose effect stops the meridional advance of air to the pole. Möller states that this important relation of interchange was not clearly expressed in Ferrel's theory. He first assumes that a circulation between the hot and cold zones takes place unhindered, and, provided the circulation takes place, he makes the high velocities to exist in the upper current. Ferrel also computes the great forces which would be necessary in order to produce those high velocities, and he admits that these really do not exist. He speaks of this theory as only approximately correct, whereas the computed forces and great meridional differences of pressure fail in nature, and the high westerly wind-velocities, such as his theory requires, do not exist.

Prof. Möller concludes (1) that the regular and undisturbed circulation of the atmosphere between the hot and cold zones is not accomplished in the manner hitherto supposed, and as has been presumed in Ferrel's calculations, and states that if Ferrel's theory is to become of practical use, it will be necessary to study more exactly the relations between the friction of air on the surface of the earth, and especially the friction or the mixture of air between upper and lower strata. (2) If friction of air against the earth's surface is great, the velocity of the winds is less ; but if friction, or mixture of air, between upper and lower strata is great, then the lower winds blow more violently. (3) In higher latitudes no storm can be caused by horizontal meridional gradients of temperature without mixture or friction between the upper and lower strata.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The Savilian Professor of Astronomy, Mr. H. H. Turner, gave his inaugural address on Friday last, in the new schools, before the Vice-Chancellor and a large audience. The Professor illustrated his subject, "The International Photographic Chart of the Heavens," by numerous lantern-slides, and referred particularly to the large share in the work allotted to the Oxford Observatory, and to the progress which had already been made.

Prof. Sylvanus P. Thompson gave a lecture before the Ashmolean Society on Monday last, on the subject of "Magic Mirrors." The lecture was illustrated by numerous specimens and experiments, and was much appreciated by a large audience.

An election to the Siphthorpien Professorship of Rural Economy is announced to take place in Easter Term, 1894.