increased attention and care. M. Wurtz having resumed his seat, M. Dumas presented a letter from Mr. Crookes, in which he summarises his theories of radiant matter, and submits them for discussion before the French Academy. After having explained the Crookesian view of the fourth state of matter, M. Dumas added that he felt confident these assumptions would be the occasion of discussions of the same character as that which the Academy had just witnessed.

PHYSICAL NOTES

HERR DORN of Breslau has published a fresh series of experiments on the propagation of electricity by current water in tubes, and allied phenomena (*Wied. Ann.*, Nos. 4 and 5). In agreement with Helmholtz's theory, he finds the electromotive force from current water in capillary tubes independent of the cross section and the length of these. The value of the "electric moment" of water and glass (3·936 Daniell) deduced from this electromotive force corresponds nearly to that deduced by Helmholtz from Quincke's observations on the propagation of water in glass tubes by the electric current. Observations of the electric current produced by water flowing in capillary tubes lead to a somewhat smaller value. For wider tubes (within pretty wide limits) the current strength, with a given mean velocity of the streaming water, proves empirically to be nearly proportional to the radius of the tube. Traces of a sliding of the water on the glass-wall may perhaps co-operate in producing the variations of electromotive force observed in course of time. Through motion of material particles in a liquid, therefore, an electric current arises.

THE diffusion of salts in aqueous solution has been investigated by Herr Long (*Wied. Ann.*, No. 4), by a method similar in principle to that of Schuhmeister (though different in detail), viz., making a continuous water-current flow over the salt solution and measuring the amount of diffusion by the quantities of salt that pass over in given times. Various interesting relations were found, *e.g.*, the chlorides, bromides, and iodides of the alkali metals form a series, in which NH_4 stands between K (the higher) and Na; and KCl, KBr, KI, and KCy have nearly the same velocity of diffusion. Such is the case also with the corresponding NH_4 and Na salts and with the chlorides of the bivalent metals Ba, Sr, Ca, and Mg, the nitrates, and the sulphates. It seems generally that those salts which diffuse most quickly also conduct best in aqueous solution. Salts with large molecular weight and volume seem to diffuse most easily, while among the waterless salts those which absorb most heat in dissolving or (the same thing) whose molecules, through the work done, finally reach the finest state of division, have the greatest velocity of diffusion. The chlorides of the alkalies stand in the same series with regard to molecular volumes, velocities of diffusion, conductivity, and absorption of heat. This is the case, too, with the corresponding bromides and iodides. Cyanide of potassium behaves as to diffusion and conductivity exactly like the chloride, bromide, and iodide of the metal. In the second group (nitrates) the order is the same as to conductivity and diffusion; but with regard to molecular volumes and heat-absorption the salts form a special series. In the group of sulphates the individual salts have the same order as to diffusion and conductivity, but the values for molecular volume and heat of solution are quite irregular; indeed as regards velocity of diffusion and absorption of heat the waterless salts seem to stand in inverse order. These results are fully discussed by Herr Long.

A CURIOUS physical phenomenon has been lately described by Dr. Grassi (*Reale Ist. Lomb. Rend.*, f. viii. and ix.). An apparatus is formed of three concentric vessels with an annular space of about two centimetres between the first and the second, and the second and the third. The outer space is filled with oil, the next with water. The oil is heated by a gas furnace to a little over 100°, and the water boils. Then hot oil, at *e.g.*, 150° is poured into the central space. This quickly cools to a temperature close on 100°. Dr. Grassi found that the central oil cooled more rapidly the higher the temperature of the outer oil; and with more delicate apparatus (in which the vaporised water was conducted and returned, and the outer oil kept at any required constant temperature) he arrived at definite numerical results, which he tabulates. With the outer oil at a mean temperature of 129°·9, *e.g.*, the time of cooling of the inner oil from 130° to 110° was 49s.; when the former was 105°·1, the latter was 57s. Alcohol and ether gave more decided results. The maximum difference was got with ether; the outer oil being at 57°·5°, the inner took 25s. to cool from 57° to 50° (7 degrees); whereas the former being 39°·3°, the latter became 39°·5s. In all the experiments the cooling of the inner oil commenced at a temperature little above the maximum of the external oil. When the outer oil is at a higher temperature, at a certain point the heat begins to prevail which is transmitted directly from the outer to the inner oil. An analogous phenomenon (to which Dr. Grassi refers) was that of some members of the Accademia del Cimento, who found that water in a vessel surrounded by ice cools more rapidly if the ice be heated to accelerate fusion.

DR. J. PULUJ lately communicated a paper to the Scientific Club of Vienna on "Radiant Electrode-matter," in which he traverses the researches of Crookes, Hittorf, Goldstein, and others upon the phenomena of electric discharges in high vacua. He maintains at the outset that the discharges of "radiant matter" observed by Crookes at the negative pole are not residual gas at all, but are particles of metal torn off from the surface of the pole. He thinks this proved by the mirror-like deposits of metal that are formed on objects interposed in the path of the discharge. That aluminium in this way forms no mirror is a difficulty in the way of this theory; but Dr. Puluj gets over this by remarking that the cause of this lies in the chemical constitution of the metal, and that the particles of an aluminium electrode fly round so far that they deposit themselves on the electrode! All the magnetic effects of these discharges Dr. Puluj regards as explainable by ordinary electro-magnetic laws, assuming that a stream of electrified matter acts as an electric current; but he apparently is not acquainted with the theory put forward by Maxwell on this point. Dr. Puluj has also constructed what he calls an *electrode-lamp*, which gives a bright light when worked by an induction-coil capable of affording a spark of 10 cm. length. In this lamp the radiant discharges of electrode-matter are concentrated upon a piece of carbon which glows with a white heat, but remains unchanged and unconsumed.

DR. CUSCO, ophthalmic surgeon in one of the hospitals of Paris, has invented a lens of variable focus, in which the pressure of a column of water or other transparent liquid is made to alter the curvature of the flat faces of a cylindrical cell of brass closed with thin glass disks. The pressure can be regulated by a manometer gauge to any required degree within the limits of working. It is said that the lens gives a sharp, well-defined focus. It is constructed for Dr. Cusco by M. Laurent.

M. HENRI BECQUEREL continues his researches on the magneto-optic properties of gases. He has recently examined the gases oxygen, nitrogen, carbonic dioxide, nitrous oxide, and olefiant gas, and finds that, except in the case of oxygen, the magnetic rotation of the plane of polarisation due to a field of given intensity varies inversely as the square of the wave-length of the ray, as is the case with solids and liquids. In an older research of Becquerel's it was shown that for non-magnetic solids and liquids the rotation R was proportional to a function of the refractive index n, very nearly represented by the expression $n^2(n^2-1)$; or, in other words, the quantity $\frac{R}{n^2(n^2-1)} = c$. For all non-magnetic solids and liquids the value of c lay between 0·26 and 0·59. In the case of gases in which the rotation is but a ten-thousandth part of that of most solids or liquids the same result holds good, and the values of c for gases fall between 0·26 and 0·59. The above law, that the magnetic rotation is *inversely* proportional to the square of the wave-length, implies that violet rays are more rotated than the red; or, in other words, that there is a positive dispersion. In the case of oxygen it is found that the red rays are rotated more than the green, affording an inverse or *negative* dispersion. This is the more curious as oxygen gives a positive rotation as if it were a diamagnetic body. In fact, Becquerel remarks, oxygen behaves as if it were a mixture of a magnetic and a diamagnetic body, the magnetic having small negative rotation and great negative dispersion, the diamagnetic having great positive rotation and small positive dispersion.

GEOGRAPHICAL NOTES

IN a private letter addressed to Herr von Hesse-Wartegg, the well-known explorer, Dr. Nachtigall, writes from Berlin:—"The German African Society (Deutsche Afrikanische Gesellschaft) has at the present moment not less than six different expeditions travelling through Central Africa. The large funds necessary for the outfitting of these numerous travellers are raised partly

through private subscription, partly through subsidies of the German Government. Among the travellers I may name (1) Dr. M. Buchner, who, starting from San Paolo de Loanda in an easterly direction, may have already reached the large lakes of the Upper Nile or the Upper Congo; (2) Dr. Oscar Lenz, who is on the way from Marocco to Timbuctoo, whence he will proceed to Senegambia; (3) a large expedition, comprising Dr. Böhm, von Schöler, De Kayser, &c., which will establish a station near the Tanganyika lake, in connection with the stations of the International Association; (4) Gerhard Rohlfs and Dr. Stecker will soon proceed to Abyssinia, and thence the latter through the Gallas country to the sea-coast; (5) Dr. Pogge, together with several other travellers, will shortly start from San Paolo de Loanda for the interior, to establish a German station in the neighbourhood of the Muate Janvo, about in the middle of the Continent; finally (6) Herr Flegel will follow the course of the Binué upwards, and explore the sources of that river." The German African Society has certainly developed under the presidency of Dr. Nachtigall a very unusual activity, and it is only to be hoped that these great efforts in the interest of the exploration of Africa may have good results.

THE French journal *L'Exploration* has much improved recently; its reports of geographical societies in all parts of the world are specially valuable. Its value would be still greater if it would aim at greater originality, and display more enterprise in the collection of news. It rarely gives any authorities for its numerous notes, thus minimising their value; and too much space is devoted to the translation of long articles from the *Times* and other popular sources. This may perhaps render it interesting to the general French public, but greatly detracts from its scientific and international value. However, if it goes on improving in the future as it has done during the last few months, it will ultimately become a really valuable geographical organ.

THE new number of *Le Globe* contains a useful account of geographical work in Central Asia, in 1878–1879, contributed by M. Vennikof.

IN view of the present importance of Asterabad, Her Majesty's Consul opportunely gives a brief geographical description of the province. It is situated in the south-east corner of the Caspian Sea; its inhabitants do not exceed 45,000, and the town can only boast of 8,000 souls. It is bounded on the south by the high range of mountains which separate the Caspian provinces from the other parts of Persia; on the north it is bounded by the Atrek as far as Chat, at the confluence of that river and the Sombar, while beyond that point the position of the boundary is doubtful. The west is bounded by the Caspian Sea and the province of Mazanderan, and in the east it adjoins the province of Meshed. Gez, Molla Kellé and Gumush Téppé are the only ports in use. The province is well-wooded, and is watered by numerous mountain streams. Its inhabitants belong to the Kajar tribe, of which the Shah is the personal head. The fertility of the soil is great, and the timber in the forests is magnificent, but unfortunately there are no roads worthy of the name.

M. BOUTHILLIER DE BEAUMONT, the President of the Geneva Geographical Society, has just published a pamphlet entitled *Choix d'un Méridien Initial Unique*.

THE *Colonies and India* publishes an interesting summary of a plan which Mr. G. J. Morrison, the engineer of the short-lived Woosung railway, has sketched for the restoration of the Grand Canal, which at present is usually impassable in places. The essential point in his scheme is the substitution of proper locks for the wasteful sluices now in use, with of course more extensive works at the crossing of the Yellow River.

THE same paper states that the Legislative Assembly of the Transvaal has before it a measure providing for a trigonometrical and geological survey of the country, in the course of which it is expected that abundant mineral wealth will be proved to exist in the colony.

ON July 13, at the end of the French legislative session, the Minister of Marine and the Colonies presented to the Lower House a credit of 1,300,000 francs for establishing fortified posts from Medina on the Senegal to Bafoulabe on the Niger, on the route which will be followed by the projected railway for connecting these two large rivers. It includes also several other items connected with the same scheme. It was adopted on the same day and voted by the Senate on the 15th, so that the first step may be said to have been taken for the establishment of the connecting link between Algiers and St. Louis, *viâ* Timbuctoo.

PLANTS OF THE COAL-MEASURES[1]

M. RENAULT has recently published a memoir, in which he reproduces the views of M. Brongniart respecting the relations which the Lepidodendra bear to the Sigillariæ, still insisting that the former are cryptogamic Lycopods, whilst the latter are exogenous Gymnosperms. In endeavouring to establish this position, the French palæo-botanist concludes that if the exogenous Diploxyloid stems (*i.e.*, Sigillarian ones) are but matured states of some Lepidodendra, every Sigillarian type of organisation ought to be found in a young or Lepidodendroid form, because, he contends, the type of the central organisation, once established, undergoes no further change with advancing age. In support of his position he affirms that there are three such Sigillarian types, viz. (1) *Sigillaria vascularis*, (2) Diploxyloid stems, (3) *Favularia* and *Leiodermaria*. At present he contends that only the second of these forms has been discovered in *Lepidodendron Harcourtii*. He further believes that there are three types of Lepidodendron known, represented by (1) *L. rhodumense*, with a solid central vascular axis, in which the vessels are not intermingled with medullary cells; (2) by *L. Harcourtii*, in which the vascular axis is a cylinder surrounding a cellular medulla; and (3) an undescribed plant, which he names *L. Jutieri*, in which the vascular cylinder is broken up into detached bundles of vessels.

The author of the present paper considers that the above conclusions are not in accordance with the facts, and he proceeds to give his reasons for this conclusion by demonstrating that we certainly have *two* of the three supposed Sigillarian types represented in a young or Lepidodendroid state: the first by *Lepidodendron vasculare* of Binney, and the second by *L. Harcourtii*, whilst, judging from M. Renault's own description, the *L. Jutieri* represents the third type. On the other hand, the author believes that of M. Renault's three Lepidodendroid types the first is only a young state of the second, as illustrated by the development of the Burntisland and Arran Lepidodendra described in previous memoirs, whilst the able Frenchman appears not to have been acquainted with the existence of the very characteristic type of the *L. vasculare* of Binney.

The author gives the series of facts upon which his opinions are based by tracing the history of the development, first, of *Lepidodendron Selaginoides*, the *L. vasculare* of Binney, and second, of *L. Harcourtii*.

Commencing with the declaration that the *Lepidodendron vasculare* of Mr. Binney is but the young state of the *Sigillaria vascularis* of the same author, he proceeds to show the successive stages by which the vasculo-cellular medullary axis of the former becomes not only inclosed within the exogenous cylinder of the latter, but that this cylinder ultimately develops into a very conspicuous example of the Diploxyloid form of stem. The growth of the exogenous cylinder begins at one point of the periphery of the vasculo-medullary axis, from which point it extends both laterally and radially. The exogenous growth thus first appears in the transverse section of the Lepidodendroid twig as a small crescent, thickest at its centre, but whose two horns creep gradually round the medullary axis, its constituent vascular wedges also growing radially as the lateral growth advances, until at length the exogenous zone forms a complete ring, inclosing the vasculo-medullary axis, in which state it becomes the *Sigillaria vascularis* of Mr. Binney and M. Renault. The various stages of this growth are represented in the plates, in addition to which a section is described and figured of a branch about to dichotomise, in which process the vasculo-medullary axis has divided into two equal halves, one being destined for each branch. One of these halves of the vasculo-medullary axis displays, with the utmost distinctness, the characteristic crescentic commencement of an exogenous zone, whilst the other half retains its primary non-exogenous state. The latter condition thus belongs to the *Lepidodendron vasculare* of Binney, whilst the former as clearly represents the *Sigillaria vascularis* of the same author, and the Sigillarian character of which is recognised by M. Renault. We thus have in one stem two branches, one of which, according to the views of the French savant, is a Crypto-

[1] "On the Organisation of the Fossil Plants of the Coal-measures. Part XI." Paper read at the Royal Society by W. C. Williamson, F.R.S., Professor of Botany in the Owens College, Manchester. Revised by the Author.