

from a point is entirely determined when its initial direction is given. According to this we obtain a determinate surface if we prolong all the geodesics proceeding from the given point and lying initially in the given surface-direction; this surface has at the given point a definite curvature, which is also the curvature of the  $n$ -fold continuum at the given point in the given surface-direction.

§ 4.—Before we make the application to space, some considerations about flat manifoldnesses in general are necessary; *i.e.* about those in which the square of the line-element is expressible as a sum of squares of complete differentials.

In a flat  $n$ -fold extent the total curvature is zero at all points in every direction; it is sufficient, however (according to the preceding investigation), for the determination of measure-relations, to know that at each point the curvature is zero in  $n \frac{n-1}{2}$  independent surface directions. Manifoldnesses whose curvature is constantly zero may be treated as a special case of those whose curvature is constant. The common character of these continua whose curvature is constant may be also expressed thus, that figures may be moved in them without stretching. For clearly figures could not be arbitrarily shifted and turned round in them if the curvature at each point were not the same in all directions. On the other hand, however, the measure-relations of the manifoldness are entirely determined by the curvature; they are therefore exactly the same in all directions at one point as at another, and consequently the same constructions can be made from it: whence it follows that in aggregates with constant curvature figures may have any arbitrary position given them. The measure-relations of these manifoldnesses depend only on the value of the curvature, and in relation to the analytic expression it may be remarked that if this value is denoted by  $\alpha$ , the expression for the line-element may be written

$$\frac{1}{1 + \frac{\alpha}{4} \sum x^2} \sqrt{\sum dx^2}$$

§ 5.—The theory of surfaces of constant curvature will serve for a geometric illustration. It is easy to see that surfaces whose curvature is positive may always be rolled on a sphere whose radius is unity divided by the square root of the curvature; but to review the entire manifoldness of these surfaces, let one of them have the form of a sphere and the rest the form of surfaces of revolution touching it at the equator. The surfaces with greater curvature than this sphere will then touch the sphere internally, and take a form like the outer portion (from the axis) of the surface of a ring; they may be rolled upon zones of spheres having less radii, but will go round more than once. The surfaces with less positive curvature are obtained from spheres of larger radii, by cutting out the lune bounded by two great half-circles and bringing the section-lines together. The surface with curvature zero will be a cylinder standing on the equator; the surfaces with negative curvature will touch the cylinder externally and be formed like the inner portion (towards the axis) of the surface of a ring. If we regard these surfaces as *locus in quo* for surface-regions moving in them, as Space is *locus in quo* for bodies, the surface regions can be moved in all these surfaces without stretching. The surfaces with positive curvature can always be so formed that surface regions may also be moved arbitrarily about upon them without bending, namely (they may be formed) into sphere-surfaces; but not those with negative curvature. Besides this independence of surface regions from position there is in surfaces of zero curvature also an independence of direction from position, which in the former surfaces does not exist.

(To be continued.)

### SCIENTIFIC SERIALS

*Zeitschrift für Ethnologie*, No. 6.—The present number gives a compendium of useful suggestions, which might advantageously be acted on in other countries besides Germany, addressed by the Anthropological Society of Berlin to all persons engaged in exploring, or other expeditions to distant regions. In those directions for observing and collecting whatever is most adapted to extend and rectify our actual knowledge, information is given in regard to the various races with whom travellers may come in contact, and the special geographical, linguistic, social and other conditions, which more particularly require further elucidation.—Prof. A. Bastian gives us in this number with his habitual

completeness an exposition of the worship of the heavenly bodies among different nations, and the extent to which local conditions of climate and ethnological differences have influenced the character of the adoration offered to the sun and the moon and the stars. According to him a true worship of the sun—except in the polar regions—is only to be found on elevated plateaux, where the return of the orb of day was welcomed with gratitude after the colder night, while in low-lying tropical lands the aborigines looked with dread at the glowing ball of fire which each summer seemed to threaten their world with annihilation. We can strongly commend this paper as a most comprehensive, although not specially novel exposition of Aryan and other mythological systems.—The German engineer, Herr H. Keplin, has drawn attention to the mussel-hills (*Casquiros sambaquis*) of Brazil in the district of the Rio do San Francisco do Sol. The position of these deposits appears to refute the idea of their being mere Kjøkkenmødings, while the great respect shown by the natives for the dead, and their care to provide them proper sepulture, would seem to afford further evidence that these elevations, which often rise to a height of 50 feet, cannot be due to the hand of man. In reference to the above, it may interest our own archeologists to know that Herr Walter Kauffman draws attention in the same number to his discovery in the neighbourhood of Hull, at a spot known as Castle Hill, near Holderness, of a burial place belonging, as he conjectures, to the transition period between the Stone and Bronze ages. Herr Kauffman found on the western side of the hill, where the ground had been cut for building purposes, a fragment of some loam vessel, a compact mass of oyster shells, some flint flakes, and a human rib. After carefully removing the earth, Herr K. discovered at from 4 to 4½ feet below the surface the vertebrae of another skeleton, and finally collected nearly all the bones of two skeletons, completely enclosed in a mass of oyster shells.—Dr. A. B. Meyer, of Manilla, in the course of a short visit in the Philippines, found skulls which presented that peculiar appearance of sharpening or filing of the teeth, described by the old traveller, Thévenot, and the accuracy of which has often been called in question. The Negrito skulls from the Philippines, examined by Dr. Meyer, also exhibited the artificial flattening of the heads noticed by Thévenot.—Herr Virchow drew attention last summer to the fact that occasional deviations present themselves from the normal cranial configuration of a race, which ought to teach us extreme caution in regarding any single specimen as a typical form. He was led to make this remark by his observation in the Anatomical Museum of Copenhagen of the skull of Kay Lykke, a man of the noblest Danish descent, who had flourished two hundred years ago, and been celebrated in his day for his personal beauty, his effeminacy, and the sensual bias of his disposition. Yet the skull of this once elegant, accomplished, and self-indulgent courtier of the 17th century, belonging to an otherwise brachycephalic race, is more strikingly dolichocephalic and depressed than the Neanderthal head, and might readily be supposed to have belonged to an Australian savage. The cranial capacity which is given by Professor Panum, of Copenhagen, as 1,250 cubic centim., is, moreover, below the amount that is conjecturally assumed for the Neanderthal skull.

The supplement to the vol. of the "Zeits. f. Ethnologie," for 1872, is exclusively occupied with the Linguistic Notes of Dr. G. Schweinfurth, drawn up as the result of his travel in Central Africa, and gives numerous vocabularies and specimens of the languages of the different tribes who occupy the district of the Bahr-el-Ghasal, among whom Dr. Schweinfurth lived more than two years.

*Nuovo Giornale Botanico Italiano*, vol. iv. Nos. 1—4, Jan.—Dec., 1872. The volume for 1872 of this journal, edited by one of the most accomplished of Italian botanists, Prof. Caruel, contains evidence of considerable scientific activity in the Peninsula. A large space of these four numbers is devoted to cryptogamic botany; we have papers on the mosses of Abyssinia, by De Venturi, and of Ceylon and Borneo, by Hampe; on the fungi of Parma, by Passerini; on Diatoms, by Ardissonne, and on a new classification of cryptogams, proposed by Prof. Cohn. Besides several papers on systematic, descriptive, and geographical botany, one of the most interesting on physiological and histological subjects is by Saccardo, on the amyloid corpuscles contained within the fovilla of pollen, illustrated by a plate. Prof. Caruel contributes a very valuable biographical notice of the Italian botanist, Andrea Cesalpino, born at Arezzo in 1519, and a summary of the contents of his great



work, "De Plantis," published at Florence in 1583, which his biographer states to contain the essential features of the classification propounded by A. L. Jussieu two centuries later.

*Annalen der Chemie und Pharmacie*, February, 1873. The number commences with a paper on a new derivative of sulpho-carbamic acid, by H. Hasiwetz and J. Kachler. The new body is obtained by the action of carbonic disulphide on camphor in the presence of ammonia. Measurements of its crystals are given. The numbers obtained by an analysis agree well with the formula  $C_8, H_{10}, N_4, S_2$ ; this is regarded as an ammonia salt; a copper compound  $C_8, H_2, N_2, S_2, Cu$ , has been obtained, but the acid cannot be isolated from it, as  $SII_2$  refuses to precipitate the copper. Several other compounds of the body are described.—The next paper is a short note by M. Berthelot on the formation of Acetylen by the silent electric discharge. Messrs. R. Boettger and Theodor Petersen contribute a paper on the Nitro-compounds of Anthrachinon. The following bodies are described:  $\alpha$  Mononitroanthrachinon,  $\alpha$  Monamidoanthrachinon, and  $\alpha$  Diazoanthrachinon Nitrate; the behaviour of these  $\alpha$  bodies with concentrated sulphuric acid is then described.—On the Vanadates of Thallium, by Thomas Carnelly. The author describes the method of preparation and properties of the salts in question; this paper has already appeared in the April number of the Chemical Society's journal, as also has the next, on Ethyl-amyl, by Harry Grimshaw, and Schorlemmer's paper on the Heptanes from Petroleum.—Crystallographic Notices, I. by C. Klein, is a long paper on the measurement, &c. of crystals; a contribution to our knowledge of Neurin, by Julius Mauthner; "Remarks on my Water Air-pump," by N. Jagn; and a paper on Excretin from Human Excrement, by F. Hinterberger. The author has established the formula  $C_{20}, H_{36}, O$  for this body, and has obtained a Brominated derivative  $C_{20}, H_{34}, Br_2, O$ .

*Bulletin de la Société de Géographie*.—The first article in the March number is by the Abbé Durand, formerly a missionary in Brazil, on the Solimoes, the name given to the Amazon from its junction with the Rio Negro upwards, this being the name of the most powerful tribe on its banks. The Abbé gives an account of his journey up the river as far as Peru. His article contains many valuable facts as to towns, and people, and products of the district through which he passed. The next article is the last of Capt. Derrégagaix's papers on the South of the Province of Oran; the present one treating of the Geology and Meteorology of the district. This is followed by a translation of part of Col. Yule's essay on the geography of the Oxus prefixed to Wood's "Journey to the Source of the Oxus."—M. N. de Khanikoff contributes a paper on our knowledge of the Khanate of Khiva.

## SOCIETIES AND ACADEMIES

### LONDON

Royal Society, April 24.—On the Durability and Preservation of Iron Ships, and on Riveted Joints, by Sir William Fairbairn, Bart., F.R.S.

On the employment of Meteorological Statistics in determining the best course for a Ship whose sailing qualities are known, by Francis Galton, F.R.S.

Zoological Society, April 29.—Anniversary Meeting.—Viscount Walden, F.R.S., president, in the chair.—After some preliminary business the report of the Council was read by the Secretary, Mr. P. L. Sclater, F.R.S. It stated that the number of ordinary members of the Society on January 1 last, was 3,030, of Foreign members, 25, and of Corresponding members, 197. The total income of the Society in 1872 was 26,728*l.*, being 2,017*l.* more than that of 1871, and exceeding the income of any previous year, except that of the year 1862, when the International Exhibition was held. The total expenditure of 1872 had been 26,900*l.*, and a balance of 1,956*l.* had been carried forward for the benefit of the current year. The assets of the Society on December 31, 1872, were calculated at 10,532*l.*, while the liabilities were reckoned at 5,490*l.* The Reserve-fund consisted of a sum of 8,000*l.* Reduced 3 per Cents. The Scientific publications of the Society for 1872 had consisted of the usual volume of "Proceedings," four parts of "Transactions," a Revised List of the Vertebrated Animals, now or lately living in the Society's Gardens, and a General Index to the ten years of the Society's "Proceedings," from 1861 to 1870. The most important work undertaken in the Society's Gardens in 1872 had

been the bridge over the Regent's Park Canal, intended to connect the Society's new grounds on the north bank, with the present Gardens. This had been completed in October last at a total cost of 1,333*l.* The new Lodge and Entrance-gates in Primrose-hill Road had likewise been finished, and the new entrance opened to the public for the first time on Easter Monday. The total number of visitors to the Society's Gardens in 1872 had been 648,088, being 52,171 more than the corresponding number in 1871. The greatest number of admissions in any one day in 1872 had been 44,608, which took place on May 20 (Whit Monday). The number of animals in the Menagerie on Dec. 31, 1872, was 2,010. Many of the Accessions during the year had consisted of specimens of rare or little known animals, of which full particulars are given. The Report concluded with a long list of donors, and their several donations to the Menagerie. The Meeting then proceeded to elect the new Members of Council and the Officers for the ensuing year, and a ballot having been taken it was found that Viscount Walden, F.R.S., had been elected President, Mr. Robert Drummond, Treasurer, and Mr. P. L. Sclater, F.R.S., Secretary of the Society. The new Members of Council elected were Francis Galton, F.R.S., John P. Gassiot, Jun., St. George Mivart, F.R.S., George Russell, and Richard H. S. Vyvyan.

Geological Society, April 9.—His Grace the Duke of Argyll, K.T., F.R.S., president, in the chair. The following communications were read:—"Lakes of the north-eastern Alps, and their bearing on the Glacier-erosion Theory," by the Rev. T. G. Bonney, F.G.S. The purpose of this paper was to test, by the lakes of the Salzkammergut and neighbourhood, the theory of the erosion of lake-basins by glaciers, which has been advanced by Prof. Ramsay. The author premised (1) that an extensive glacier could not exist without a considerable area to support it; (2) that under no circumstances could a glacier excavate a cliff of considerable height (say 1,000 ft.) approximately vertical; (3) that owing to the proximity of the regions, a theory of excavation which applied to the Western and Central Alps ought to be applicable also to the Eastern Alps. He then proceeded to examine a number of lakes in detail. The Königsee lies in a remarkably deep, steep-sided valley, terminated by a cirque, with cliffs full a thousand feet high, and has no large supply area behind. The Hallstadersee is similarly situated, has a cirque at the head, and two lateral valleys nearly at right angles to the lake, up which arms of it have formerly extended. These are not likely to have furnished glaciers which could have excavated the lake; and above the cirque there is no large supply area. The Gasauthal consists of lake-basins separated by valleys of river-erosion. The Fuschelsee and Wolfgangsee, on the south side of the Schafberg, are separated by a narrow sharp ridge of hills, incapable of nourishing glaciers large enough to grind them out; there are no signs of glaciers from other directions having eroded them. The Mondsee and Attersee (once one lake) on the north lie under the steep cliffs of the Schafberg, which could not have nourished a large glacier; and the ridge of the Schafberg is too sharp to admit of the supposition that a great glacier, coming from the south, has passed over it to excavate the lake; yet the Attersee, in a position least favourable to glacial action, is the largest and deepest lake in the Salzkammergut. The head of the valley in which these lakes lie is really among low hills, in the direction of the Austro-Bavarian plain. The Traunsee was shown to give no evidence in favour of a theory of glacial erosion. Since then these lakes either had at their heads preglacial cirques (the very existence of which was incompatible with much erosive power on the part of a glacier), or were beneath sharp and not greatly elevated ridges of rock, the author concluded that they had not been excavated primarily by glaciers. He considered a far more probable explanation to be, that the greater lake-basins were parts of ordinary valleys, excavated by rain and rivers, the beds of which had undergone disturbances after the valley had assumed approximately its present contour. He showed that the lakes were in most cases maintained at their present level by drift; and that, while in a region so subject to slight disturbances as the Alps, positive evidence for his theory would be almost impossible to obtain, no lake offered any against it, and one, the Königssee, was very favourable to it.—"On the Effects of Glacier-erosion in Alpine Valleys," by Signor B. Gastaldi. The author described the occurrence in the valley of the Lanzo and other Alpine valleys, at heights between 2,000 and 3,000 metres (6,700 and 10,000 f. e.), of large cirques, in two of which, in the valley Sauze de Césanne, the bottom was occupied in the autumn