motion, we immediately place upon the plate a disk or a coin, to which the fingers give a first movement of rotation round one of its diameters.

The hand being quickly drawn back, the aërial vortex continues to make the coin turn round like a top, and absolutely keeps it captive in its radius of action. The coin, while turning upon one of its diameters, makes a sphere, and a later experiment will show that a revolving sphere constitutes a centre of attraction.

Fig. 3.—*Equilibrium of Revolving Spheres.*—A free sphere keeps itself in equilibrium, and turns round another sphere, to which a rapid movement of rotation is imparted.

The apparatus consists of a pin, A, which is able to turn in a support, and has a pulley, made to receive a transmitted movement. Upon the pin A is placed a sphere, S, composed of from eight to ten flat circular pieces (these may be either flat disks, or disks cut into a crescent shape; it does not matter which). The pin may be at any angle whatever to the horizon; in this experiment it is inclined at 45°, but it may be horizontal

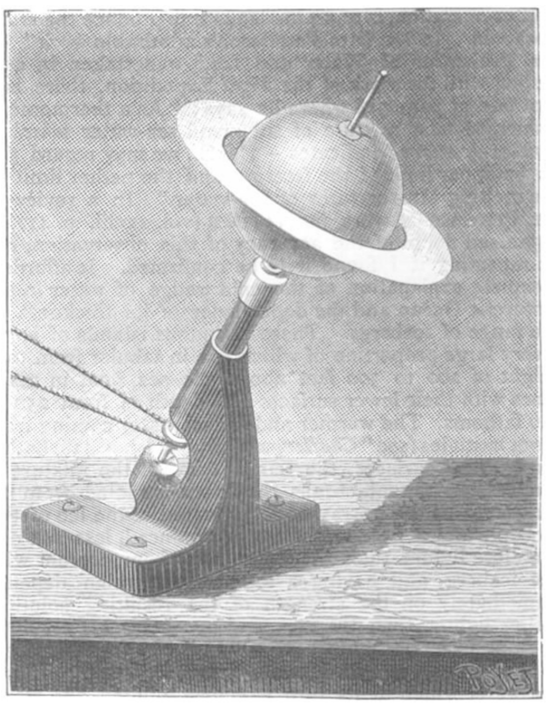


FIG. 4.

or vertical. The angle of 45° was chosen because it seemed to be most difficult for the experiment, which would therefore be the more conclusive. When the sphere S is turned round rapidly, you feel on the hand a strong blast which escapes all around from its equator. Bits of paper which are placed near it are thrown far away. Nevertheless, if a balloon is put near this blast, it is quickly attracted towards the revolving sphere, and describes orbits round it in the plane of the equator. As the experiment took place in a room, where there were obstacles producing eddies, and as also gravity has too much effect by reason of the proximity of the ground, it is very difficult to obtain a regular movement. The balloon comes easily in contact with the revolving sphere, and is then driven away by the collision too far to be caught again. A very simple contrivance consists in placing round the sphere S a wire guard or circle of iron, F, 1 millimetre in diameter, attached to the support by three similar wires.

The balloon will then keep on turning round the motive sphere, even ceasing to touch the guard in the lower part under the action of gravity. The experiment can be made in different ways, and the guard may even be suppressed, but these variations teach us nothing new.

In studying the vortex movements which the sphere imparts in the medium in which it is plunged, we easily calculate the ratio of the attraction which it exercises on the balloon.

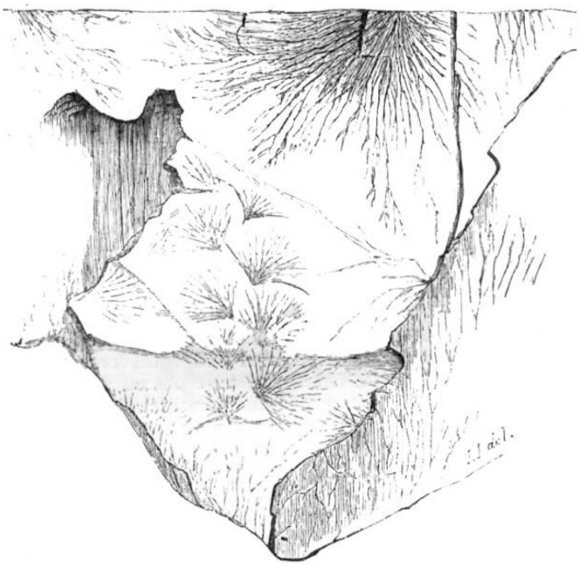
Fig. 4.—The guard of the revolving sphere is taken away, and we place parallel to its equator a circle of paper with an interior diameter greater than the exterior diameter of the sphere; the circle is caught into the movement of rotation, and maintains itself strongly in the plane of the equator.

ON OLDHAMIA

THE organic origin of Oldhamia has often been disputed. Originally described by Edward Forbes from specimens found at Bray Head, near Dublin, in rocks of the Cambrian formation, it has been found in a few other localities in Ireland, in rocks of a similar formation. In the dispute the weight of the evidence has seemed to be in favour of the views of Forbes, Jukes, Harkness, and Kinahan, that this lowly form is a fossil probably belonging to the Polyzoa, or to the Sertularian Polyps. So the matter has stood for a long time. A recent paper by Prof. W. J. Sollas, published in the Proceedings of the Royal Dublin Society for January last, once again opens the discussion. In the hope of throwing light on this problematical structure, thin slices for microscopic examination were cut, both parallel and transverse to its planes of cleavage. When these were placed under the microscope, all trace of the Oldhamia structure appeared to have vanished. An examination with the unaided eye showed, however, that it was still there, presenting itself as narrow, undulating, and branching bands of a lighter colour than the surrounding matrix. Its appearance, moreover, varied in an extraordinary manner according to the direction in which it was viewed. Looked at obliquely in a strong light, the thread-like bands are brilliantly illuminated, and appear faintly coloured with spectral tints; looked at directly, the bands become fainter, and are less clearly distinguishable from the matrix. In certain positions the slice taken at right angles to the bedding has an appearance somewhat suggestive of shot-silk, and, from the planes of cleavage, markings which remotely resemble in form the dendritic markings of Sutton stones extend into the surrounding matrix.

These appearances suggest the presence of some mineral possessing high reflection or refraction arranged in more or less parallel planes. Mr. Teall, in the same paper, gives full details of the mineral characters of the rock. Aided by these, Dr. Sollas finds that the lighter-coloured bands, which correspond to the Oldhamia markings, owe their distinction from the surrounding matrix to the presence of an excess of sericite scales; and that the curious shot-silk appearances are produced by the local deflections of these scales from parallelism with the cleavage planes into directions tangential to curves, which are probably transverse sections of those long ridges which, when seen on the exposed surface of a cleavage plane, are recognised as the usual form of Oldhamia. It would appear possible that these ridges are wrinklings of the cleavage planes produced during the shearing which led to their formation. These observations were made on the form known as *O. radiata*, and in some supplementary remarks Dr. Sollas adds that when Oldhamia is present it shows itself on the surface of the laminæ as rounded discontinuous ridges, which are without definite boundaries, and have the appearance of fine wrinkles. When the phyllode is fractured obliquely to the cleavage laminæ, the Oldhamia markings are found to extend through the rock as fine ridges or wrinkles which mark the surface of oblique fracture in a similar manner to those of the cleavage face. In fact, the appearances are remarkably similar to those of *ausweichungs-clivage*, described by Heim in his "Gibergsbildung"; but the observations throw no light on the remarkable radiate form sometimes assumed by the structure. In a paper in the same journal Mr. Joly mentions that, in examining specimens of *O. antiqua* and *O. radiata*, he detected the following peculiarity: a sunken or depressed delineation of one form accompanied a raised or relieved delineation of the other form. Thus, if on any specimen *O. antiqua* appeared as a depression, on that same surface the *O. radiata* appeared in relief.

From this observation it appeared probable, if any meaning was to be attached to the relation, that a further



relation would be found to obtain between the mode of delineation and the position in the rock. This, a further examination revealed; in this order: on the upper surface, or what was most probably the surface of deposition (the cleavage of the Cambrian slate of Bray Head coincides generally with the plan of bedding), the *O. radiata* appeared invariably as a depression, the *O. antiqua* in relief.

When fragments were peeled off the slate, the marks were found to be transmitted, or extending to the layers beneath, so that lines on the upper are seen as continued on the adjacent lower layer, this, too, for thicknesses exceeding a millimetre. The accompanying woodcut recalls the appearance of a surface of rock in which this is fairly well shown.

ON THE DISTRIBUTION OF TEMPERATURE IN THE ANTARCTIC OCEAN[1]

IN the regions of the Antarctic Ocean where icebergs are numerous, and where in winter the sea-water freezes, the distribution of temperature in the deeper layers of water is peculiar. The facts are detailed in the "*Challenger* Narrative" (vol. i.). The general result of her observations went to show that, from the most southerly station, a wedge of cold water stretches northwards for more than 12° of latitude, underlying and overlying strata at a higher temperature than itself (p. 418).

Although the conditions and facts likely to throw light upon the cause of the existence of this cold intermediate or superficial stratum overlying water which at any rate in its upper layers has a temperature higher than that of freezing distilled water are discussed, no satisfactory explanation of the phenomenon is given. One important fact is noticed at page 421. "The fact that the cold wedge above referred to extended north just as far as the icebergs did in March 1874 points to there being some connexion between the temperature and the presence of melting icebergs." It is well known that icebergs consist of land-ice, which is as nearly as possible pure frozen water, and melts in the air at 32° F. It was thought that the effect of immmersion of such a substance in a medium having a temperature 3° F. lower than its melting-point would be to indefinitely preserve it, that in fact only the lower surfaces of the icebergs large enough to reach to a depth of 300 fathoms would suffer any melting at all. The existence of the cold stratum was ascribed wholly to the cold brine, separated from the ice on the freezing of the sea-water, sinking downwards with an initial temperature of from 28°·5 to 29° F. This cause, though existing and in operation, is quite inadequate to produce the effect observed. In Dr. Otto Pettersson's admirable work "On the Properties of Water and Ice," undertaken in connexion with the work of the *Vega* Expedition, there is a footnote at page 318 where he says: "As a thermometer immersed in a mixture of snow and sea-water *which is constantly stirred* indicates − 1°·8 C., we may regard this as the upper limit of the freezing and the nether limit of the melting temperatures of sea-water." In a review of Dr. Pettersson's work in NATURE (vol. xxviii. p. 417) I expressed doubt of the accuracy of this observation, but on repeating it I found it to be confirmed. It affords a complete explanation of the cold wedge of water in the Antarctic Ocean and the dependence of its thickness on the range of icebergs. These enormous islands of ice, a very large proportion of which rise in tabular form to a height of 200 to 300 feet above the sea, float in many cases with their lower surfaces at a depth of from 250 to 300 fathoms. The warmer and denser water coming from lower latitudes (see "*Challenger* Narr." vol. i. p. 428) bathes these lower surfaces, the temperature of the mixture at the surface of contact falls, the heat abstracted from the sea-water melts a corresponding amount of the ice of the iceberg, and a saline solution is produced, less salt and therefore lighter than the water away from contact with the iceberg, and having a temperature which depends immediately on the strength of the resulting solution. Being lighter than the surrounding water, this resulting solution necessarily flows up along the sides of the berg to the surface, and its place is taken by fresh undiluted sea-water which in its turn is cooled, diluted, and transferred to the surface. The result is the production of a most energetic engine of circulation and means of cooling and equalising the temperature of the water within the reach of icebergs. As there is continual renewal of the ocean water brought into contact with the ice, and as its composition is constant, the temperature produced is practically constant, namely 28°·8 to 29°·0 F., or − 1°·7 to − 1°·8 C. The layer of lighter water from 50 to 80 fathoms thick at the surface is due principally to this melting of land-ice, though it is also due in very small proportion to the melting of sea-ice.

Table giving the temperature at which ice melts in sea-water containing different percentages of chlorine

Temp. C.	1°·0	1°·1	1°·2	1°·3	1°·4
Per cent. Cl... ...	1·040	1·131	1·222	1·313	1·404
Temp. C.	1°·5	1°·6	1°·7	1°·8	1°·9
Per cent. Cl... ...	1·495	1·586	1·678	1·769	1·880

This table is taken from a paper on ice and brines, communicated to the Royal Society of Edinburgh on March 21, 1887.

[1] Abstract of a paper read by Mr. J. Y. Buchanan before the Royal Society of Edinburgh, March 21, 1887.