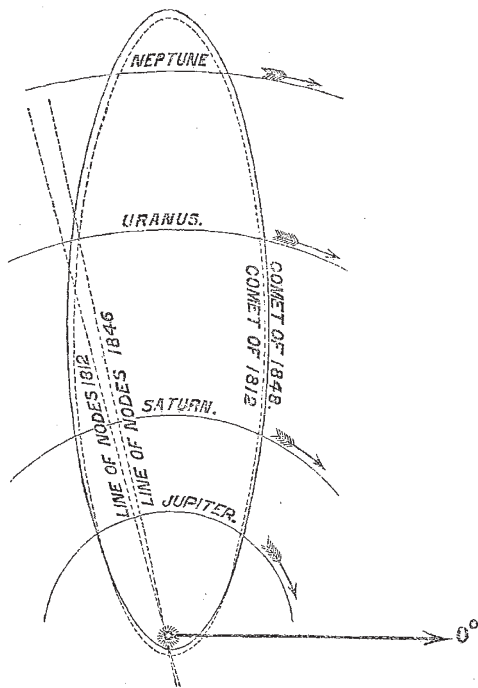


ASTRONOMY

Kirkwood on the Origin of Comets

THE recent important investigations of Hoek on the origin of comets may be said to have opened out quite a new field of astronomical research of the highest importance. We are glad, therefore, to lay before our readers an abstract of a continuation of the work which we owe to Professor Kirkwood, who has communicated it to *Silliman's Journal*. Professor Kirkwood has dealt with the comets 1812, i. and 1846, iv.

The wonderful similarity of the elements of these, except in the longitude of the ascending node, is very remarkable. It is also noticeable that the longitude of the descending node of the latter is very nearly coincident with that of the ascending node of the former. These remarkable coincidences are presented to the eye in the following diagram, where the dotted ellipse represents the orbit of the comet of 1812, and the continuous curve, that of the comet of 1846.



Dr. Kirkwood remarks :—

“It is infinitely improbable that these coincidences should be accidental : they point, undoubtedly, to a common origin of the two bodies.” And adds :—

“The theory of comets now generally accepted is that they enter the solar system *ab extra*, move in parabolas or hyperbolas around the sun, and, if undisturbed by the planets, pass off beyond the limits of our system to be seen no more. If in their motion, however, they approach very near any of the larger planets, their direction is changed by planetary perturbations; their orbits being sometimes transformed into ellipses. The new orbits of such bodies would pass very nearly through the points at which their greatest perturbation occurred : and accordingly we find that the aphelia of a large proportion of the periodic comets are near the orbits of the major planets. ‘I admit,’ says M. Hoek, ‘that the orbits of comets are by nature parabolas or hyperbolas, and that in the cases when elliptical orbits are met with, these are occasioned by planetary attractions, or derive their character from the uncertainty of our observations. To allow the contrary would be to admit some comets as permanent members of our planetary system, to which they ought to have belonged since its origin, and so to assert the simultaneous birth of that system and of these comets. As for me, I attribute to these a primitive wandering character. Travelling through space they move from one star to another in order to leave it again, provided they do not meet any obstacle that may force them to remain in its vicinity. Such an obstacle was *Jupiter*, in the neighbourhood of

our sun, for the comets of Lexell and Brorsen, and probably for the greater part of periodical comets; the other part of which may be indebted for their elliptical orbits to the attractions of *Saturn* and the remaining planets.

“Generally, then, comets come to us from some star or other. The attraction of our sun modifies their orbit, as had been done already by each star through whose sphere of attraction they had passed. We can put the question if they come as single bodies or united in systems. This is the point I have undertaken to investigate. Since some time already I had felt the truth of the following thesis :—

“*There are systems of comets in space that are broken up by the attraction of our sun, and whose members attain, as isolated bodies, the vicinity of the Earth during a course of several years.*”

“In the researches here referred to it has been shown by M. Hoek that the comets of 1860 iii., 1863 i., and 1863 vi., formed a group in space previous to their entrance into our system. The same fact has also been demonstrated in regard to other comets which need not here be specified. Now, the comets of 1812 and 1846, iv. have their aphelions very near the orbit of Neptune, and hence the original parabolas in which they moved were probably transformed into ellipses by the perturbations of that planet. Before entering the solar domain they were doubtless members of a cometary system. Passing Neptune near the same time, and at some distance from each other, their different relative positions with regard to the disturbing body may account for the slight differences in the elements of their orbits.

“*At what epoch did they enter the solar system?* The mean between the longitudes of the aphelia of the two comets is $271^{\circ} 41'$. Neptune had this longitude in 1775; the comet of 1812, in 1777; and that of 1846, in 1809. Now, with the known period of Neptune and the periods of the comets as determined by Encke and Peirce, we find (neglecting perturbations) that—

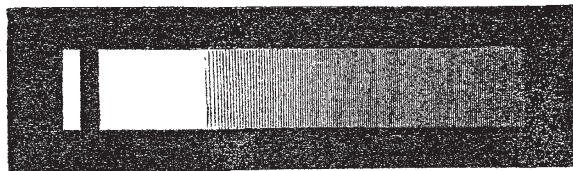
Neptune was in longitude $271^{\circ} 41'$ in the year	694 B.C.
The Comet of 1812	696 ”
” 1846, iv.	696 ”

It seems, therefore, that the three bodies were very nearly together about 695 years before the Christian era. It is consequently not improbable that the elliptical form of the two cometary orbits dates from this epoch.”

BOTANY

Spectroscopic Examination of Diatoms

THE vegetable nature of the Diatomaceæ is now generally admitted, but if any further proof were needed we have it in marked results from the application of the spectroscope. Mr. H. L. Smith has been enabled to prove the absolute identity of *chlorophyll*, or the green endochrome of plants, with *diatomin*, or the olive yellow endochrome of the Diatomaceæ. The spectrum-microscope used was made by Browning, of London. Mr. Smith states that it is not at all difficult to obtain a characteristic spectrum from a living diatom, and to compare it directly with that of a desmid, or other plant. From about fifty comparisons of spectra, he concludes that the spectrum of chlorophyll is identical with that of diatomin. The spectrum in question is a characteristic one, and is figured below.



A very black, narrowish band in the extreme red, reading at the lower edge, which appears to be constant, about $\frac{1}{3}$ of Mr. Sorby's scale, is too characteristic to be mistaken. There are two other very faint bands, not easily seen, and somewhat more variable in position. The black band in the red is always present, and is remarkably constant in the position of its lower edge. In making comparisons of spectra it is of the utmost importance that the slit of the spectroscope should be absolutely in the focus of the achromatic eye lens. If this be not attended to there will be a slight parallax; and bands really identical in position, e.g., those of blood (scarlet crurine), will not absolutely correspond when

two spectra are formed, one from blood on the stage of the microscope, and the other from the same on the stage of the eye-piece.

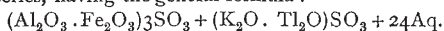
The dark band of the chlorophyll spectrum is slightly variable in width—and the action of acids and alkalis sometimes causes a slight displacement, the former raising (moving toward the blue end) and the latter depressing. The endochrome of a diatom after treatment with acid is green, and the acid, in this case, produces scarcely any displacement of the band, which may be observed even in the dark reddish mass of the dead Diatomaceæ, almost identical in colour with the ferrous carbonate so often found in bogs where the larger diatoms are abundant; and what is more remarkable is, that the carbonate gives no absorption bands at all. As a general rule, alcoholic solutions of chlorophyll and diatomin have the band slightly depressed, reading I to I½ on the interference scale.—[Amer. Jour. Sci. and Arts.]

CHEMISTRY

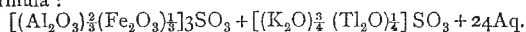
Thallium Salts.—I.

MM. LAMY AND DES CLOISEAUX have resumed the study of the principal thallium salts, with the view of ascertaining their chemical composition, optical properties, and crystalline form (Annales de Chimie et de Physique, xvii. 310). The method of obtaining crystals was that which M. Deville has for a considerable time been in the habit of employing in his laboratory. A given substance is placed in contact with water, or some other solvent, either in a closed or lightly covered vessel, and exposed to the usual conditions of temperature of an inhabited apartment; if these do not suffice, the liquid is heated every day for an hour to a certain extent. In course of time, even the most microscopic crystals, if submitted to this process, become large, well-formed, and transparent.

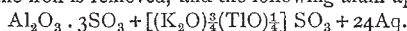
The thallium in these salts was determined as iodide; a compound which from its sparing solubility (especially in water containing a little potassic iodide), as well as on account of its great specific gravity and crystalline character, is very well adapted to the purpose. The density of thallos sulphate, Tl_2SO_4 , is 6.603,* and its form a right rhomboidal prism, geometrically and optically isomorphous with ammonic sulphate. The crystals often appear unsymmetrical, on account of the unequal development of the different faces. The optic axes are wide apart; and the dispersion of the axes, as observed in oil, is feeble, with $\rho < \nu$. To the already known¹ thallium alums may be added a mixed series, having the general formula:



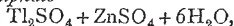
Special attention is directed to one of these, which was obtained accidentally in the course of a lixiviation, and had the formula:



Its colour is slightly yellow, and in solubility it much resembles potassic alum. After several solutions and recrystallisations, the whole of the iron is removed, and the following alum appears:



Zinco-thallos sulphate—



which had already been described by Willm and Werther, belongs to the oblique rhomboidal prismatic system, and is geometrically isomorphous with ammonio-ferrous sulphate, potassic magnesio-sulphate &c. (as, indeed, Werther has shown); but it is optically different from these salts, both in orientation and in the sign of its acute bisectrix (negative).

Plane angle of the base $107^\circ 5' 14''$

Plane angle of the lateral faces $99^\circ 31' 24''$

Obliquity of the primitive prisms $106^\circ 10' 00''$

The optic axes lie in the plane of symmetry. There is a strong proper dispersion with $\rho < \nu$. The inclined dispersion is weak, and only brought out by a difference in the brightness of the colours lying at the edges of the hyperbolæ of the two systems of rings. Thallos nitrate, $TlNO_3$, has the specific gravity 5.550, and occurs in right rhomboidal prisms of $125^\circ 52'$ (the corresponding angle for nitre is $118^\circ 50'$). The plane of the optic axes is perpendicular to the corresponding plane in potassic nitrate. The acute bisectrix is negative, and the dispersion of the axes considerable, with $\rho < \nu$. This salt had been already examined optically by Miller. In order to prepare thallos carbonate,

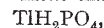
* The temperature in this and following determinations is not given in the memoir.

(Tl_2CO_3), a saturated solution of thallos oxide in alcohol was exposed to air, in contact with a lamina of thallium. At the end of six months, very large crystals were obtained. These have an adamantine lustre, and a specific gravity 7.164; they belong to the clinorhombic system, thus agreeing neither with plumbic, potassic, nor ammonic carbonate. Macles by hemitropy round one particular axis, are frequently observed. The plane of the optic axes is normal to the plane of symmetry, and almost exactly perpendicular to the base. The acute bisectrix is negative, and normal to the horizontal diagonal of the base; the double refraction energetic. The dispersion of the optic axes is well marked, with $\rho < \nu$; while the horizontal dispersion is, on the contrary, inappreciable. An attempt to prepare other thallos carbonates did not succeed.

Di-thallos phosphate—



is a very soluble salt, anhydrous at 200° , and crystallises in the rhombic system. Lustre vitreous. The dispersion of the optic axes is strong, with $\rho > \nu$. Mono-thallos phosphate—



is very soluble in water, and readily crystallises in long voluminous needles which were submitted to the growing process already described. Density 4.723. The crystals may be referred to a clinorhombic prism of $34^\circ 59'$, having a base only slightly sloping towards the lateral faces. Macles by hemitropy are common, giving rise to a re-entering angle of $176^\circ 32'$. The plane of the optic axes is parallel to the horizontal diagonal of the base. Acute bisectrix negative; horizontal dispersion indistinct; proper axial dispersion considerable. The

pyrophosphate—

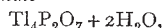


crystallises in magnificent transparent prisms, soluble in water with partial decomposition, softened by a heat of 120° , and having the density 6.786. Its form is an oblique rhomboidal prism. The crystals are fragile, and have a somewhat adamantine lustre. The plane of the optic axes is normal to that of symmetry, and almost parallel to the base. While the horizontal dispersion is but slight, the proper dispersion of the axes is the greatest hitherto observed, as shown by the following means of measurements taken in oil and air, determining the apparent separation of the axes in air at 24° :

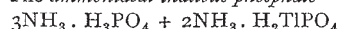
$$2E = 125^\circ 48' \text{ (red rays); } 112^\circ 30' \text{ (yellow);}$$

$$2E = 89^\circ 47' \text{ (green rays); } 52^\circ 34' \text{ (blue).}$$

The hydrous pyrophosphate—



separates from the mother-liquid of its predecessor. It is soluble in water with but little decomposition; but it is less stable at a high temperature than the anhydrous salt, which, on the other hand, it exceeds in the intensity of its vitreous lustre, its hardness and cohesion. The plane of the optic axes is normal to the plane of symmetry: the acute bisectrix negative and perpendicular to the horizontal diagonal of the base. Horizontal dispersion feeble; proper dispersion of the axes considerable, with $\rho < \nu$. The ammoniacal thallos phosphate—



is obtained by adding ammonia to the common phosphate, filtering to remove tri-thallos phosphate, and evaporating the mother-liquid. The crystals are very soluble in water, and completely isomorphous with ammonic phosphate. Their figure is that of a right prism with square base, elongated in the direction of the vertical axis, and terminated by an octohedron of $119^\circ 50'$. The double refraction is on a negative axis.

E. J. M.

PHYSICS

Pfaundler on the Regulation of Ice

THE fact observed by Faraday that two pieces of ice freeze together when brought into contact has met with various explanations. Helmholtz, for example, assumes that pressure is always at work in regulation; hence depression of the fusion point of the ice, and a cold sufficient to freeze a small portion of water in another part of the mass. Tyndall, on the other hand, admits the hypothesis of pressure only where it is actually observable; but, in other cases, explains the phenomena by a difference between the fusion-point inside and at the surface of the ice. Schultz has actually verified Tyndall's theory with water from which the air had been expelled.