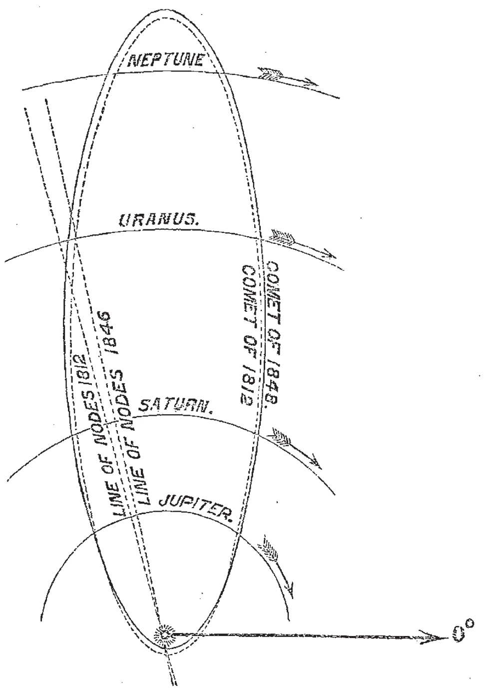
ASTRONOMY

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 *Sillimans' 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° 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—

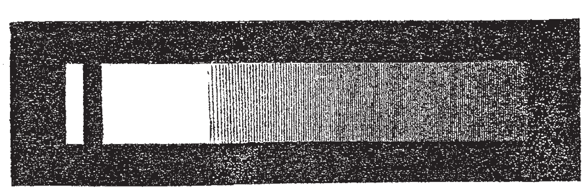
Neptune was in longitude 271° 41′ in the year 694 B.C.				
The Comet of 1812	,,	,,	,,	696 ,,
,, 1846, iv.	,,	,,	,,	696 ,,

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 $\frac{7}{8}$ 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 cruorine), will not absolutely correspond when