observations with strict accuracy, but he hopes to correct his coefficients by observation when the satellite has been observed throughout a revolution of Jupiter. He finds that the perijove goes round Jupiter in 300 revolutions of VIII., or 600 years; the node in 40 revolutions of VIII., or 80 years.

Mr. J. Jackson of Trinity College, Cambridge, has also begun some researches on the motion of this satellite. A. C. D. C.

Comets.

After the eight comets of 1911 the year 1912 with three only may be considered somewhat barren. At its beginning six comets of the preceding year were still under observation, but it was not until September that the first new discovery was made.

Comet 1911 *a* (Wolf) was observed at Algiers till January 25, and is stated to have been of the twelfth magnitude at the middle of the month. *Ast. Nach.* 4607 contains an investigation by M. Kamensky of the motion of this comet at former returns. He finds some discordances in the observation of 1884, which he thinks can be readily explained by a want of symmetry in the comet's shape, but concludes that the comet gives no evidence of any non-gravitational force such as Encke's comet has been thought to do. *Comet* 1911 *c* (Brooks), which will be remembered as a conspicuous object before travelling into the southern hemisphere, was followed in Chile till January 31. A detailed account of the spectrum of this comet by Mr W. H. Wright is published in *L.O.B.*, No. 209, in which the writer points out its general similarity to the spectra of Halley's Comet, Daniel's Comet (1907 *d*), and the Daylight Comet 1910 *a*. The bands identified by Professor Fowler (*M.N.*, vol. lxx. p. 6) in the spectrum of Morehouse's Comet (1908 *c*) with the bands of "low pressure" and "high pressure" carbon monoxide are strongly represented. *Comet* 1911 *e* (Borrelly's periodic Comet) was last observed at Algiers on May 8. It was then exceedingly faint, being rated below fourteenth magnitude. Apparently the latest observation of *Comet* 1912 *f* (Quénisset), which, after being in high N. Declination before discovery, travelled south beyond the reach of northern observers in November, was made in Chile on January 25. *Comet* 1911 *g* (Beljawsky), which had been a fine naked-eye comet in October, was observed at Cordoba on January 28th, but, as it was stated to be "visible in a large telescope," it is probable that it was then a faint object. *Comet* 1911 *h* (Schaumasse) was observed at Algiers till after the middle of February. M. G. Fayet found for it elliptical elements bearing a marked resemblance to those of Comet 1894 I. (Denning), but identity seems impossible, as the periodic time in both cases is approximately seven years, and the interval between their perihelion passages about seventeen and a half years. Moreover, as Dr. Crommelin pointed out (Observatory No. 445, p. 93), if the two

objects were identical, and the major axis had been much altered by perturbations, the period would not now be so nearly the same as formerly. This comet adds one more to the family of Jupiter.

Comet 1912 *a*.—The first comet of the year was found on September 8 by Mr. Walter F. Gale, who will be remembered as the discoverer of Comet 1894 II. When first seen it was of about the sixth magnitude, and visible to the naked eye. A striking feature of this comet was a double tail, of which the two components were separated by an angle of between 50° and 60°. A photograph taken at the Union Observatory, Johannesburg, on September 13 shows the tail in the form of a fan, the principal streamer being just over 5° in length.

Travelling northwards, the comet became visible in England in October. Telescopically it then showed a large coma with central condensation and stellar nucleus, and the two tails were distinctly visible.

A description of the spectrum by M. Idrac, as observed at Meudon, is published in *C.R.* (No. 194, November 1912), where it is shown that the coma exhibited the ordinary comet spectrum indicative of cyanogen and other carbon compounds. The comet was at perihelion on October 4. The orbit has a high inclination —about 80°, and the comet will be within a few degrees of the North Pole at the end of January.

Comet 1912 *b*.—This comet was discovered at Nice by M. Schaumasse on October 18, and shown by M. G. Fayet to be identical with Tuttle's Comet. The return was interesting as being unexpectedly early. Without applying corrections for perturbations, Kaplan Niko Miličevič, using the instantaneous period of Rahts at the last return, had predicted in his search ephemeris (*A.N.*, 4602) 1913 January 3 for the date of perihelion. The actual passage took place in 1912 October 28, and M. E. Fayet has shown that a shortening of the period by about two months was due to a diminution of the major axis of the comet's orbit, in consequence of perturbations by Jupiter about 1901. This last return is also interesting as being the shortest on record, and Dr. Crommelin has remarked (Observatory No. 454, p. 407) that there appears to be a more or less regular wave in the period with a cycle of about 88 years, maxima occurring about 1790 and 1871, and minima about 1817 and 1912. In appearance the comet was a faint telescopic object. It showed a round nebulosity 3′ in diameter, on October 19, with an ill-defined condensation of magnitude 10½ to 11 towards the centre.

Had perihelion occurred two months later, as expected, the comet would have passed very near the earth at the middle of December, and the return would have been the most favourable since the comet's discovery by Méchain in 1790.

Comet 1912 *c*.—This, the last comet of the year, was discovered by M. Borrelly at Marseilles on November 2. It was a faint telescopic object of the tenth magnitude and had already passed perihelion on October 20.

The relationship between the η Aquarids of May and Halley's Comet, suggested as probable by Professor A. S. Herschel (*M.N.*, vol. xxxviii. p. 379), seems to be now well established. Mr. Charles E. Olivier (*Astron. Journal*, vol. xxvii. p. 139) gives elliptical elements of the orbit of the meteor swarm (assuming the major axis to be the same as that of the comet) observed on six nights in 1910 and 1911. *Ast. Nach.* 4573 also contains parabolic elements by Cuno Hoffmeister from observations in the same years. The similarity between the two sets of elements and those of Halley's Comet is very striking.

	Ω.	i.	π.	q.	log e.
Olivier .	45°·6	162°·6	148°·6	0·626	9·985
Hoffmeister	45	167·5	147·8	0·610	...
Halley's Comet	57·3	162·2	169·0	0·587	9·984

Mr. Olivier attributes the fact that the agreement is not more complete to the circumstance that none of the meteors he observed was nearer to the actual orbit of the comet than 5,000,000 miles, while some were as far from it as 13,000,000 miles, the effect being to increase the perihelion distance and change the longitudes.

It was thought that the Comet 1892 III. (Holmes), and Comet 1852 IV. (Westphal) might be observed in 1912, though M. Viljev considers the most probable date for the perihelion of the latter to be 1914 April 23, with a probable error of $7\frac{1}{2}$ months. An ephemeris for Holmes's comet was published by Dr. H. J. Zwiers, and ephemerides for Westphal's Comet by Herr Hnatek on various assumed values of the period between 60 and 62 years. Up to the present it appears that nothing has been seen of either comet.

Definitive elements of the orbit of Comet 1910 I.—the bright "daylight comet"—were published in *Ast. Nach.* 4605 by M. S. Mello e Simas. He finds no sensible deviation from a parabola, the elements of the most probable orbit being:—

T	1910 Jan. 17·0946, Paris M.T.	
ω	320° 53′ 41″	1910·0.
Ω	88° 45′ 54″	
i	138° 46′ 56″	
log q	9·110505	

T. E. R. P.

Solar Activity in 1912.

Sun-spots.—The year just past appears to have been that of the sun-spot minimum; the large proportion of days on which the Sun was free from spots, the small numbers and areas of the spots on the days on which any were seen, and the low latitudes which they affected, all point to the same conclusion. In the year 1911 there had been 186 days without spots; in 1912 there were about