Period, lightcurve and ephemeris of the new asteroid with variable brightness 1931 PH,

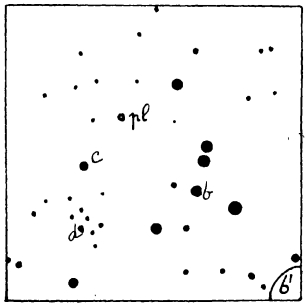
by *H. van Gent.*

1. This asteroid was detected incidentally when searching Johannesburg Franklin Adams plates of the Corona Australis region (see *B. A. N.* 243) for variable stars in the blink microscope of the Kapteyn Astronomical Laboratory at Groningen. During the search it was noted as a variable star visible on one plate but invisible on another one.

When the object was examined on a number of plates it showed its planetary character at once by its displacement on plates of the same night. The asteroid was then easily found by the aid of a 10 × magnifying glass on 58 plates covering the interval from 1931 Aug. 7 to Aug. 13; by an ephemeris computed by G. PELS it was also found on a plate with two exposures taken on 1931 Aug. 17.

The object showed considerable changes in brightness. Therefore its brightness was estimated on all available plates in the same way as the variable stars treated in *B. A. N.* 227 and 243. Fig. 1 shows the comparison stars used for these estimates; the asteroid (pl) is given in this figure in its position ($\alpha_{1925} = 18^h55^m49^s.3$; $\delta_{1925} = -38°05'.6$) and brightness on plate 7877. The size of the figure in minutes of arc is 6′ × 6′. The arc described by the asteroid in the interval Aug. 7—Aug. 13 is so small that the asteroid and the comparison stars were always together visible in the field of the magnifying glass, which makes the estimates easily to perform and reliable. The shape of the image is a little different from that of the comparison stars by the object's motion during the exposure (30 min.), so that the uncertainty of a single estimate will be slightly greater than would have been the case for a variable star of the same brightness.

FIGURE 1.



In the same way as described in *B. A. N.* 227 pp. 165 and 167 the brightnesses of the comparison stars have been derived in steps as well as in magnitudes. They are:

comparison star	brightness	
	in steps	in magnitudes
	st	m
b	·0	14·0
c	4·2	14·5
d	9·4	15·0

An account of the estimates is given in Table 1. The columns contain respectively the plate number, the Jul. Day Hel. M. Astr. Grw. Time for the middle of the exposure [1]) and the brightness in steps.

TABLE 1.

Plate	Jul. D. Hel. Astr. M. T. Grw. 2420000 +	bright-ness in steps	Plate	Jul. D. Hel. Astr. M. T. Grw. 2420000 +	bright-ness in steps
	d	st		d	st
7838	6561·4594	2·1	7870	6563·4407	7·3
7839	·4809	5·2	7871	·4622	11·4
7842	6562·2063	9·4	7872	·4836	9·4
7843	·2278	8·4	7873	·5051	5·2
7844	·2492	7·3	7874	·5266	7·3
7845	·2707	4·2	7875	·5480	6·3
7846	·2922	2·1	7876	6564·2094	4·2
7847	·3136	4·2	7877	·2308	6·3
7848	·3351	6·8	7884	6565·4275	6·4
7849	·3566	7·3	7885	·4490	5·9
7850	·3782	8·6	7888	6566·2072	9·4
7851	·3997	9·4	7889	·2287	10·4
7852	·4211	6·8	7890	·2523	8·6
7853	·4426	7·7	7891	·2765	7·3
7854	·4641	4·2	7892	·2987	5·9
7855	·4856	4·2	7893	·3201	3·2
7856	·5070	4·2	7894	·3416	4·2
7857	·5285	5·2	7895	·3631	5·2
7858	·5500	6·8	7896	·3845	6·3
7859	6563·2108	9·4	7897	·4060	7·3
7860	·2322	10·4	7898	·4275	10·4
7861	·2502	9·4	7899	·4489	10·4
7862	·2689	7·7	7900	·4704	10·4
7863	·2904	7·3	7901	·4919	8·4
7864	·3119	6·3	7902	·5134	6·3
7865	·3333	5·5	7903	·5348	5·2
7866	·3548	4·2	7904	6567·2228	8·1
7867	·3763	4·2	7905	·2443	9·4
7868	·3978	3·2	7961	6571·3467	—
7869	·4192	2·5	—	·3631	—

By superposition of rising or falling branches a period of ^{d}·21297 was derived. The phases of the observations were then computed by means of the formula: phase = (J. D. — 2420000) × 4^{d-1}·6955. The observations were arranged according to phase and means were taken in order to construct the lightcurve, as shown by Table 2 and Fig. 2. The table contains the number of observations the mean of which was taken, the mean phase and the mean brightness in steps.

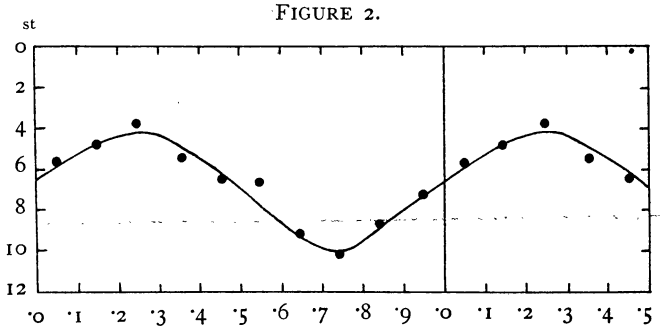
[1]) These are the heliocentric times for stars in the middle of the plate field. For the asteroid they should be increased by the amount ^{d}·005769 $r(1-\cos\gamma)$, in which r denotes the heliocentric distance of the asteroid in astr. units and γ the angle between the earth and the sun as seen from the asteroid.

In order to make the J. D. times of the table planetocentric they should be decreased by the amount ^{d}·005769 $r\cos\gamma$.

TABLE 2.

n	phase	brightness	n	phase	brightness
	P	st		P	st
8	·049	5·66	4	·549	6·62
7	·145	4·83	5	·645	9·22
5	·246	3·78	5	·743	10·20
6	·355	5·53	6	·842	8·72
5	·457	6·50	7	·948	7·24

FIGURE 2.



The mean error of a single estimate was found to be $\pm$ 1st·58.

The range of the lightcurve is about 6st, corresponding to about ^{m}·6.

The object is a rotating body of the same kind as Eros, but much smaller. The rotation time corresponds to double the light period or ^{d}·42594, two maxima and two minima of brightness occurring during one rotation. In the observations there is no sensible difference between the odd and the even minima, which justifies their superposition in the lightcurve.

2. Though the plates of the opposition 1931 cover the interval from Aug. 7 till Aug. 17 only, it was thought worth while to measure exact positions of the object on all the plates, as the long series of plates on the same night offer an opportunity for a direct determination of the object's geocentric distance. The measures were carried out by Mr. G. PELS, who derived a geocentric distance of 1·05 astr. units for 1931 Aug. 13.

An orbit was computed by the method of Gauss-Encke from the following positions:

		α (1925)	δ (1925)
1931 Aug.	7·96541	284°·38608	— 38°·31543
	12·80493	283·68351	— 37·90998
	17·85074	283·23436	— 37·41083

This orbit, derived by Mr. PELS, gave the following elements:

$$\left.\begin{aligned} M &= 322°·992 \\ \omega &= 337°·938 \\ \Omega &= 17°·299 \\ i &= 8°·153 \end{aligned}\right\} \begin{aligned} &1931 \text{ Aug. } 8 \\ &1925·0 \end{aligned}$$

$$\varphi = 13°·196$$

$$\mu = 1032''·37$$

$$a = 2·2774$$

The geocentric distance on 1931 Aug. 13, as derived from this orbit, came out to be 1·02 astr. units, in good agreement with the value found above, viz. 1·05 astr. units.

As the orbit has been computed from an arc of 10 days only, its elements are rather uncertain. Consequently an attempt to recover the object in the next opposition by the aid of an ephemeris based on these elements would very likely fail. At present the best way to get further hold of this interesting asteroid seems to be to complete the observed arc of the opposition 1931 to a longer interval. Observers, especially observers on the southern hemisphere, are kindly requested to look up their 1931 plates on which the object may be present. A search ephemeris, computed by Mr. PELS from the elements shown above, is given below:

	α (1925)	δ (1925)	Δ
	h m	° ′	
1931 May 27	19 51·1	— 33 59	1·30
June 4	52·6	— 34 50	
12	51·6	— 35 45	
20	47·9	— 36 41	1·09
28	41·8	— 37 34	
July 6	33·6	— 38 18	
14	24·1	— 38 47	·98
22	14·2	— 38 58	
30	05·3	— 38 50	
Aug. 7	18 58·2	— 38 23	1·00
15	53·8	— 37 42	
23	52·4	— 36 50	
31	54·1	— 35 55	1·11

I want to thank Mr. PELS for his collaboration and for putting the results of his measures at my disposal.