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AMATEUR OBSERVING BY THE A. L. P. O. MINOR PLANETS SECTION*

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For many decades hardly any amateur astronomers observed minor planets due to alleged difficulties of distinguishing them from field stars. The availability of the Vehrenberg photographic star atlases eliminated this problem to magnitude 13 or 14, and in the late 1960's enabled several amateur astronomers independently to initiate asteroid observing programs. Of these I especially praise two.

Dr. J. U. Gunter of Durham, North Carolina, has from 1971 to the present published *Tonight's Asteroids*, a bimonthly newsletter with finder charts for brighter asteroids accompanied by fascinating text. This publication, free for self-addressed stamped long envelopes, has introduced hundreds throughout the world to the delights of asteroid observation. It has led more than one intelligent young person to a career as a professional astronomer specializing in minor planet research.

The value of even casual minor planet observation to enhancing amateur observing skills is considerable. In J. U. Gunter's own words, "No experience more completely welds the observer, his instrument, and his charts into a smoothly coordinated unit than minor planet observation." Dr. Gunter's contribution to astronomy thus becomes farther reaching than has been generally acknowledged.

Professor Richard Hodgson, Dordt College, Sioux Center, Iowa, in 1973 organized the Minor Planets Section of the A.L.P.O. and began publishing the quarterly *Minor Planet Bulletin*. This publication is designed to coordinate amateur activity in minor planet studies, with reports on observation, historical research, news notes, and other topics. It also has great value as a medium of communication between amateur and professional astronomers. Professor Hodgson retired from the Minor Planets Section in 1983 to pursue other interests. The institutions he founded remain in capable hands, an enduring legacy to this man of vision.

I here describe one aspect of the activities of the Minor Planets Section, asteroid observation. These include two principal categories, positions and magnitudes.

Through the years our members have produced a small but steady stream of photographs, mostly on film. Many of these photographs are astrometrically measurable. But we have experienced great difficulty in obtaining access to measuring engines on which to measure these photographs. This has been a severe discouragement to the astrophotographers. I appeal to participants in this conference, and their colleagues, who have access to measuring engines to make them available to photographs by Minor Planets Section members. Please communicate with me following this presentation.

The bulk of the position observations reported in the *Minor Planet Bulletin* are approximate visual positions, generally measured off Vehrenberg atlas grids. These are not sufficiently accurate to be useful in orbit improvement. In the 1970's a number of published ephemerides were in error by several arcminutes or more. Reports by amateur observers of these discrepancies identified those planets whose orbits most urgently needed improvement. Such errors are extremely rare nowadays.

These visual observations, primarily by individuals seeking to lengthen their personal lists, remain of value in a different sense. As observations are extended to 14th and 15th magnitude and beyond with 35 centimeter and larger telescopes, a number of planets have been found to have magnitudes differing appreciably from those catalogued. Though the accuracy of these visual estimates may be challenged, they do identify planets meriting additional measurements by photographic or photoelectric photometry. Here lies a particularly valuable interface between amateur and professional observer. I foresee many future improvements to the absolute magnitude data base by this cooperative venture, as dedicated amateurs survey ever-fainter asteroids recently added to the catalogues.

On several occasions visual observers have noted rotational brightness variations and followed up their findings by obtaining a series of visual lightcurves. The accuracy and limitations of visual lightcurves resemble those of photographic photometry. Useful results can usually be obtained only for fairly short periods and amplitudes exceeding 0.5 magnitude. And of course the resulting lightcurves are not utilizable by the techniques of photometric astrometry. Nevertheless there are

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compensating advantages which should not be overlooked. Chief among these is the fact that most amateurs have observing time limited only by the weather. They can, and have, obtained through lightcurves over time intervals of weeks or months, rotation periods much more accurate than from photoelectric runs which must stop after a few days when the telescope is relinquished to another observing program.

We have encountered an obstacle, seemingly insurmountable by visual means alone, to obtaining four to five significant figure rotation periods from the times of lightcurve extrema separated by several hundred rotation cycles. This arises from the inability to time maximum and minimum light closer than ten to fifteen minutes in a typical six hour rotation period. With an observing run of four to six hours, it is not possible to uniquely count extremum cycles from one night to the next. An ambiguity of 0.5 cycle remains, and thus one has two possible periods. Extending the interval of observation improves both of these competing periods but cannot distinguish between them.

I therefore appeal for a cooperation between professional or amateur photoelectric observers and amateur visual observers, and volunteer the office of my position as Recorder of the Minor Planets Section to facilitate this communication. For a planet of suitably large amplitude, a photoelectric observer obtains lightcurves on one or two nights with extrema sufficiently well-timed to uniquely count rotation cycles from one night to the next. He then requests the amateur to continue visual lightcurves over as long a time period as possible. Perhaps a single photoelectric lightcurve at the end could tie the whole data set together. Or a visual observer finds a large amplitude lightcurve in his survey, and requests the photoelectric observer to obtain lightcurves on two closely spaced nights to resolve the above ambiguity of his own extended measures.

This technique also applies to the photoelectric observer who obtains two closely spaced lightcurves and then a third a month or more later. The period obtained from the closely spaced lightcurves is insufficiently accurate to unambiguously count cycles between the widely spaced ones. Intervening visually timed extrema can remove the ambiguity.

Cooperative efforts of the types described above have already been employed successfully to planets 216, 699, 1168, 1192, and 1219. They should be continued.

Any good quality photoelectric lightcurve of a minor planet is eminently publishable. With currently available low-cost detectors and detector-computer interfacing, the opportunity for worthwhile amateur contribution is great. A few good lightcurves have been obtained, but achievement to the present is far below potential. In a separate paper, Kenneth Zeigler describes a successful ongoing photoelectric project.

Members of the Minor Planets Section contribute occultation observations of stars by asteroids as opportunity permits. Responsibility for collection, analysis, and dissemination of results lies with the International Occultation Timing Association rather than the Minor Planets Section.

PHOTOELECTRIC STUDIES OF ASTEROIDS: THE AMATEUR CONTRIBUTION*

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(Received: 11 July Revised: 8 August)

The amateur astronomer is capable of making a significant contribution in the photoelectric study of asteroids. Described is a program of astronomical research based entirely at the high school level. High school students at Globe High School in Globe, Arizona are currently involved in a program of photoelectric photometry of asteroids which has yielded a considerable volume of important information as to the rotational rates and surface properties of 25 bright asteroids.

Photoelectric photometry of asteroids has long been an area of astronomical study dominated almost exclusively by the professional astronomer working from major observatories. To date only a few amateur astronomers have become involved in photometric studies of asteroids. This is unfortunate in that there are many asteroids within the reach of modest size amateur telescopes that have virtually no observational history. The cost and size of good quality photoelectric equipment has also decreased dramatically during the past several years making this instrumentation available to the amateur.

Photometric studies of asteroids can yield important information as to the rotational period, pole axis orientation, and general surface roughness of these small solar system objects. There are not enough hours of telescope time available at major observatories nor an adequate number of professional observers involved to study these small solar system bodies in sufficient detail. Clearly this is an area of research in which the amateur astronomer may make a significant contribution. It was with this in mind that Gila Observatory was established. Gila Observatory is dedicated to promoting serious astronomical research at the high school level.

In many high school science courses such as chemistry, biology, and physics, classroom lecture materials are supplemented by a laboratory experience designed to demonstrate basic scientific principles to the students. Such laboratory experience clarifies and reinforces materials learned in the classroom. High school astronomy has not typically been a laboratory oriented course.

A laboratory oriented astronomy course utilizing Gila Observatory as an astronomical laboratory has been instituted at Globe High School in Globe, Arizona. In this unique astronomy program students have learned through

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direct experience how man has explored the mysteries of the star filled universe. Through this experience students have learned how to apply the modern scientific method to studies in astronomy and have gained valuable experience in basic scientific research. Additionally these students have had the opportunity to make a significant contribution to the astronomical community.

The History of the Program

As a professional educator for many years I had long envisioned the creation of an astronomy course that would allow students to become involved in serious astronomical research. Development of the present program began during the spring of 1983 with the construction of Gila Observatory. During the early phases of the program I provided the majority of the financial support including the cost of observatory construction. The selected site for the new observatory was a 3700 foot ridge 3 miles west of Globe. This site offered easy access and dark clear skies. During the construction phase of the project as many as 13 students were on hand at the construction site at any given time. Due to the large number of students involved, the construction was complete within a month and the observatory became operational in June of 1983. Without the dedication of the students involved the construction would have required a considerably longer period of time to complete.

The telescope originally housed within the 2.5 meter diameter observatory dome was a Celestron 11 inch Schmidt Cassegrain telescope. An SSP-3 solid state photometer was also among the original equipment of the observatory. The SSP-3 photometer was chosen on the basis of its simplicity of operation and relative durability. These were important criteria to consider in the selection of scientific equipment for student use.

The photometer is interfaced to a TRS-80 micro-computer which controls the photometric integration time, records and stores each photometric reading along with the universal time of that reading, and performs all data reduction. This system has saved literally thousands of hours of data reduction time during the past two years.

Early in the planning stages of the program it had been decided that photoelectric photometry of asteroids would be the primary research program at the new observatory. Additional programs involving photoelectric photometry of variable stars and comets as well as a program of astrophotographic research have been instituted.

During the first half of 1985, the Celestron 11 inch telescope at the observatory was replaced by a Celestron 14 inch Schmidt Cassegrain telescope. Additionally an EMI Starlight 1 photon counting stellar photometer was made available to the program by Fairborn Observatory.

Research Program Results

At the time of this writing the student research program is entering its third year of operation. During the past two years, as a result of the research of the students involved, 25 asteroids have been observed and their rotational periods deduced from their light variations. During this same time four papers describing the results of the asteroid photometry program have been published in the literature. An additional paper describing some of the results of the variable star photometry program has also been published. During the same period of time, the 11 students involved have won over 20 awards of excellence at the Central Arizona Regional Science Fair and two four year scholarships to Arizona State University.

Future Plans

The future of this educational program looks bright. It has received funding from the school district for the 1985-86 school year. As in the previous school year, students who enroll in the course will receive three units of college credit in addition to the one unit of high school credit for the successful completion of the course. During 1985 and 1986 the students will continue photometric studies of asteroids and variable stars. Additionally a program of narrow band photometry of comet Halley will be undertaken in conjunction with the research of Dr. Mike A'Hearn of the University of Maryland. Currently a series of written laboratory exercises in photoelectric photometry designed to acquaint the student with the many uses of this technique are being developed. These written laboratory exercises and other materials developed during the two year history could be made available to other high schools and colleges in order to aid them in the development of similar programs.

Student interest in the program at Globe High School has also increased. All students involved in the program during the 1984-85 school year have expressed an interest in continuing their research during the 1985-86 school year and a second year course in astronomy research is currently under development. In order to allow all students involved in the program to have adequate telescope time, an additional telescope is being considered. Currently, a search for outside funds that would allow the construction of a 24 inch telescope for student use is underway.

It is the youth of today that will be the astronomers, planetary scientists, geologists, and physicists of the future. Now more than ever it is important for high school students to become acquainted with the methods of modern science.

EDITOR'S NOTE

Careful readers will have noticed that the masthead on the first page of this issue lists it as "part 1" of Volume 12, Number 4. Part 2 will be a comprehensive index of the *Minor Planet Bulletin* for Volumes 1-12 covering the years of 1973-1985. This extremely useful resource is being compiled by Clifford Cunningham. This index will be completed in the near future and will be mailed with issue 13-1 in late 1985. I know that all readers will join me in thanking Mr. Cunningham for undertaking this monumental task.

PHOTOELECTRIC PHOTOMETRY OF ASTEROID 4 VESTA

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Photoelectric photometry for asteroid 4 Vesta was made from North Valley Stream Observatory during the nights of April 28 and 30, 1985. Vesta's rotational period has been previously reported as either 5 hours 20 minutes or 10 hours 40 minutes. The data presented here favor the longer period, but not conclusively. The amplitudes observed on April 28 and 30 were 0.11 ± 0.01 and 0.14 ± 0.02 magnitudes, respectively.

Observations

During April and May of 1985, the asteroid 4 Vesta was usually in a favorable position for photoelectric photometry. The opposition date was on April 22 with a B magnitude of 6.49. The photometric observations described here were taken from North Valley Stream Observatory, located on Long Island approximately 20 miles east of New York City.

The observations were made using an Optec SSP-3 solid state photometer coupled on to an eight-inch Schmidt Cassegrain telescope with digital readout readings. On April 28, a V filter was used and on April 30, both B and V filters were used. Observational circumstances for the two nights are given in Table I.

Vesta was near to a sixth magnitude star, 92 Virginis. This star was selected to compare Vesta's brightness. At the time of the observations on April 28, Vesta and 92 Virginis were approximately one-quarter degree from each other. Vesta was to the northeast from 92 Virginis. Then on April 30 they were still one-quarter degree from each other, but Vesta had moved to the northwest of 92 Virginis in retrograde motion. Both objects were located close enough in the sky so that differential extinction effects could be ignored.

On April 28, 26 entries were made at 10 minute intervals over 4 hours and 10 minutes. On April 30, 31 entries were made again at 10 minute intervals over 5 hours and 20 minutes. The resulting lightcurves are presented in Figures 1 and 2 where the verticle scale represents the differential V magnitude with respect to the comparison star 92 Virginis.

1985 UT Date	R.A. (1950)	Dec.	Ecliptic Long.	Lat.	r	Δ	α
Apr 28	13 50	+01 30	206	12	2.20	1.22	7.5
Apr 30	13 52	+01 35	206	12	2.20	1.22	8.2

Table I
Observational Circumstances

Results

Vesta is listed as a V-type asteroid with a diameter of 545 km. It has been previously well observed, but additional observations are needed to resolve an ambiguity in its rotational period and to determine the direction of its polar axis.

During the night of April 28, the observations were cut short because of weather problems. The photometric data showed an amplitude of 0.11 ± 0.01 magnitude. Even though Vesta's rotation period is perhaps 5 hours and 20 minutes, the observing duration was not long enough to cover one complete cycle. Only a fragment of the lightcurve could be detected. On April 30, the observations were completed in 5 hours and 20 minutes and a V magnitude amplitude of 0.14 ± 0.02 was detected.

The lightcurves from both nights show similar shapes, but they are not identical. They are consistent with Vesta's previously reported 5 hour and 20 minute rotational period if only one maximum and minimum are present per rotation. However, it is possible that Vesta's rotational period could be as long as 10 hours and 40 minutes if two maxima and minima occur per rotation. Comparing the April 28 and 30 lightcurves shows that they reached nearly the same amplitude. However, the light maximum on April 30 fluctuated more than on April 28 perhaps because Vesta was monitored on two different sides. If Vesta's rotational period is 5 hours and 20 minutes it would have rotated 9 times between the two nights of observation and the observations would have been made of the same side. However, if Vesta's rotational period is 10 hours and 40 minutes it would have rotated 4 and one-half times between the two nights of observation. Therefore two different sides would have indeed been observed.

It is entirely possible that the differences in the observed maxima may simply be due to atmospheric fluctuations and other sources of noise in the data. However, the seeing conditions on both nights were just as good and the comparison star was monitored carefully during the observations. Therefore there is some evidence here that Vesta's rotational period could be 10 hours and 40 minutes although 5 hours and 20 minutes also satisfies the data.

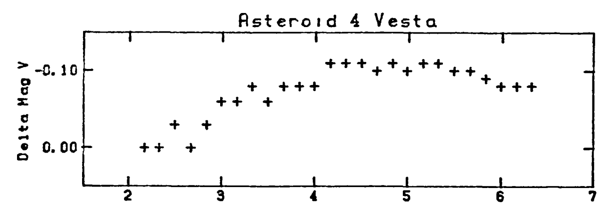

Figure 1
Photoelectric Lightcurve of Asteroid 4 Vesta on April 28, 1985 U.T.

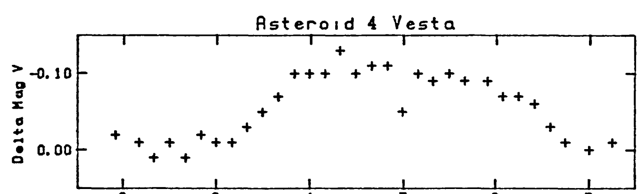

Figure 2
Photoelectric Lightcurve of Asteroid 4 Vesta on April 30, 1985 U.T.

PHOTOELECTRIC PHOTOMETRY OPPORTUNITIES
NOVEMBER - JANUARY

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The table below lists asteroids which come to opposition during the months of November, 1985 - January, 1986 that represent useful targets for photoelectric photometry observations. Observations are needed because the asteroid has either an unknown or ambiguous rotational period or because the asteroid will be observable at a very low phase angle. The table also includes asteroids which are candidates for pole determinations (see the article by Di Martino and Zappalá in issue 12-1) or are targets for radar observations (see the article by Ostro in *MPB* 10, No. 4). The table gives (in order of opposition dates) the asteroid number and name, opposition date, opposition B magnitude (the V magnitude is about 0.8 brighter), the rotational period (in hours), the estimated lightcurve amplitude (in magnitudes), and the designation PER if observations are needed to determine the rotational period. AMB implies that previous period determinations have given ambiguous results and these alternate periods are listed in the table. PHA indicates observations of the phase curve are desired because the asteroid will be at an unusually low phase angle, POL indicates the asteroid is a pole position candidate, and RAD indicates the asteroid is a planned radar target. Question marks are used to denote uncertain or unknown values. An outline of recommended observing procedures in given in *MPB* 11, No. 1, page 7. Also recommended is the book *Solar System Photometry Handbook* (see the review by Tholen in *MPB* 11, No. 4). Ephemerides for all of the asteroids in the table are included in this issue. An extended ephemeris is given for the fast moving Apollo asteroid 1866 Sisyphus. Some of these may appear on finding charts prepared by Dr. J. U. Gunter, 1411 N. Mangum St., Durham, NC 27701 USA. These charts are free for a self-addressed stamped envelope.

Asteroid	Opp'n Date	Opp'n B Mag	Per	Amp	
15 Eunomia	Oct 13	8.8	6.08	0.4	RAD
21 Lutetia	Nov 4	10.9	8.167	0.2	POL
354 Eleonora	Nov 23	11.0	4.277	0.2	POL
216 Kleopatra	Nov 25	10.2	5.399	0.5	RAD
270 Anahita	Nov 25	11.9	15.06	0.3	PHA
1866 Sisyphus	Nov 28	13.0	?	?	PER + RAD
16 Psyche	Dec 6	10.0	4.196	0.3	RAD
81 Terpsichore	Dec 9	12.1	?	?	PER
451 Patientia	Dec 23	11.2	9.727	0.1	PHA
511 Davida	Dec 26	10.3	5.167	0.2	RAD
18 Melpomene	Jan 2	9.7	11.572	0.3	RAD

Photoelectric Photometry Opportunities

DATE			R.A. (1950) HR	MIN	DEC. DEG	MIN	MAG B	PHASE ANGLE
Minor Planet			15 Eunomia					
1985	Oct	7	1	19.1	31	15.	8.88	12.1
		17	1	9.9	30	44.	8.76	10.0
		27	1	1.2	29	42.	8.77	10.1
	Nov	6	0	54.4	28	18.	8.91	12.4
		16	0	50.5	26	47.	9.11	15.6
		26	0	50.0	25	19.	9.35	18.8
	Dec	6	0	53.0	24	4.	9.58	21.5
		16	0	59.2	23	7.	9.81	23.6
		26	1	8.1	22	30.	10.02	25.1
Minor Planet			16 Psyche					
1985	Oct	17	5	17.3	18	54.	10.96	18.6
		27	5	16.6	18	40.	10.79	16.0
	Nov	6	5	13.0	18	25.	10.62	12.8
		16	5	6.9	18	9.	10.46	9.0
		26	4	58.7	17	53.	10.25	4.8
	Dec	6	4	49.6	17	40.	10.04	1.8
		16	4	40.5	17	29.	10.30	4.8
		26	4	32.7	17	24.	10.55	8.8
1986	Jan	5	4	27.0	17	26.	10.76	12.4
		15	4	23.9	17	34.	10.97	15.4
		25	4	23.4	17	50.	11.17	17.6
Minor Planet			18 Melpomene					
1985	Nov	6	7	18.1	8	37.	10.75	27.2
		16	7	21.1	7	58.	10.55	24.7
		26	7	20.4	7	33.	10.34	21.4
	Dec	6	7	16.0	7	26.	10.12	17.3
		16	7	8.4	7	41.	9.91	12.7
		26	6	58.3	8	18.	9.74	8.3
1986	Jan	5	6	47.4	9	15.	9.70	6.3
		15	6	37.2	10	27.	9.90	8.6
		25	6	29.0	11	46.	10.20	12.6
	Feb	4	6	23.9	13	7.	10.51	16.4
Minor Planet			21 Lutetia					
1985	Oct	7	3	3.6	13	18.	11.25	14.8
		17	2	56.6	12	51.	11.08	9.8
		27	2	47.4	12	19.	10.86	4.8
	Nov	6	2	37.3	11	46.	10.69	1.8
		16	2	27.6	11	18.	11.08	6.5
		26	2	19.8	10	60.	11.34	11.3
	Dec	6	2	14.7	10	56.	11.59	15.3
		16	2	12.5	11	7.	11.84	18.5
		26	2	13.4	11	32.	12.08	21.0
1986	Jan	5	2	17.2	12	10.	12.31	22.6
Minor Planet			81 Terpsichore					
1985	Oct	17	5	22.0	32	44.	13.11	22.3
		27	5	24.0	33	40.	12.89	19.7
	Nov	6	5	22.2	34	32.	12.66	16.4
		16	5	16.7	35	14.	12.43	12.6
		26	5	8.0	35	42.	12.23	8.6
	Dec	6	4	57.5	35	51.	12.09	5.8
		16	4	46.9	35	40.	12.17	6.7
		26	4	37.7	35	12.	12.39	10.1
1986	Jan	5	4	31.5	34	34.	12.65	13.9
		15	4	28.7	33	53.	12.91	17.2
		25	4	29.7	33	13.	13.17	19.8

DATE	R. A. (1950) HR	MIN	DEC. DEG	MIN	MAG B	PHASE ANGLE
Minor Planet 216 Kleopatra						
1985 Oct 7	4	22.1	18	13.	10.99	22.5
17	4	23.7	16	44.	10.77	19.2
27	4	21.9	15	1.	10.55	15.1
Nov 6	4	17.0	13	10.	10.35	10.5
16	4	9.8	11	17.	10.18	6.2
26	4	1.7	9	34.	10.15	5.1
Dec 6	3	54.0	8	9.	10.38	8.6
16	3	48.0	7	8.	10.63	12.9
26	3	44.5	6	34.	10.89	16.8
1986 Jan 5	3	44.0	6	25.	11.16	19.9
15	3	46.4	6	36.	11.41	22.3
Minor Planet 270 Anahita						
1985 Oct 7	4	33.7	23	41.	13.01	24.1
17	4	33.5	23	35.	12.77	20.7
27	4	29.3	23	19.	12.52	16.4
Nov 6	4	21.5	22	51.	12.26	11.2
16	4	11.0	22	13.	12.00	5.5
26	3	59.4	21	27.	11.68	0.6
Dec 6	3	48.5	20	39.	12.16	6.3
16	3	39.7	19	56.	12.50	11.5
26	3	34.1	19	23.	12.83	15.9
1986 Jan 5	3	32.1	19	4.	13.14	19.5
15	3	33.5	18	58.	13.43	22.1
Minor Planet 354 Eleonora						
1985 Oct 7	4	19.5	- 3	55.	11.88	16.6
17	4	17.6	- 5	12.	11.72	14.6
27	4	13.2	- 6	24.	11.57	12.5
Nov 6	4	6.8	- 7	26.	11.45	10.6
16	3	58.7	- 8	9.	11.38	9.7
26	3	50.0	- 8	28.	11.38	10.1
Dec 6	3	41.6	- 8	20.	11.44	11.8
16	3	34.4	- 7	46.	11.55	14.0
26	3	29.2	- 6	48.	11.67	16.2
1986 Jan 5	3	26.3	- 5	32.	11.81	18.2
15	3	26.0	- 4	1.	11.94	19.8
Minor Planet 451 Patientia						
1985 Oct 27	6	32.1	19	54.	12.28	18.4
Nov 6	6	33.0	20	26.	12.10	16.5
16	6	31.1	21	5.	11.91	14.0
26	6	26.6	21	51.	11.71	10.9
Dec 6	6	19.6	22	41.	11.51	7.2
16	6	10.8	23	34.	11.23	3.1
26	6	1.1	24	26.	11.08	1.2
1986 Jan 5	5	51.6	25	15.	11.40	5.4
15	5	43.4	25	57.	11.64	9.2
25	5	37.4	26	35.	11.85	12.6
Feb 4	5	34.0	27	8.	12.05	15.3
Minor Planet 511 Davida						
1985 Oct 27	6	41.8	13	29.	11.66	20.6
Nov 6	6	44.5	13	42.	11.47	18.8
16	6	44.5	14	5.	11.25	16.5
26	6	41.7	14	39.	11.03	13.4
Dec 6	6	36.3	15	25.	10.80	9.7
16	6	28.7	16	23.	10.56	5.6
26	6	19.8	17	29.	10.32	2.2
1986 Jan 5	6	10.7	18	39.	10.50	4.6
15	6	2.6	19	51.	10.76	8.7
25	5	56.5	21	0.	11.00	12.4
Feb 4	5	53.0	22	5.	11.24	15.6

DATE	R. A. (1950) HR	MIN	DEC. DEG	MIN	MAG B	PHASE ANGLE
Minor Planet 1866 Sisyphus						
1985 Nov 15	23	48.1	-80	3.	14.97	86.2
16	23	57.8	-77	45.	14.86	85.4
17	0	4.8	-75	14.	14.75	84.5
18	0	10.3	-72	29.	14.63	83.4
19	0	14.6	-69	30.	14.50	82.2
20	0	18.0	-66	14.	14.38	80.8
21	0	20.9	-62	43.	14.25	79.3
22	0	23.4	-58	55.	14.11	77.6
23	0	25.5	-54	49.	13.98	75.7
24	0	27.3	-50	29.	13.86	73.6
25	0	29.0	-45	54.	13.73	71.4
26	0	30.5	-41	6.	13.62	69.2
27	0	31.9	-36	11.	13.52	66.9
28	0	33.2	-31	10.	13.44	64.6
29	0	34.4	-26	10.	13.38	62.4
30	0	35.6	-21	13.	13.34	60.3
Dec 1	0	36.7	-16	25.	13.32	58.4
2	0	37.8	-11	49.	13.32	56.7
3	0	38.8	- 7	26.	13.34	55.2
4	0	39.9	- 3	20.	13.38	53.9
5	0	40.9	0	29.	13.43	52.8
6	0	41.9	4	2.	13.50	51.8
7	0	42.9	7	19.	13.57	51.0
8	0	43.9	10	19.	13.66	50.3
9	0	45.0	13	5.	13.74	49.8
10	0	46.0	15	37.	13.84	49.3
11	0	47.1	17	56.	13.93	48.9
12	0	48.1	20	5.	14.03	48.5
13	0	49.2	22	2.	14.12	48.2
14	0	50.3	23	51.	14.22	47.9
15	0	51.4	25	30.	14.31	47.7
16	0	52.6	27	3.	14.41	47.5
17	0	53.7	28	28.	14.50	47.3
18	0	54.9	29	47.	14.59	47.0
19	0	56.1	31	0.	14.68	46.9
20	0	57.3	32	9.	14.77	46.7
21	0	58.6	33	12.	14.85	46.5
22	0	59.9	34	12.	14.93	46.3
23	1	1.2	35	8.	15.02	46.1

ASTEROID NEWS NOTES

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Forty-three New Asteroids and a Milestone

Through the August batch of Minor Planet Circulars (MPCs), 43 asteroids were newly numbered, bringing the total past the 3300 milestone to 3302. A fair number of the newly numbered asteroids do not fall in the main belt. (3290) 1973 SZ1 falls in the Hilda region at 4 AU, and (3273) 1975 TS2 falls in the Cybele region at 3.4 AU. The group includes one high-inclination Phocaea-type object, (3267) 1981 AA, and one high-inclination Hungaria-type object, (3266) 1978 PA. Two Mars crossers are newly numbered: (3270) 1982 DA, and (3287) 1981 DK1; the latter is only a very shallow Mars crosser. The list also includes two asteroids of Amor type: (3271) 1982 RB, and (3288) 1982 DV.

New Asteroid Names

Thirty-six asteroids received permanent names recently. Most of the objects were named after people. Names that MPB readers might recognize include (2871) Schober, named for the Austrian asteroid lightcurve observer, (3041) Webb, author of the famous Celestial Objects for Common Telescopes, and (3254) Bus, named after the person largely responsible for the success of the UCAS Asteroid Survey (which is slightly redundant, because UCAS stands for United Kingdom-Caltech Asteroid Survey; the survey was performed with the UK Schmidt telescope in Australia). The parent body of the Geminid meteor shower, 1983 TB, was named (3200) Phaethon, after the son of Helios, who operated the solar chariot for a day, lost control of it, and almost incinerated the earth. Mathematically inclined readers should be interested by (3142) Kilopi; the name recognizes that the number 3142 is the circumference of a circle (rounded off) with a diameter of 1000 units! And now for the MPB quiz of the quarter: At the current rate of new asteroid numberings, how long will it take before some lucky person has the honor of naming an asteroid Megapi?

Earth-approaching Asteroid Update

Only one earth-approaching asteroid was discovered since the last issue, but an interesting object it turns out to be. The object's designation is 1985 PA. It was discovered by E. F. Helin and M. A. Barucci with the 0.9-m CERGA Schmidt telescope on August 15. The interesting aspects of the object are twofold. First, the orbit has one of the highest inclinations known for an asteroid: 56 degrees. Second, from photometry obtained by the author on August 24-26, the lightcurve has an amplitude of at least 0.9 mag and a period of possibly 8 days(!), although a period nearly commensurate with 1 day cannot be ruled out yet. The object has a perihelion distance of 1.0009 AU, which may make it seem to be an Apollo-type object to some readers. However, the object's longitude of perihelion is close to the earth's longitude of perihelion, so that in fact the asteroid does not cross the orbit of the earth, which technically makes the object an Amor. The orbit is still preliminary, however, so its status may yet change. Stay tuned.

LOW PHASE ANGLE ASTEROIDS

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Based on recent correspondence, now appears to be a good time to repeat the reasons for this quarterly list. Asteroids that pass through very low phase angles undergo a strong surge in brightness known as the opposition effect. The reason or reasons for the opposition effect are still being debated. The answers are likely to come only after more data are obtained on a wide variety of different objects. Therefore, asteroid observers who are equipped with photoelectric photometers can help provide the necessary data on the opposition effect by observing the asteroids in Table I below. In general, photographic or visual photometry are not able to provide the precision needed for this study. Nevertheless, the table can also be of use to visual observers who are engaged in the hobby of tracking down as many different asteroids as possible. At the times indicated, the asteroids will be on the order of 0.3 mag brighter than they would otherwise be just a few days earlier or later. Thus asteroids near the detection limit of an observer's equipment will be easiest to find at the moment of lowest phase angle (all other things being equal; lightcurves do, of course, enter into the picture, and in an unpredictable way for the asteroids with unknown rotational lightcurves).

Another computer run was necessary to extend the list into 1986. Unlike the previous computer run, no magnitude limit was set, so some of the fainter objects have crept back into the table. As before, however, the cutoff for inclusion in the table was at 0.20 degrees phase angle or less.

TABLE I

Asteroid	Phase Angle	Mag B	Date/Time UT (1985)
721 Tabora	0.01	14.2	Nov 1 14
1378 Leonce	0.09	16.4	Nov 3 20
1442 Corvina	0.03	15.7	Nov 6 10
1074 Beljawskya	0.14	14.3	Nov 17 5
656 Beagle	0.18	14.9	Nov 20 0
1544 Vinterhansenia	0.05	14.5	Nov 21 11
536 Merapi	0.00	13.1	Nov 22 1
1517 Beograd	0.06	15.4	Nov 27 14
2588 Flavia	0.07	16.5	Nov 27 14
1773 Rumpelstilz	0.02	16.5	Dec 6 12
2046 Leningrad	0.01	15.7	Dec 6 19
2273 Yarilo	0.10	15.6	Dec 14 23
534 Nassovia	0.16	14.0	Dec 21 3
369 Aeria	0.14	12.5	Dec 25 7
1340 Yvette	0.16	16.7	Jan 4 11
1963 Bezovec	0.16	13.0	Jan 7 8
1233 Kobresia	0.00	15.4	Jan 12 1
407 Arachne	0.05	12.8	Jan 14 16
2887 1977 QD5	0.17	16.8	Jan 16 0
288 Glauke	0.10	13.9	Jan 18 21
998 Bodea	0.18	16.2	Jan 20 20
2164 Lyalya	0.16	17.8	Jan 25 14
3245 1973 UL5	0.13	17.3	Jan 25 20
2719 1965 SU	0.03	15.7	Jan 28 10
3183 1949 PP	0.03	17.5	Jan 30 15
2921 6525 P-L	0.17	19.3	Jan 31 9