THE MINOR PLANETS

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Minor Planets is the term used to denote the smaller members of the sun's family. They are also called "asteroids" or "planetoids".

DISCOVERY

Early in the 18th century, Bode discovered the following series. He said,"Start with 0,3,6,etc. and keep doubling.Result:

0, 3, 6, 12, 24, 48, 96, 192
Add 4 to each number.

4,7, 10, 16, 28, 52, 100, 196
Divide each by 10.

.4, .7, 1.0, 1.6, 2.8, 5.2, 10.0, 19.6

This is a close approximation of the distances of the planets from the Sun as measured in astronomical units.However, no planet was known to fit the distance of 2.8 A.U.. A search was instituted, and 4 dwarf planets with diameters of less than 500 miles were found.They were:

No.	Name	Year of Discovery	Discoverer	Diameter (miles)
1	Ceres	1801	Piazzi	485
2	Pallas	1802	Olbers	304
3	Juno	1804	Harding	118
4	Vesta	1807	Olbers	243

The total number of minor planets whose orbits have been accurately determined is now about 1,600.

NOMENCLATURE:

As was usual the asteroids were given names from mythology, but this practice did not last for long, and now the discoverer has his choice. Consequently, we not only have names such as Astraea but also such atrocities as Pittsburghia, Chicago, and Rockefellia. Nowadays,a numerical nomenclature is used. The asteroid is known first by its year of discovery, then by a letter denoting the half-month of its discovery, and then by a letter denoting the order of discovery. Thus:

1971 January	(1st half):	1971:AA,AB,AC,AD,AE,etc.....
	(2nd half):	1971:BA,BB,BC,BD,BE,etc.....
February	(1st half):	1971:CA,CB,CC,CD,CE,etc.....
	(2nd half):	1971:DA,DB,DC,DD,DE,etc.....
March	(1st half):	1971:EA,EB,EC..etc.....

ORBITS:

Most of the minor planets have circular orbits with their mean distance at 2.8 astronomical units as predicted by Bode's Law.The average orbital inclination is 9^{0} with the isolated case as high as 30^{0}. Most of their perihelions lie in the same direction as the perihelion of Jupiter's perihelion. This indicated the great influence that Jupiter has on the minor planets. See fig.1.

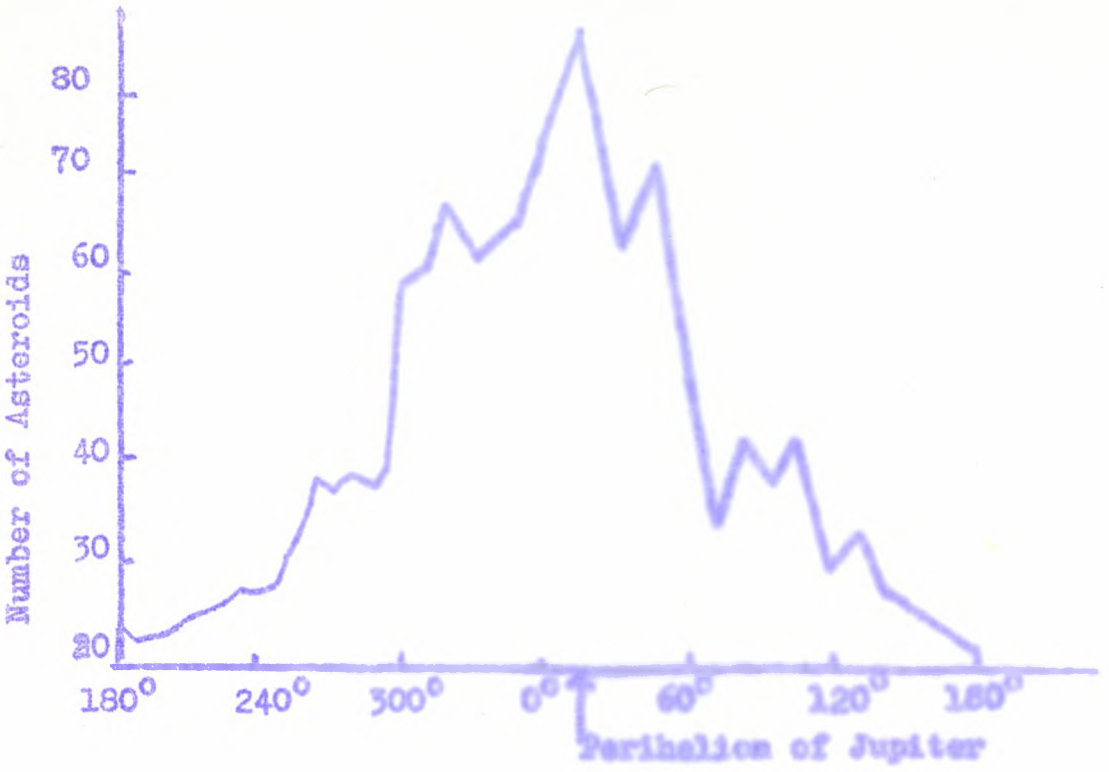

Fig.1-LONGITUDE OF PERIHELIA-

It has been discovered that Jupiter has another effect on the orbits of the minor planets. If we examine the orbits closely we will find that no asteroid has a period which is 1/3, 2/5, 3/7, 1/2, or 3/5 that of Jupiter. With a little explanation, the reason for this can be made clear.

Suppose that an asteroid has a period exactly 1/3 that of Jupiter. The planetoid will reach the position where it, Jupiter, and the Sun are nearly in a straight line 3 times in 11.9 years, which is the period of Jupiter. When the objects are lined up, the influence of Jupiter's gravitational attraction is strongest and the orbit of the planetoid is changed most. (This is called a perturbation.) Thus, a perturbation occurs every 11.9/3= 3.97 years. With these frequent and powerful gravitational pulls, the asteroid cannot maintain its orbit for long. Thus the zone becomes emptied of planetoidal material.

There is a similarity here to the gaps in the rings of Saturn, for they are formed in the same way: by perturbations of an exterior body or bodies. In this case, a body orbiting Saturn would have a period of 11.3 hours, which is half that of Mimas, a third that of Enceladus, a quarter that of Tethys and one sixth that of Dione.

LIGHT VARIATIONS:

Some of the minor planets vary in brightness. This is an indication that they are not spherical bodies, although Ceres, Pallas and Vesta have circular discs. An examination of fig.2 will reveal the reason for the light variations:

VARIATION

NON-VARIATION

If the asteroid were shaped roughly like a brick, and were tumbling through space, light variation would be noticed. As the ends and then the sides of the asteroids were presented alternately, the planetoid would seem to dim and then brighten. If the sides were constantly toward the observer, then no light variation would be noticed.

Keeping track of these variations is an interesting project for an observer with a moderate sized telescope. The method is similar to that used for observing variable stars. (See "Observing Variable Stars With Binoculars" by the author.) Ephemerides for several asteroids are given at the end of this article.

GROUPS OF ASTEROIDS:

There are several groups of asteroids. Many of these are located just outside the gaps mentioned in the section on orbits. All of the members of the group have similar orbits and similar periods. Nothing is remarkable about the individual members of these groups other than the orbital similarities.

There are two groups, however, which deserve a more lengthy discussion. They have the name "Trojans". What is remarkable about these asteroids is that they move in an orbit identical to that of Jupiter, except that they are either 60° ahead of, or behind, Jupiter. This means that Jupiter, the Sun, and the Trojans form equilateral triangles. (See fig.3)

Fig.3-POSITION OF THE TROJAN ASTEROIDS

The preceeding group is composed of "Achilles" and six other asteroids, while the following group is composed of "Patroclus" and four others. They were named after characters in "The Iliad", the classic by Homer. (Strange that Greek names should be in a group of Trojans! Another attempt at the wooden horse trick?)

ORIGIN OF ASTEROIDS:

Two theories have received popular support as possible origins of the asteroids. The first is that the asteroids were formed when a single planet exploded. This would account for the irregular shape of many asteroids; that is, they are fragments, whereas bodies formed through the nebular hypothesis, which is currently in vogue for the formation of the other planets, should be more or less spherical. However, it has been calculated that all of the known minor planets together would have a diameter of only 650 miles and a mass 1/4000 that of the earth.

The second theory suggests that the asteroids are the remains of extinct comets. There is some evidence that comet nuclei have properties similar to those of the planetoids.

NOTABLE ASTEROIDS:

Ceres: This is the largest asteroid. It has a diameter of 485 miles and a magnitude of 7.5. It was the first discovered, in 1801, by Piazzi, in Sicily. It is named for the patron goddess of Sicily.

Vesta: This is the brightest asteroid reaching a magnitude of 6.3 at mean opposition distance. Since its diameter is 243 miles, it must have a very reflective surface.

The "Sun-Grazers":

There are 6 asteroids which merit special attention because of the closeness of their perihelia to the sun. Their orbital elements are given here in Table 1:

Asteroid	Discovery Year	Semi-Major Axis	Inclination	Eccentricity	Sid. Per Years
Eros	1898	1.97 A.U.	$10^{\circ}.8$	0.22	1.76
Amor	1932	1.92	$11^{\circ}.9$	0.44	2.67
Icarus	1949	1.08	$23^{\circ}.0$	0.83	1.12
Adonis*	1936	1.97	$1^{\circ}.5$	0.78	2.76
Apollo*	1932	1.49	$6^{\circ}.4$	0.57	1.81
Hermes*	1937	1.29	$4^{\circ}.7$	0.48	1.47

*= Data uncertain for these asteroids.

Eros was the first example of a superior planet having a shorter orbital period than Mars. Eros has a highly eccentric orbit. Its perihelion distance is very close to 93 million miles, which can bring it close to the earth at times. It can pass to within 11 million miles of us.

Icarus can come even closer, only 400,000 miles, which is only about twice the moon's distance from us! Icarus also skims very close to the sun, only 17 million miles from it, which is about half the mean distance of Mercury. That is how Icarus was named: for the Greek boy who flew too close to the sun.

It should be noted that the orbits of Icarus and the Earth are subject to perturbations and, therefore, the minimum distance between the objects is variable. An exact intersection is possible, but for a collision to occur both bodies would have to arrive at the intersection at the same time, so that the possibility of such a catastrophe is highly unlikely, despite reports in the press every time that Icarus passes by.

Adonis, Apollo and Hermes also pass very close to the sun, their orbits having perihelia inside the orbit of Venus. However, they were recorded on only one instance and have never been seen since.

It should be mentioned here, that any one of these bodies, in passing by a major planet could suffer a collision. Should the collision take place in a populated area of the Earth, a catastrophe would occur, as these objects are from 1000 to 1500 yards in diameter and are travelling at a great rate. It must be remembered, though that the Earths surface is 75% water, and of the remaining 25%, man inhabits only 1%! An asteroid crashing in the sea would created quite a tidal wave, but man has lived thro through those before. One landing on solid ground would create quite a crater, but the odds of landing on a heavily populated area are 99 to 1 against!

EPHEMERIDES FOR THE OBSERVATION OF BRIGHTER ASTEROIDS IN 1971.

Pallas: See page 60 of the RASC Observers Handbook.
Vesta: " " " " " " "

Dates and Magnitudes at Opposition

Irene	Jan.18	10.1	Iris	Oct.16	10.6
Daphne	Mar.2	10.6	Flora	Nov.4	8.5
Iris	Mar.26	10.4	Pomona	Nov.16	10.2
Hebe	Apr.19	10.4	Urania	Nov.17	10.5
Antigone	May 15	10.3	Calliope	Nov.21	10.6
Eunomia	May 29	10.1	Cleopatra	Nov.25	10.1
Victoria	July 7	10.0	Clotho	Nov.28	10.2
Metis	Oct.16	9.3	Melpomene	Dec.19	9.4

Positions for locating these asteroids may be had by contacting the author. All should be visible in telescopes of moderate size.

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