

# ASTOUNDING

SCIENCE-FICTION

TITLE REGISTERED U. S. PATENT OFFICE

CONTENTS JULY, 1941

VOL. XXVII NO. 5

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Monthly publication issued by Street & Smith Publications, Incorporated, 79 Seventh Avenue, New York City. Allen L. Grammer, President; Henry W. Ralston, Vice President; Gerald H. Smith, Treasurer and Secretary. Copyright, 1941, in U. S. A. and Great Britain by Street & Smith Publications, Inc. Reentered as Second-class Matter, February 7, 1936, at the Post Office at New York, under Act of Congress of March 3, 1879. Subscriptions to Countries in Pan American Union, \$2.25 per year; elsewhere, \$2.75 per year. We cannot accept responsibility for unsolicited manuscripts or artwork. Any material submitted must include return postage.

Printed in the U. S. A.

STREET & SMITH PUBLICATIONS, INC. • 79 7th AVE., NEW YORK

OUT THIRD  
FRIDAY  
EACH MONTH  
Next Issue on  
Sale July 18th  
\$2 per Year  
20c per Copy

# VERMIN OF THE SKY

By R. S. Richardson

*How the asteroids get their names—and not the names of Greek and Roman gods and goddesses. They're named for pet dogs, girl friends, telescope donors, or anything handy!*

THE chief astronomer selected a plate from half a dozen on the drying rack and surveyed it with the gloomy look of those for whom life holds few surprises.

"These last night's plates?" he said to his assistant, busy at the other end of the darkroom with some reducer.

"Just came out of the wash a minute ago," the younger man replied.

The chief took a magnifying glass from his vest pocket and began to examine the star images in detail, systematically covering each square inch of the plate, and occasionally returning to check a suspicious object. One after another he subjected the plates to this searching scrutiny without apparently finding what he sought.

"No novae?" his assistant inquired.

The chief shook his head. "No novae. Nothing there but asteroid trails. Plates are fairly crawling with them." He thrust the magnifying glass back in his pocket. "Vermin! That's what we ought to call them. Vermin of the sky!"

The astronomical publications are silent as to how the estimated 50,000 asteroids circulating between the orbits of Mars and Jupiter came to be known among members of the profession as vermin of the sky. It is highly probable that they were christened by an irate astrophysicist during some such scene as the

above and the name has stuck ever since. But although they may look with scorn on the little asteroid trails that clutter up their photographs of the nebulae and star clusters, nevertheless there have been recent developments in minor planet research which in their appeal to the imagination challenge anything the astrophysicist has to offer.

Perhaps the most startling discovery is that asteroids are by no means confined to a narrow zone as formerly supposed but can come alarmingly close to the Earth. It will be recalled that for a long time Eros was considered the nearest neighbor of the Earth-Moon system, sometimes approaching within 14,000,000 miles. Its visits were heralded far in advance and widely publicized, because Eros made such a fine test body to use in checking up on the astronomical unit of distance. But now, like a star of the old silent motion pictures, Eros is almost forgotten amid a rush of glamorous newcomers.

THE FIRST of these was Amor which came within 10,000,000 miles of the Earth on March 22, 1932. This made quite a stir and astronomers congratulated themselves on having a new object to use in determining the solar parallax. But hardly had the record been established than it was broken by Apollo

that cut the distance down to 6,500,000 miles. The orbit of Apollo falls just a trifle inside the Earth's and the asteroid is large enough so that it could probably be detected in transit across the Sun's disk. This is noteworthy in that it shows how the observation of a small black body in front of the sun does not necessarily mean Vulcan has been discovered at last, as Apollo also goes out beyond the orbit of Mars.

Apollo's record lasted until 1936 when Adonis swept by at the uncomfortable distance of 1,300,000 miles. Then, before astronomers had a chance to recover their breath, another asteroid whizzed past that set what may be an all-time low. For on October 30, 1937 at twelve o'clock Greenwich Civil Time Hermes missed the Earth by only 485,000 miles. What is more, calculations show that under the most favorable circumstances it can approach within 220,000 miles, or about 1,500 miles closer than the Moon ever comes. This really means absolutely nothing for the elements of Hermes' orbit are so uncertain it could just as well be 220,000 inches as miles.

The diameter of Hermes was estimated at a mile and its mass at three billion tons. Astronomers are doubtful if a body of this size should be included among the asteroids and would better be classified as a meteor. The idea receives some credence from the fact that it came from the direction of the radiant point of the Taurid meteors. If actually a member of this swarm, it is the first case of a meteor being "seen" outside of the Earth's atmosphere.

There is no danger of a collision between Hermes and the Earth in the immediate future at least, for calculations carried forward into 1942 show that at no time will it

be closer than 100,000,000 miles. The accompanying diagram shows the positions of Hermes and the Earth before and after the near crack-up of October, 1937, and also three corresponding positions of the asteroid for 1941.

The discovery of bodies moving in orbits so close to the Earth has caused many staid and dignified stargazers to do some thinking along lines previously handled by writers for the Sunday magazine sections. For one cannot help wondering, if we know of two asteroids that may come closer than a million miles, how many others are flying about of which we know nothing? Is it possible that the great meteor crater of Arizona and the Siberian catastrophe of 1908 represent the effects of asteroids that didn't miss us? And what a thrill it would be to watch safely from the Earth while a big one piles into the Moon!

When an object such as Adonis or Hermes is discovered, the observer immediately wires its position to the Harvard College Observatory which acts as a clearing house for such information. Harvard, in turn, wires the position to all the principal observatories in the United States so that others may join in the hunt. At the same time, computers start work on a preliminary orbit based upon the discovery positions which will serve to locate the object temporarily. Much of this orbit work is done by advanced astronomy students as part of their regular training. Computing an orbit for the first time is a grueling ordeal that leaves the student pale and haggard and anxious to start in on another one. Speed comes quickly with practice and with good luck an expert can grind out an orbit in a few hours. Numerical computation has had a peculiar fascination

for some people, and once started on an orbit they will abandon everything else until it is complete to the last decimal point.

WHEN an asteroid has been observed for several months so that a reliable orbit has been determined sufficiently accurate to find it at later returns, the manuscript is—or was—sent to the Astronomisches Rechen-Institut in Berlin which by international agreement is the official keeper of the asteroids. If the hard-boiled staff of the

Rechen-Institut is convinced that your asteroid is really a new one, and your orbit is as good as you claim it is, they will give it a permanent number and see that it appears in each issue of the *Kleine Planeten* under whatever name you have chosen.

During all this time the asteroid has been designated by a temporary catalogue number such as 1937 UB, but now it is ready for a name of its own. Finding a suitable name no one has used before has gotten to be quite a job in itself. The original plan was to use feminine names taken from classic mythology. When these were exhausted astronomers turned to Shakespeare and the Wagnerian operas, but gradually more modern names began to appear—until now practically anything goes. How-

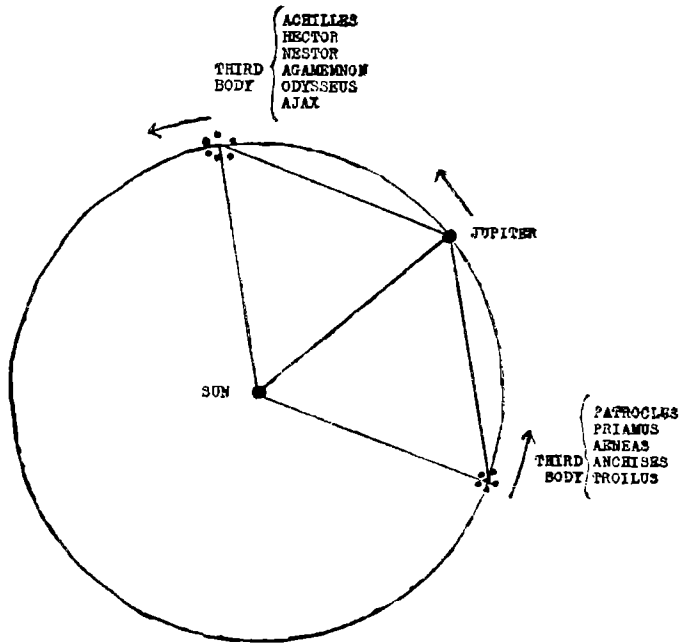


Fig. 1. One of the classical special solutions of the Three-Body Problem actually exists in nature. Each of the two groups of Trojan Planets forms, with Jupiter and the Sun, an equilateral triangle, resulting in an orbit that is predictable and perfectly stable for immense eras of time.

ever, the feminine form of the name is still retained by adding an *a* or *ia* at the end. The only male asteroids are at the extreme inner and outer fringes of the zone.

A large number of prominent astronomers are now named after asteroids instead of the old system of honoring them with a crater on the Moon. Running down the list in the *Kleine Planeten* for 1941 many are recognized at a glance. One finds *Watsonia* (729), *Schwarzchilda* (837), *Newcombia* (885), *Moultona* (993), *Lundmarka* (1334), *Leuschneria* (1361), and *Stromgrenia* (1422). The late Professor Barnard is represented by *Barnardiana* (819), while his wife is *Rhoda* (907). Some wealthy men also appear on the list, which looks suspiciously like a scheme to raise

money for new equipment. There is Carnegia (671), Rockefellia (904), Hooveria (932), and McDonaldia (991).

The highly eccentric asteroid Hidalgo was named after the Mexican hero in commemoration of the Hamburg eclipse expedition to Mexico in 1923. An admirer of the famous asteroid hunter, Dr. Palisia, named three of them for his most notable characteristics: Probitas (902), Perseverantia (975), and Hilaritas (996). Ekard (694) has no special significance until you happen to notice it is Drake spelled backward. Its orbit was computed by a student while attending Drake University in Iowa.

Names of friends and members of the family are naturally popular. Muschi (966) is the nickname of a certain German astronomer has for his wife. Mildred (878) was named after a daughter of Dr. Harlow Shapley, Director of the Harvard College Observatory; and Erida (718) is a daughter of Dr. A. O. Leuschner, formerly head of the Students' Observatory at the University of California.

Even favorite foods are on the list as shown by Limburgia (1383), and there is a musical instrument Piccolo (1366). The origin of many of the names is fairly obvious but some are rather puzzling. Thus whether Arnica (1100) refers to somebody's sweetheart or an external remedy for sprains and bruises, is not clear.

Every year the Greenwich Observatory publishes in the *Monthly Notices of the Royal Astronomical Society* a progress report on minor planets that reads like a combination of Vital Statistics and Personals in the daily paper. One learns, for example, that 188 asteroids were dis-

covered during the past year of which 171 are believed to be new. Members of the Society will be glad to hear that 1940 UQ has been identified with Alabaster, missing for the last six years. Following are asteroids whose orbits have been officially approved and admitted for publication in the *Kleine Planeten*. Below are those that have received names. They regret to announce that 37 asteroids have gotten lost.

An average of 210 asteroids have been discovered per year since 1930, the biggest haul coming in 1933 when 269 were reported. It is estimated that 50,000 are within range of the 100-inch reflector.

OUT ALONG the orbit of Jupiter are two groups of asteroids whose motion is one of the curiosities of the heavens. They are asteroids that are trapped in a gravity prison from which they are powerless to escape, held captive by invisible bonds from the Sun and Jupiter.

One group composed of six asteroids always precedes Jupiter in his orbit by sixty degrees; the second containing five members always follows Jupiter by sixty degrees. These asteroids are known as the Trojans, being named a bit ironically after heroes in the Trojan War. Clustered around the point preceding Jupiter are Achilles, Hector, Nestor, Agamemnon, Odysseus, and Ajax; while around the following point are Patroclus, Priamus, Aeneas, Anchises, and Troilus. Somebody blundered badly in assigning these names, for the Greeks should all be on one side of Jupiter and the Trojans on the other, instead of instituting what looks like a fifth-column movement with Hector in among the Greeks and Patroclus over in the Trojan camp.

It can be seen from the diagram that the two groups of Trojans together with the Sun and Jupiter form the corners of two gigantic equilateral triangles. They might well be called "eternal triangles" for it so happens that such a planetary configuration is dynamically stable; the tiny Trojans are locked forever in the embrace of the Sun and Jupiter. An observer in space looking down from directly above the Sun and keeping his face always turned toward Jupiter would see the system apparently at rest. This strange situation arises from the fact that the Trojan groups are acting out a particular answer to what is considered the toughest problem in theoretical astronomy. For they are playing the role of the "third body" in a famous theorem published by the great mathematician Lagrange in 1772.

Astronomers long ago had cracked the two-body problem. That is, if two planets are alone in space and their masses, velocities, and positions are known at any *one instant*, then their history is known for *all time*, past or future. But introduce a third body into the system and at once their motions become so involved that no one has ever been able to solve the problem in a practical form.

What Lagrange did was to show that there was one special case where the three-body problem could be completely solved—the case of an equilateral triangle formed by a tiny body and two massive ones. Under these circumstances the motion is permanent. At the time, Lagrange's theorem was regarded merely as an astronomical curiosity—beautiful to behold on paper but with little chance of being seen in the sky.

When Asteroid 588 was discovered

and its orbit determined, astronomers suddenly awoke to the fact that here was that special case of the three-body problem they had been looking for. An intensive search was made for similar asteroids with the result that another was found the following year and eleven are now known in all. The last to be discovered was Ajax in 1936.

Actually the Trojans are not fixed precisely at the two critical points on either side of Jupiter but are located at considerable distances from them. As they revolve about the Sun they swing ceaselessly back and forth past the point in space where the corner of the triangle falls. Thus the Trojans have a little freedom of motion—like prisoners pacing their cell to carry the analogy further.

Their only hope of rescue appears to be in the planet Saturn. While the motion of the triangles is permanent so far as Jupiter and the Sun are concerned, it is possible that the attraction of another body might cause a Trojan to approach so close to Jupiter that its motion would be radically altered, after which it would no longer be a Trojan. Since the age of the solar system is reckoned in thousands of millions of years, evidently Saturn has seldom been able to free a Trojan or otherwise none would be left by this time. And it is doubtful if Saturn can reverse the process and turn non-Trojans into Trojans.

A remarkable asteroid that may once have been a Trojan is Hidalgo (944). Any former Trojan would continue to move in an orbit that passes very close to Jupiter's. The orbit of Hidalgo passes near Jupiter's and extends far on outside the zone of asteroids to the orbit of Saturn. It is so elongated one can-

not help wondering if Hidalgo might also have been a comet with a large nuclei that for some reason ran out of gas, rather than a true asteroid.

There is one other possibility that might conceivably result in escape for a Trojan. With half a dozen asteroids oscillating about the same point in space a collision could occur. The prospect is pretty slim, however, for the length of the swings is of the order of 100,000,000 miles and are made in different directions. Also the asteroids reach the end of their swings at different times although their periods are all nearly equal.

THE DISCOVERY of the Sun-Jupiter-Trojan system raises the question of whether other such systems may exist; for example, an Earth-Moon-asteroid system. A tiny satellite of this type would be moving along the Moon's orbit sixty degrees behind or ahead of Luna. It might have escaped detection owing to extreme faintness or simply because nobody is on the lookout for such an object. Even if accidentally photographed it might not be recognized as a satellite, for since it would be moving among the stars with the same speed as the Moon, it would leave a bright streak across the plate which would naturally be taken for a meteor trail.

The discovery of two new moons of Jupiter in 1938 has aroused interest in the old idea that they may be captured asteroids. There are two schools of thought on the origin of the satellites. According to one, the planets are pictured as the benign parents of the satellites, presiding over their family with tender solicitude. The other regards them as ruthless dictators sweeping through space and gathering up any unfortunate asteroids that happen to fall into their clutches.

Although it might seem easy to imagine conditions whereby an asteroid would become a satellite, it is doubtful if Jupiter could turn the trick *alone*. If he could have the aid of Saturn or a resisting medium, or if he could sneak up on an asteroid without making his presence known in advance, he might be able to pull it off. In general it would seem that conditions are rarely favorable to effect a capture.

The converse case of the escape of a satellite from its primary is equally difficult. At times Jupiter VIII, IX, and XI are attracted by the Sun almost as much as by Jupiter and come perilously close to the limit of escape. They revolve in orbits so large that even the Jovians would need a six-inch telescope to see them. Jupiter VIII almost got away in 1913 when it was hovering on the brink for a while. It has been suggested that an asteroid might lead a double life, spending part of its time as a satellite and the remainder revolving around the Sun in an orbit of its own.

The writer has discussed the matter with the discoverer of Jupiter IX, X, and XI, and found him loath to admit any of his satellites are former asteroids or that they are likely to stray beyond Jupiter's control. On the whole, the experts seem to be of the opinion that the satellites were born of the planets and thus have been satellites throughout their entire existence. In other words, once a moon always a moon.

IN CONTRAST to the Trojans and satellites held in check on a short leash, the wildest asteroid of the 1500 is undoubtedly Andromache (175). Only within the last few years has she been brought under control after refusing to abide by the rules laid

down for her ever since she was discovered in 1877. The trouble has been that Andromache goes around the Sun in almost exactly half of Jupiter's period which places her right on the edge of one of the gaps or "forbidden" zones in the asteroid belt. An asteroid with a period of one half, one third, et cetera, of Jupiter's is regularly subjected to his powerful attraction which tends to force it out of the region. Fortunately Andromache is one of the asteroids discovered by Watson who left a fund to be used in keeping track of them. Without this endowment she would have been lost long ago.

As if the natural difficulties of following Andromache were not enough, man-made obstacles have kept arising. Right at the start Watson's telegram was lost preventing other astronomers from securing observations so necessary for an accurate orbit. This meant that the orbit had to be based entirely on

Watson's own positions some of which were later found to be wrong. It happened that two other asteroids were also discovered at the same time both of which were numbered 175 which led to more confusion. In the resulting mix-up, Andromache was lost into the daylight and for sixteen years was gone without a trace. One search ephemeris after another was computed but failed to locate the planet. Watson thought the attractions of the major planets were responsible and calculated perturbations until his death but never saw Andromache again.

Then she was accidentally picked up as 1893 Z and identified as Andromache by the similarity of the two orbits. From then on it developed into a battle between the theoretical astronomers and Andromache with no quarter asked on either side. Strong-arm mathematical methods that had worked on other unruly asteroids were tried and found wanting. As year after year went by

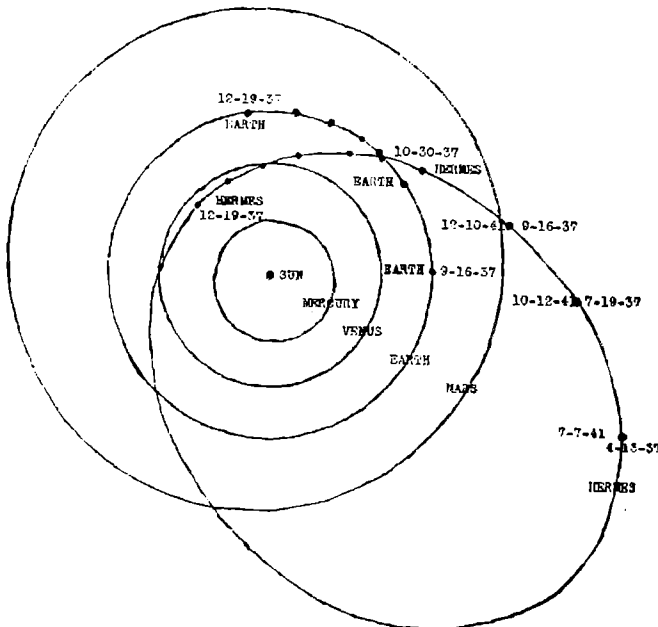


Fig. 2. The orbit of the asteroid Hermes, one of the planetoids that pass close to the Earth. Its closest passage in 1937 was not observed as the body was discovered too late.



Andromache gradually came to have the distinction of being the chief factor in the development of one of the most awful subjects known to man, the numerical computation of the general perturbations of the planets. Finally by devising a new scheme of allowing for the disturbing effects of Jupiter, Andromache was brought into line. Astronomers now feel they can predict her position with all the necessary degree of accuracy for years to come and so have given up the chase.

But some lingering doubts still remain. At a sort of a farewell address given at the close of thirty-five years of investigation, the director concluded with the remarks: "We shall now part from Andromache and once more give her the freedom she has craved ever since she was made a captive after the fall of Troy. But this freedom is given with the distinct reservation that she will permit astronomers to account for whatever minor whims she may indulge in hereafter."

ONE of the saddest features about being a purely theoretical research man is the virtual certainty that any explanation of natural phenomena he may propose will ultimately be found wrong. Regardless of the prestige his theory commands today, a century later will find it on the junk pile. And nothing is deader than a scientific theory once its usefulness is over. They never come back.

Readers of science fiction should be agreeably surprised, therefore, to hear that the spectacular old explosion hypothesis of the origin of the asteroids is again in favor after almost being abandoned entirely. Advanced by Olbers shortly after his discovery of Pallas in 1802, it

was at first highly successful not only in explaining the known facts but in predicting others as well. If the asteroids are fragments of a planet, they should move in orbits that intersect at the point of explosion, and the first few discovered seemed to do this. When later, others were found that did not, the theory was in no way weakened, for it was pointed out that in the course of thousands of centuries the attraction of the major planets would have obliterated all traces of a common meeting place. Many asteroids were found to vary in brightness which would be expected of the shattered remains of a planet. Some like Eros are thought to consist of several pieces almost in contact revolving around their center of gravity.

The explosion theory was dealt a hard blow by Simon Newcomb when he traced back the various changes the orbits had undergone in the course of ages in the hope of finding a point of intersection. He developed formulae which he believed capable of setting the time of the explosion almost to the day. But much to his disappointment there was no evidence that a point of intersection had ever existed and the theory gradually lost ground after that.

The results of the latest investigation, however, now make it seem practically certain that some of the asteroids originated from a single mass. An enthusiastic Japanese asteroid worker, K. Hirayama, has shown that three so-called invariable elements exist impervious to the disturbing effects of Jupiter. They must be determined through an elaborate mathematical analysis, but once brought to light, the agreement among the orbits is revealed in a striking manner. Five families have

been found named after the most prominent member, the largest being the Flora family of 57 asteroids. It seems incredible that all 57 could have orbits practically identical in three respects purely as the result of chance. The existence of several families indicates that not one-but a series of explosions occurred.

MODERN SCIENCE has also partially removed one of the most awkward proponents of the theory faced in the old days. This was trying to think of a convincing reason why a solid planet should have occasion to blow up in the first place. They spoke vaguely of disruption by tidal action, of instability caused by excessive speed of rotation, and of violent chemical reactions. But as a rule this part was treated in a rather sketchy fashion.

The discovery of radioactive substances in the Earth's crust has provided an entirely new source of internal energy. As the theory stands today, the original asteroid was a body having a mass about two-thousandths of the mass of the Earth, roughly corresponding to the satellite Titan. To produce an explosion, it is necessary to assume a strongly radioactive core and a thick nearly non-radioactive crust—a world containing within itself the seed of its own destruction. Presumably the pressure was relieved at intervals by blowing off part of the outer layers.

Another theory of the origin of the asteroids which has been streamlined recently explains them as the debris from a huge comet captured by Jupiter and made to revolve around the Sun in a nearly circular orbit. As it disintegrated, its path became strewn with the fragments

that we now call the asteroids.

There is a much closer resemblance between comets and asteroids than is generally supposed. Frequently an astronomer upon discovery of a new body is unable to determine what it is and refers to it as an "object." Comets are popularly considered to be glowing masses of gas with a long tail streaming out behind, but most of them consist of nothing but a starlike nucleus surrounded by a faint nebulosity. What is more astonishing, several well-known asteroids have been reported enveloped in nebulosity. An experienced comet and meteor observer, J. Comas Sola of Barcelona, has photographed nebulosity around both Oceana (224) and Elsa (182), and Jocasta (899) has twice been photographed with a halo. Nor can an elongated orbit be considered decisive proof of a comet, as shown by the case of Hidalgo (944), previously mentioned. On the other hand, Comet Schwassmann-Wachmann moves in a nearly circular orbit and might be regarded as an asteroid of faint nebulosity.

Once a member of the solar system the comet would soon be broken up, as many have been seen to do in the past. The insignificant mass of the average comet is not a fatal objection, as the great comet 1882 II had a mass estimated at a thousandth of the Earth's which is certainly more than all the asteroids combined, discovered and undiscovered.

Although the theory gives a tolerably plausible explanation for the asteroids, it fails completely to answer another equally puzzling question.

Where did the comet come from?