Galaxy

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ASTEROID ROUNDUP

By Willy Ley

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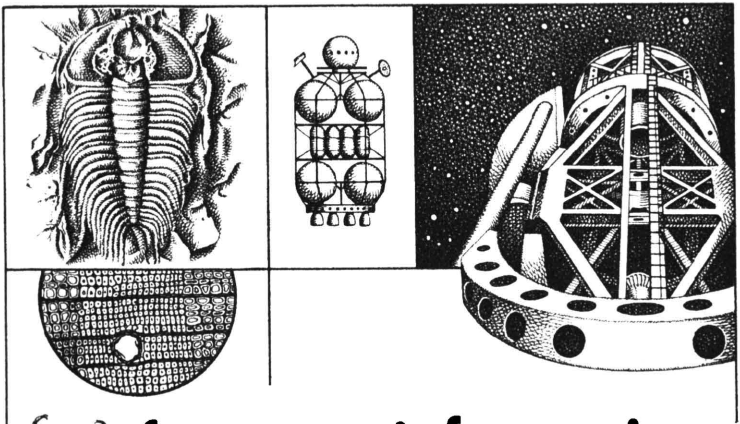
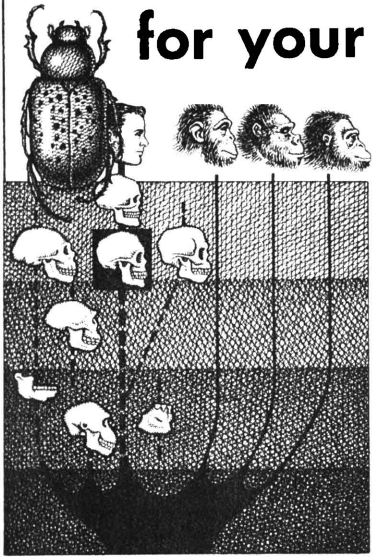


for your information

By WILLY LEY



ASTEROID ROUNDUP

THIS year marks the 60th anniversary of an important astronomical discovery which, however, did not then take place. Now this might sound confusing, so let me rephrase it by saying that 60 years have gone by since an important astronomical discovery could have been made. If that is still not quite clear, it has to be said more bluntly by stating that Harvard

College Observatory missed something important 60 years ago. Two years later, the astronomers at Arequipa, Peru, missed the same chance of amassing some fame. They both photographed Planetoid No. 433 and did not realize what it was that showed on their plates.

Of course, it is conceivable that they may have been somewhat tired of planetoids (or asteroids) by that time. The first one of that swarm of diminutive planets between the orbits of Mars and Jupiter had shown up during the night preceding January 1, 1801. Professor Giuseppe Piazzi, trying to correct a typographical error in a recently published catalogue of fixed stars, had noticed a faint star where there should be none at all. Further observation and a calculation of the orbit by Karl Friedrich Gauss established that it was not a comet, as suspected at first, but a small planet.

It was named Ceres and we now know that it is the largest member of the Asteroid Belt, with a diameter of 480 miles.

IN the late evening hours of March 18, 1802, an amateur astronomer, Wilhelm Matthaus Olbers, M.D. of Bremen, found a second such planet while on the lookout for comets. It was called Pallas and turned out to be the second largest, with a diameter of just a trifle over 300 miles. The same Dr. Olbers discovered one more, Vesta, in 1807, but Vesta was already No. 4, for Harding had found No. 3, Juno, in 1804.

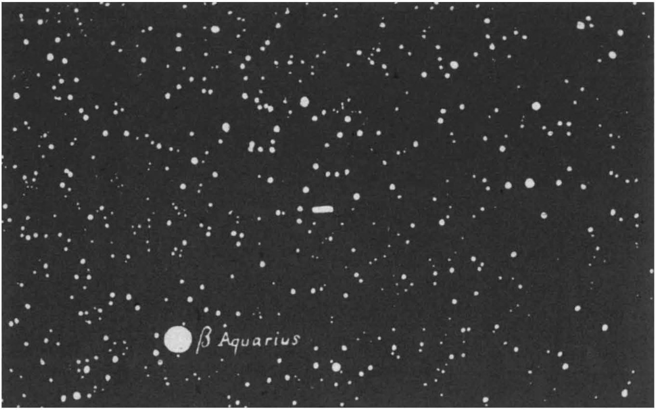
I haven't been able to discover yet just why Dr. Olbers—indubitably the expert in this field, with two discoveries out of a total of four—believed and convinced others that there were only four planetoids. Almost a score of years passed until somebody decided to see whether there mightn't be more.

This skeptical character was, like Dr. Olbers, an amateur, one Mr. M. Hencke of Driesen in Germany. After fifteen years of search, he was able to announce the discovery of No. 5, Astraea, thirty-eight years after the discovery of No. 4, Vesta. Two years later, Mr. Hencke informed the world that he had found No. 6, Hebe.

Then others went to work. When the 50th anniversary of the discovery of Ceres came around, No. 14, named Irene, had just been identified.

So far, the joy of discovery had not been tarnished, but then it began to be dimmed by sheer numbers. In 1870, the number of known and named planetoids had grown to 110. In 1890, it had increased to 300.

It was then that a Dr. Isaac



Part of photographic plate taken in August, 1898, at Urania Observatory in Berlin, which led to discovery of Eros.

Roberts made a fateful suggestion. One could keep track of these little bodies best by means of the photographic plate, he said. Astronomers previously had checked the actual appearance of the sky, along the band where the planetoids had to be, against star maps. Anything that showed in the telescope but could not be found on the chart had to be either a comet or a planetoid. It would be simpler, Dr. Roberts said, to photograph these areas, following the apparent movement of the fixed stars with the instrument. The stars would then show up as points, while things that moved—comets and planetoids—would show as short lines.

Professor Max Wolf of Heidelberg was the first to adopt this suggestion. The results were simply disastrous. Yes, you could check on known planetoids in that manner—but you could not avoid discovering dozens of new ones at the same time.

WITHIN the four years from 1891 to 1895, no less than 107 new asteroids were discovered! At the turn of the century, the total number was 559, of which 452 had been numbered and named! Professor Wolf and his assistants had added more than a hundred to the 300 known in 1890, Prof. Charlois of Nice had added around 95, and Prof. Palisa of Vienna 83! C. H. F. Peters had found 52 or 53 and many others could boast half a dozen.

Naturally, there were countless duplications. The job of identifying the short lines on countless plates alone assumed almost superhuman proportions.

A rather fast-growing group of astronomers decided that all this was more or less wasted effort and skipped reports on *Kleine Planeten* when reading their professional journals. Others decided that it was more important to keep track of the lower-numbered and larger planetoids and let others worry about identification and establishment of their new discoveries. (A few resolutely decided to study the Sun instead.) And in this general atmosphere of "too much news," there came the evening of August 13, 1898.

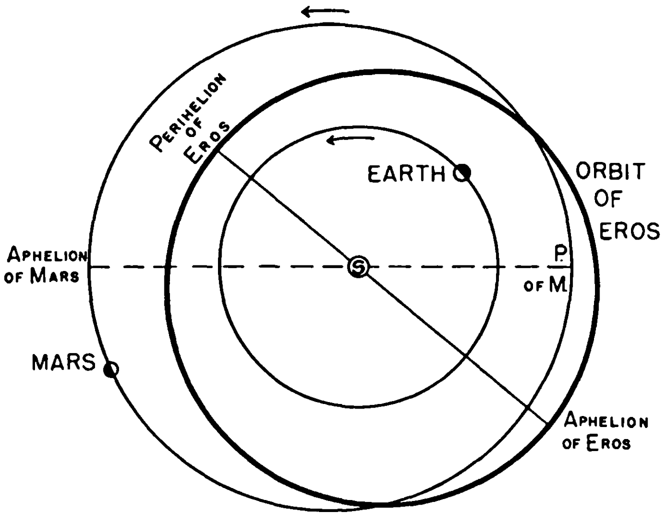
The place was the Urania Observatory in Berlin. It had been planned to be "quite some distance" from the city so that the work of the astronomers should not be hampered by city lights. But by 1898, the city was already encroaching on it. By the time of the First World War, when I was old enough to pay attention to such things, the Urania Observatory was deep inside the city and was used for instruction and popular lectures only.

In 1898, the Urania Observatory boasted the biggest telescope —a 12-incher—in all Prussia and the chief astronomer, Dr. G. Witt, had installed some photographic equipment. He must have been short of funds, for the little box that housed the small electric lamp illuminating the spider-web crosshairs had been made by the scientific staff out of a cigar box.

A more serious worry of Dr. Witt was that he did not trust the clockwork mechanism that guided the telescope. This can be corrected manually if somebody sees to it that a fixed star, picked for the purpose, does not leave its assigned place in the field of an auxiliary instrument. This job was done by a young student by the name of Felix Linke.

Linke told me later that there happened to be a heat wave at the time and that they were happy if there was a reason to go to the darkroom, which was the coolest place in the whole observatory, but that the word "cool" applied only by comparison with the rest.

THE program decided upon by Dr. Witt for the night of August 13 to 14 was to track down No. 185, Eunike. Eunike had not been seen for years. But if the old orbit calculation still held



Orbits of Earth, Eros and Mars. Earth passes line from perihelion of Eros to Sun late January every year, some three weeks after passing its own perihelion.

true, Eunike should be in the general vicinity of the fixed star *beta* of the constellation Aquarius.

The photographic instrument was pointed in the proper direction and Linke held it as steady as he could for two hours. Then Dr. Witt and his helper rushed the new plate to the "cool" darkroom and, after it had been racked up to dry, they went home to get as much sleep as the heat would permit. Next day, they went over the plate with a magnifying glass, looking for planetoid tracks.

Eunike was where she was supposed to be, or very nearly so. Another known planetoid had also left its visiting card. But near the star *beta Aquarii,* there was another track of unusual length, measuring 0.4 millimeters on the original plate. Dr. Witt thought at first that this was no track at all, but a flaw in the plate. Then he decided that it was a genuine track and, because of its unusual length, it had to be made by a fast-moving body. It could still be a comet, however.

In the evening, the 12-incher went into action for direct observation. The tiny "star" that had made the track the night before could be clearly seen. It was not a comet. Hence it had to be another new planetoid.

The customary wires to other observatories were sent and quite a lot of observations accumulated during the next six days. Then Dr. Berberich, the chief of the Computing Institute, which had been founded especially for keeping track of the minor planets, retired with all the observations of *Object* 1898 *DQ* and began to compute its orbit.

It turned out to be the most unusual orbit of any planetoid thus far. Most of it was between the orbits and Earth and Mars. And its *mean* distance from the Sun was smaller than that of any other.

It was for these reasons that Dr. Witt insisted that 1898 DQ, or planetoid No. 433, should be given a name which, by itself, emphasized that it was a special case. Starting with Ceres, Pallas, Juno and Vesta, all planetoids had been given female names, preferably classical. The new one was to receive a male name.

Dr. Witt selected Eros.

The orbit computed by Dr. Berberich showed that the point closest to the Sun, the perihelion, is only 1.13 astronomical units from the Sun. The point of Earth's orbit closest to the perihelion of Eros is passed by Earth every January 22nd. If it happened that Eros passed its perihelion on that date, or close to it, the distance Earth-to-Eros would be a mere 14 million miles.

This was considerably closer than anything else known at that time (not counting the Moon) because the closest Venus can come is 20 million miles and the closest approach of Mars about 35 million miles.

AT the time of the actual discovery by Dr. Witt, Eros had been near its aphelion and the question was—how long one would have to wait to get a close look?

Eros needed 643 days to go from perihelion to perihelion. It followed that Eros and Earth would be in the same direction, as seen from the Sun, approximately every two years and four months.

But, as a look at the diagram shows, this still implies greatly varying distances. When had Eros been at its perihelion, on or about January 22nd, any year? The answer was disappointing: it had been in January 1894, four and a half years before it was discovered.

When that date was established, a search of old plates was made and it turned out that Harvard College Observatory had Eros on *seventeen* plates exposed at that time. And Arequipa had photographed it four times in 1896.

The next really close approach of Eros, was not due until 1931. Then there was to be one almost as good in 1938, but for another one as good as the missed one in 1894, one must wait until Eros has completed 46 of its revolutions. This means 81 years, so that Eros will be a minimum distance again in 1975.

But in the meantime, astronomers have put Eros to good use even with somewhat inferior oppositions. The elementary and fundamental yardstick in astronomy is the "astronomical unit"—the distance of Earth from the Sun. By observing Eros, the value of this yardstick has been considerably refined. And as Eros comes inward in the Solar System, it is, of course, being acted on by the gravitational fields of all the inner planets. This fact can be utilized to determine the masses of the inner planets.

In the case of Venus, for example, the mass had to be derived in part from the influence of Venus on Mars. It was, to quote Dr. Paul Herget, one of the paradoxes of astronomy where "we photograph Mars to see how much Venus weighs." Photographing Eros for the same purpose gives better figures. Drs. Eugene Rabe and Gustav Stracke engaged in an elaborate and tedious investigation of the behavior of Eros to establish the masses of the two planets inside the orbit of Earth.

AT this point, somebody is likely to ask about the mass of Eros itself. Well, that's not so simple. The best we can say is that Eros, if dumped on Earth without shattering, would merely become our highest mountain.

Eros rotates around its axis and, while doing so, its brightness changes. This leads to the suspicion that it is not spherical, but of irregular shape.

In 1937, several astronomers published their observations and the conclusion they drew was that Eros might have a shape like a poorly formed brick. Assuming a density of 1.63 times that of water, they calculated that the longest axis of this "brick" was 21.5 miles and that the two shorter axes measured 13.0 and 10.1 miles. The shortest axis is the axis of rotation and the period of rotation was given as five hours and 16 minutes.

All this is still subject to correction and the figures may change somewhat, but it can be taken for granted that Eros has an irregular shape that would be impossible for a body of much larger size. It is very simply a huge mountain circling the Sun.

I may add here that its co-discoverer, Linke, has offered the suggestion that Eros may not be a single body, but several small ones rotating around their common center of gravity. It's possible, but not established.

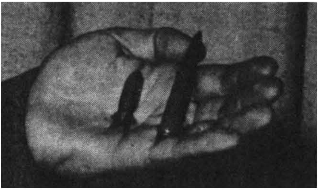
At any event, planetoid No. 433 constitutes one of the strangest and most intriguing astronomical discoveries ever made.

THE SMALLEST "BOMB"

NO weapon, it seems, ever becomes completely and permanently obsolete.

Muzzle-loading cannon, for instance, had almost become proverbial as something thoroughly out of date, useless and very nearly laughable—but then somebody invented the trench mortar and a whole family of muzzle-loading "trench artillery" sprang up during the First World War.

The war rocket was "obsolete" for nearly a century, too — so much so, in fact, that most people didn't even know there had been war rockets once. But then, as you well remember, designers replaced the old and hazardous blackpowder propelling charge with a reliable stick of smoke-



Photograph of "Lazy Dog" anti-personnel (non-explosive) missile. Cartridge next to it is regulation .30 rifle cartridge.
(Official photograph U.S. Air Force)

less power—and the war rocket was back in many different versions and in great quantities.

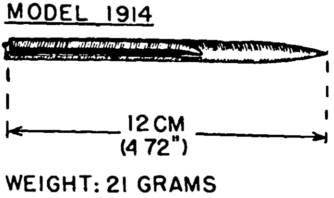
The age of the airplane and the blimp looked back on the free balloon as something of the past —especially the free balloon made of paper, like the earliest attempts of the brothers Montgolfier — but then the Japanese recalled the existence of a fast air current moving east over the Pacific Ocean and long-range bombing balloons were made, *many of them of paper!*

As a historic oddity, I might add that even the old fire-arrow staged a small comeback in the Second World War. During the fight for the Italian colonies in East Africa, the Italians quartered their troops in native-built grass huts. Other African natives, under British command, sneaked through the underbrush with bows and fire-arrows and promptly shot them aflame!

All of which is an introduction to the latest weapon of the U. S. Air Force, the "Lazy Dog." It is just a small piece of steel, weighing less than an ounce, and not much over an inch in length. Being finned like a miniature bomb, the Lazy Dog, shoveled overboard from an airplane, will point its nose down and pierce a target like a rifle bullet fired vertically downward. Being solid metal, it won't explode, but it will make holes in tires, gasoline drums and people. Its impact velocity will probably be high enough to go through the top of a car.

A novel idea? Well, no. The French invented it forty years ago, when airplanes were as wobbly as they looked and could carry some 15 or 20 lbs. of payload in addition to the pilot, whose ideal personal build was that of a jockey.

The French "anti-personnel missile," as it would be called now, still lacked aerodynamical refinement and had a shape that justified its name of "airplane arrow." It was eight millimeters (5/16 of an inch) in diameter and weighed 3/4 of an ounce.



"Airplane arrow" as used in Europe during early months of World War I.

The French must have prepared this weapon some time in advance of the First World War, because they used it in their earliest attacks against German ground troops.

Of course it took only weeks until the Germans imitated the weapon. Somebody with precise notions of legality — or a nasty sense of humor—ordered that one of the fins carry an inscription reading *Inv franc Fab allem.* This was not code, but an abbreviation of *Invention francaise Fabrication allemande*—"French invention of German manufacture."

As soon as ground troops on both sides learned to take proper cover — under a car, for example —the use of the airplane arrow was discontinued.

ANY QUESTIONS?

Today I came across a statement in an article by Arthur C. Clarke which I do not quite understand. He says in speaking of weight and inertia that it would be "six times easier to pick up a sledgehammer on the Moon, but *just as hard to swing it." Would you explain this, please?*

Jean De Grazia
597 Hopkins St.
Sewickley, Penna.

This example is intended to illustrate that we, existing under the constant and unvarying pull of Earth's gravity, have come to forget that there is a difference between weight and inertia. To us, a certain weight seems to go with a certain amount of inertia, but actually the two are not the same, which we would realize quickly if we were subjected to a gravitational field of a different strength.

Let's try to approach the problem from another angle. Six pounds of steak have, as anyone knows, a certain amount of food value. They will provide, say, a meal for six hungry people. On the Moon, the same amount of steak would weigh only one pound — but it would still be a meal for six. It is easy to realize, from this example, that we have fallen into the habit of associating a certain number of calories with a certain weight.

Now consider the problem of the sledgehammer. If you pick it up on Earth, you work against Earth's gravity and you have to lift, say, twelve pounds. If you lift the same sledgehammer on the Moon, against the lesser lunar gravity, you have to lift what to early muscles feels like two pounds. But if you swing it, on Earth or on the Moon, you have to accelerate its *mass*. That would be the same in either case, since accelerating the same mass needs the same force regardless of the gravity present.

Are there any other materials besides lead and concrete that are used for radiation shielding? If so, what radiations (meaning alpha, beta or gamma rays and neutrons) do they stop?

James Reeve
7005—5th Avenue
Los Angeles 43, Calif.

The materials most used in atomic laboratories and power plants are, as you say, concrete and lead. Concrete shielding is customary for permanent installations, while lead, in the form of bricks, is used for temporary setups.

Actually, any kind of matter could be used for shielding against any kind of radiations. It is merely a question of volume. Slabs of slate may not be a good shield, but a mountain of slate is. A fishtank full of water is poor protection, but a large lake is a different story.

The reasons for using concrete or lead are, therefore,

purely practical reasons. Concrete is needed in large quantities, but it is both cheap and available. Lead is used because of its high density, so that the v o l u m e (though not the weight) of matter to be moved around is comparatively small.

Would you please advise me about the following concept: Assume that the Earth is the only body in space. I contend that it would then be impossible for any rocket to escape from the Earth. Inasmuch as the gravitational field of the Earth extends to infinity and the speed of the rocket must be finite, it would always fall back sooner or later because the pull of the Earth will continually subtract velocity from the rocket. Right or wrong?

David Richardson
1803 *Rhodes St.*
Madison, Illinois

Wrong. But this is one of the so-called "instructive errors" that deserve discussion and clarification.

To begin with, the assumption that the Earth is the only body in space is not necessary. Even as things are, the gravitational field of the Earth extends theoretically to infinity. But it grows weaker all the time with distance and the requirement is simply that the kinetic energy of the moving (and no longer burning) rocket is greater than the force of the gravitational field at any point along its trajectory.

To explain this statement, let's look at the motion of a body falling toward Earth from infinity. At a distance of 100,000 miles from the surface, this body will have a certain velocity. At the distance of 10,000 miles, it will have a certain and obviously higher velocity. At the distance of 1,000 miles, it will have a still higher velocity. And it will have the highest velocity it can ever have at the moment of impact.

If a rocket going the other way is to reach infinity, it must have a velocity that is somewhat (only very slightly) higher than the corresponding velocities of the falling body. The impact velocity would be just a shade below seven miles per second.

Hence if the rocket near the surface of the Earth reached seven miles per second, it would go to infinity, for it would, at all points along the trajectory, have a velocity slightly higher than that of the falling body.

Earth's gravitational pull would eventually slow it down —after a sufficiently long time, the motion might be as little as three inches per century! But

Earth's gravitational pull could never bring it to a standstill.

For this reason, this velocity of seven miles per second has been named "escaped velocity" by rocket men. Astronomers still use the older but equivalent term of "parabolic velocity."

Might not differences in electric potential be one of the hazards of space travel? A body leaving Earth at zero potential (relative to the Earth) might find that other planetary bodies have electric potentials higher or lower than Terra.

H. Sheppard
24 Chatterton Blvd.
West Hill, Ontario

This question has come up in space travel discussions for some time, but unfortunately there is no satisfactory answer. The main question is, of course, whether the electric potential of another planet—for example, Mars — is actually different from that of Earth. We don't know and physicists have no way at present, short of an actual visit, to decide this question. The attitude of engineers is somewhat more positive. They feel that if such differences exist, they'll do something about it.

Dr. Wernher von Braun stated flatly: "This cannot be considered a hazard to space travel at all. The capacity of a space vehicle entering the atmosphere of another planet is extremely small and the number of coulombs which must travel into the ship or out of it to make its electric potential equal to that of the surrounding environment is very small. Any brush discharger can easily take care of this."

A slightly different situation would exist if the target planet happens to be without (or virtually without) an atmosphere, as, for instance, the Moon. At first glance, it might seem as if the ship, with its possibly different potential, would make contact suddenly. But on an airless planet, the ship would have to land with rocket motors working, balancing down on an exhaust blast. Since this blast consists of partly ionized gases, it would automatically perform the job of a "grounding" cable.

To sum up: We don't know whether this "hazard" actually exists, but we have every reason to believe that, if it does, it won't be a hazard at all.

—WILLY LEY