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CLOSEUP OF MARS
By Willy Ley

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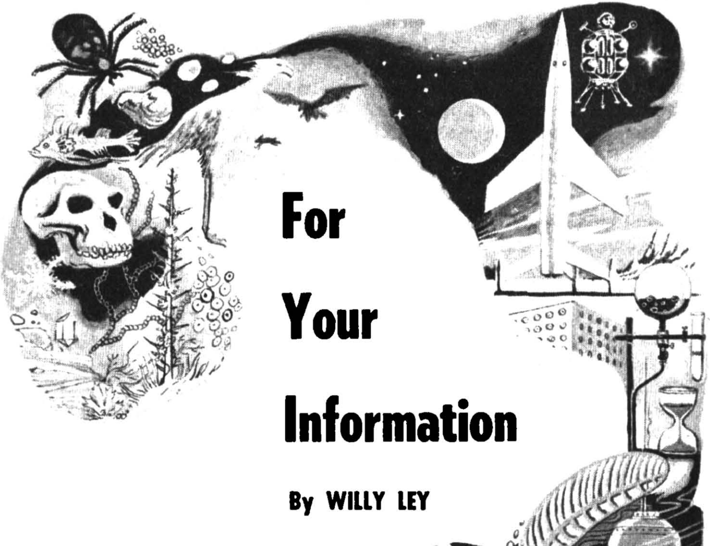
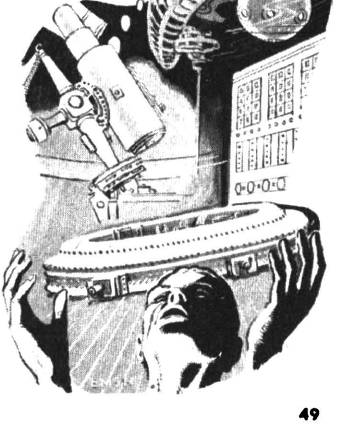


For Your Information

By WILLY LEY



CLOSEUP OF MARS

THE science news releases you'll find in the daily papers by the time this issue appears on the newsstands will probably say that Mars can be seen as a brilliant red object in the constellation Sagittarius, the Archer. I have a suspicion that it will work the other way round for most people—they'll see a conspicuous bright reddish star in the southern sky and, having read the news releases, will conclude that the other stars around it must be the constellation of Sagittarius.

This is one of the years when Mars is in "opposition," which simply means that it finds itself along a line drawn from the Sun through the Earth.

Astronomers are ready for the event. Every observatory has alloted telescope time to Mars during those four weeks from the middle of June to the middle of July. The National Geographic Society, in combination with the Lowell Observatory of Flagstaff, Arizona, has sent a team of astronomers to Bloemfontein in South Africa to obtain a coordinated photographic study from a point in the southern hemisphere. The planet will be photographed from high-flying aircraft and there has even been some hopeful talk about expending a high-altitude research missile or two.

ACTUALLY, an opposition of Mars is not precisely a rare event. Since the Earth needs 365¼ days to go around the Sun once and Mars needs 687 days to do the same, the two planets must pass each other, with the faster Earth overtaking the slower Mars at regular intervals.

What this interval must be is comparatively easy to calculate. The Earth, as seen from the Sun, moves through just about one degree of arc per day, since a full circle has 360 degrees. The exact figure for the movement of the Earth is 59 minutes and 48.2 seconds of arc. The planet Mars, also as seen from the Sun, moves about half a degree of arc per day, the exact figure being 31 minutes and 26.5 seconds of arc.

If we express this average movement in seconds of arc, the Earth covers 3548.2 per day and Mars 1886.5 per (Earth) day. The Earth, therefore, gains 1661.7 seconds of arc per day.

With this figure available, the question "when will the Earth catch up with Mars again" becomes a simple division. There are 360 times 60 times 60 seconds of arc in a full circle; dividing this by the daily gain of 1661.7, we obtain 779.92 days or 2 years and 49.42 days. Therefore, there is an opposition of Mars every 2 years and 50 days.

Well, then, if that is the case, why is there so much shouting about this opposition of 1954 and the one to come in 1956? The answer, so to speak, is that all girls are not equally pretty and one loaf of bread is not necessarily as good as another. The oppositions differ in quality because the orbit of Mars is a

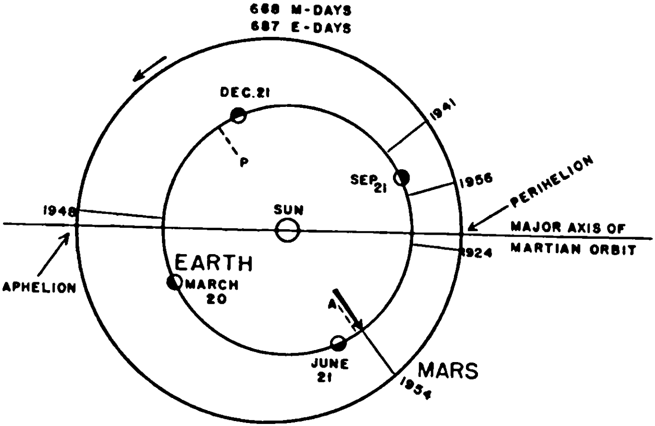


Diagram of the orbits of Earth and Mars, showing the recurring positions of the Earth at the change of the seasons. Perihelion and aphelion of Earth are indicated by the letters P and A at broken lines. The arrow points to the position of this year's opposition. A number of other oppositions are indicated by the dated lines connecting the orbits of the two planets. Some of the minimum distances during past oppositions were: 1924 (Aug. 24) 34,637,000 miles; 1941 (Oct. 10) 38,500,000; 1948 (Feb. 18) 63,000,000 miles.

rather pronounced ellipse.

At the point of its orbit closest to the Sun—the perihelion—the distance Sun-Mars is 128 million miles. At the point of its orbit farthest from the Sun—the aphelion—the distance Sun-Mars measures 155 million miles. Since the orbit of the Earth is far more circular, there is obviously a difference between an opposition occurring when Mars is at, or near, its perihelion and an opposition that occurs when Mars is near its aphelion. The opposition of 1924 was almost precisely a "perihelion opposition" while the one of 1948 was very nearly an "aphelion opposition."

Now the orbit of the Earth is not circular, either. When Earth is at its perihelion, the distance to the Sun is 91,341,000 miles. When Earth is at aphelion, the distance is 94,450,000 miles, a difference of slightly over three million miles. For the sake of getting a good look at Mars, one could only wish that Earth's aphelion were in the same direction from the Sun as the perihelion of Mars. To some extent, this is really the case. At least the Earth is still on that portion of its orbit which is farther from the Sun than average when it passes the perihelion of Mars.

This year's opposition, incidentally, will take place almost when Earth is at aphelion, although Mars is still a long way from its perihelion. The distance between the two planets is going to be about 40,300,000 miles. At the next opposition, on September 11, 1956, the distance will be about the shortest it can be, namely 35,400,000 miles.

THOUGH a perihelion opposition is obviously "better" than an aphelion opposition, astronomers do not neglect the latter by any means. In addition to what might be called general principles, there are two good specific reasons. One is that, to observatories in the northern hemisphere of the Earth, Mars is higher up in the sky when Earth is near its perihelion. This also explains the value of the team working at Bloemfontein this year. The other is connected with the position of the Martian axis of rotation.

Like that of the Earth, the axis of Mars does not stand vertically on the plane of its orbit. In the case of our own planet, there is the well-known inclination of 23° 27′. The figure for Mars reads very much alike—24° 52′.

But while the Earth's axis, at aphelion, is inclined *toward* the Sun, so that our North Polar regions have summer at that time, the axis of Mars, near Martian perihelion, is inclined *away* from the Sun. The two axes may be said to form a V and at a perihelion opposition, the Martian *South* Pole is in the light of the Sun, has summer, and is visible to us. The Martian North Pole is in darkness and we can't see it at all.

Obviously, then, our only chance to observe the Martian North Polar regions is when Mars is at the other side of its orbit—that is, during an aphelion opposition. Naturally the position of Mars' axis varies as little as ours; it always points to the same spot in space in the course of a Martian year. It so happens that there is no conspicuous star near either of the celestial poles of Mars. The "Martians," therefore, have neither a northern nor a southern Pole Star.

Just as the inclination of the Martian axis happens to be quite similar but slightly larger than ours, so the Martian day happens to be slightly longer than ours. It is 24 hours, 37 minutes and about 22½ seconds. (The most precise recent figure published gives 24h 37′ and 22.6679″.) This difference between the terrestrial and the Martian day, incidentally, is within the adjustment period of a good watch, so that

HAMILTON SPACE CLOCK: Numbers around face indicate Mars time. Small dial in center tells Earth time. Both calendars are twelve months—Mars dial is at the left; the other is Earth's.

explorers could use ordinary watches during their stay on Mars.

Because the Martian day is slightly longer than the Earth day, the Martian year, 687 Earth days long, has only 668.6 days as experienced by somebody on Mars.

As has just been mentioned, a good watch could be adjusted to the slightly longer Martian day. But an exploring party would not only like to know the Martian time, they would also like to know what time it is in Los Angeles, New York, London or Berlin or wherever they happen to come from. Beyond that, since the slightly longer Martian day tends to creep more and more into an Earth "tomorrow," they would have to have means of keeping track of the terrestrial calendar as well as of their own. Such a device is no longer a gadget of the future.

Rushing events a bit, Dr. I. M. Levitt, director of the Fels Planetarium, has designed a clock which shows both Earth and Martian time on two 24-hour dials and keeps track of the calendars as well. The two 24-hour days present no difficulties and the Earth calendar, obsolescent and rickety as it is, is at least familiar. But there were some difficulties with the Martian calendar. Dividing the Martian year into 12 months, you get eight months of 55 (Martian, of course) days each and four months of 56 days each. But at the end of the year you have

6/10th of a day left over, which is worse than the dangling quarter-day at the end of an Earth year.

To accommodate those 6/10th of a Martian day, the Martian calendar has to run in 5-year periods, the first and last of these five years being "short years" with 668 days, the other three "normal years" with 669 days and a 57th of December. This arrangement differs from astronomical reality by 0.0019 days per year and, to take care of the difference, every 500th year will have to lose a day. Even then, there is still a tiny difference, but it would take a full 10,000 years to accumulate to a full day.

Well, to get down to Earth: The conspicuous reddish star you see in the southern sky is Mars, the "red and green planet," as Dr. Hubertus Strughold called it. About a year from now, there might be something new about it to tell.

THE INNER PLANETS

I HAVE a letter from Bill Courval of 741 Isthmus Ct. in San Diego, California, asking a question about which others may have wondered, too, on occasion. The letter reads: "Since we face away from the Sun at night, why is it that the two inner planets are visible to us?" The answer is, of course, that the two inner planets Mercury and Venus are *not* visible at night, but only in the morning and evening hours before sunrise and after sunset, respectively.

The diagram shows that, seen from the Earth, the farthest Mercury can be from the Sun is about 27 degrees of arc, while Venus can be as much as 48 degrees of arc from the Sun.

If we imagine that both planets happen to be simultaneously in this especially favorable position ("extreme elongation" is the technical term), Venus would rise 48° ahead of the Sun and Mercury 27° ahead of the Sun in the morning.

The rotation of the Earth amounts to 15 degrees of arc per hour, which makes the apparent movement of the Sun across the sky 15° per hour. Therefore, the Sun would appear at the horizon just about three hours after Venus did.

But the sky begins to light up when the Sun is still some 18° below the horizon, so that the period during which the planets could be clearly visible against a *dark* sky is shortened by about one hour. Venus happens to be luminous enough to show up brightly even against a fairly light sky. Mercury is less luminous to begin with. It is also much smaller and farther away, so that

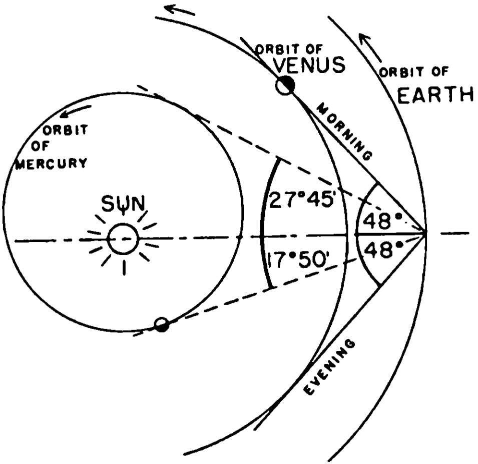
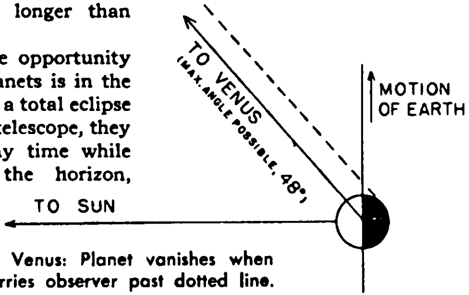


Diagram of possible positions of the two inner planets shows why, seen from Earth, they seem to be farthest from the Sun.

it soon fades in a brightening morning sky. For this reason, the period during which Mercury can be seen with the naked eye, even under very favorable circumstances, is hardly longer than half an hour.

Another and rare opportunity to see the inner planets is in the daylight sky during a total eclipse of the Sun. With a telescope, they can be seen at any time while they are above the horizon,



Limit of visibility of Venus: Planet vanishes when rotation of earth carries observer past dotted line.

whether the sky is bright or not. Probably the first astronomer to observe the two inner planets systematically during daylight hours was Giovanni Virginio Schiaparelli at Milan, Italy.

ANY QUESTIONS?

You once said on the radio that the star nearest to our sun, namely alpha *Centauri, cannot be seen from any place in the United States. Well, which is the nearest star that can be seen from the United States, especially from the vicinity of New York?*

Irene Kolitsch
23 *Railroad Avenue*
Montville, N. J.

Alpha Canis Majoris, better known as Sirius, 8.6 light-years away.

Could you shed some light on the mystery of Simultaneous Universes or Alternate Worlds, please?

Colin Parsons
31 *Benwood Court*
Sutton, Surrey, England

The idea was once treated very seriously in a German work on higher mathematics as a mathematical concept, but since the only application of this concept so far is in science fiction, it might be better to stick to literature.

What may have been the first literary example was a story written by a gentleman by the name of Winston Churchill, several decades before he became Sir Winston. The title of the story was *If Lee Had Lost at Gettysburg*. Of course he did lose, but the story pretended to have been written in a world where Lee won the battle of Gettysburg and the author had a scholar there try to figure out how the world would look if Lee had lost.

In other words, the concept makes the assumption that there is one world where the Confederates won and one where the Confederates were defeated. Likewise, there is one world where the American Colonies seceded from the British Empire and another world where they did not. Also a world in which Martin Luther did what he did and another one in which he was elected Pope. One in which Lenin overthrew the Kerenski government and one in which the train in which he traveled through Germany was derailed and Lenin perished in the accident. One in which the Allies came first with the atom bomb and one in which Heisenberg did.

In short, every important turning point in history produces—in theory—not a "new" world, but two.

Since light is known to exert pressure on small objects, it also should cause "thrust" at its source. This probably would not work in the atmosphere, but could we build a "light-beam rocket" once space has been reached? You could not ask for a higher exhaust velocity than that of light, could you?

Lt. Edward O. Olney
RCAF
Toronto, Ont., Canada

I agree on two counts: (A) that a light beam would be a propulsive force and (B) that everybody would be satisfied with an exhaust velocity of 186,000 miles per second. Unfortunately, exhaust velocity alone doesn't do it. There has to be some mass and there is also the question of efficiency involved, at which point the ratio between exhaust velocity and rocket velocity enters the picture. It so happens that two specific examples of a "light-beam drive" were worked out by T. F. Reinhardt of the U. S. Naval Air Rocket Test Station at Lake Denmark, New Jersey, for a lecture at the Annual Meeting of the American Rocket Society in Atlantic City in 1951.

To obtain a thrust of *one pound* from a light beam, one would need 1,330,000 kilowatts —which is just about the electrical power output of Niagara Falls! A medium-sized research rocket would have to have a thrust of 10,000 lbs. So the current to be fed to the light source would have to be a current of a nice round million amperes at an astronomical 13.3 million volts.

(Reinhardt added, incidentally, that a conductor for a one-million-ampere current would have to have a diameter of about 20 inches if made of copper and would weigh 1200 pounds per foot.)

If the light source had an area of one square foot, its temperature would have to be 1,620,000 degrees Fahrenheit. Naturally, you will want to limit the temperature of the light source to a practical figure, perhaps 10,000 degrees Fahrenheit. In that case, the area of the light source would have to have an area of 60 acres! All this for 10,000 lbs. of thrust, which one might obtain by burning 65 lbs. of fuel per second.

I suggest we go on using light for illumination only.

—WILLY LEY