ASTRONOMY

# Dozens of Moons

**Sun's family of moons includes not only our moon, but 30 others circling other planets, a few larger than our own moon. Jupiter leads with twelve moons.**

By MARTHA G. MORROW

➤ NOT ONE, but 31 moons shine in the heavens. There may be even more, but a score or more have been seen from here on earth.

The large moon that circles the earth is almost always visible. Sometimes only a tiny crescent can be seen faintly; at other times the moon's full disk brightens the sky. The moon is the largest and brightest thing in our night sky.

The sun's family, however, includes other moons circling other planets. A few are even larger than our own moon. But they are so far away they were unnoticed by early man and have only been discovered within recent centuries.

Four of the moons swarming around the gigantic planet Jupiter can be spotted with a good pair of binoculars. A small telescope is needed to pick up the largest of Saturn's moons. The world's largest telescopes were used to spot a few, including a half-dozen small satellites of Jupiter less than 20 miles across. All these moons shine by reflected sunlight and sometimes appear as full disks, sometimes as half-moons.

## Four at One Time

Some 340 years ago the Florentine physicist Galileo Galilei turned his telescope, the first to be used on the sky, toward giant Jupiter. In one evening he saw for the first time in history four of Jupiter's bright satellites. Thus were discovered the first satellites other than the earth's moon. One is smaller, the other three larger than our moon.

Galileo's record for discovering Jupiter's moons was equalled this fall when Dr. Seth B. Nicholson of the Mount Wilson and Palomar Observatories of California Institute of Technology and Carnegie Institution of Washington spotted his fourth tiny satellite for Jupiter. Almost 40 years elapsed between Dr. Nicholson's first and most recent discovery.

Neither Galileo nor Dr. Nicholson could be sure at first that the objects they found were Jupiter's satellites. Galileo thought perhaps he was seeing stars that happened to appear close to the planet. But nightly records of the positions of these bright objects convinced him that they were circling Jupiter.

Dr. Nicholson feared he might be mistaking an asteroid or an already familiar satellite for a new moon. Detailed calculations of the orbits of the other small satellites, however, and further study of the new object persuaded him and other astronomers that he had indeed found a 12th satellite for Jupiter.

The new satellite takes almost two years to circle Jupiter. It is one of the outer four satellites that move about 14,000,000 miles from the planet. Thus it is one of the most distant of all moons from its planet.

Two other astronomers are also credited with finding four moons. Giovanni Domenico Cassini, director of the Paris Observatory, before 1685 found four moons for Saturn, famous for its rings. Britain's famous astronomer William Herschel in the 1780's spotted two more moons of Saturn and two of the planet Uranus, which he discovered.

The 31 grandchildren of the sun, satellites that circle planets which in turn move around the sun, were formed in a wide variety of ways, reasons Dr. Gerard P. Kuiper of Yerkes Observatory of the University of Chicago.

Our moon eons ago probably was formed as a twin planet with the earth, Dr. Kuiper states. The moon is 2,163 miles across, thus its diameter is over a quarter as great as that of the earth around which it moves.

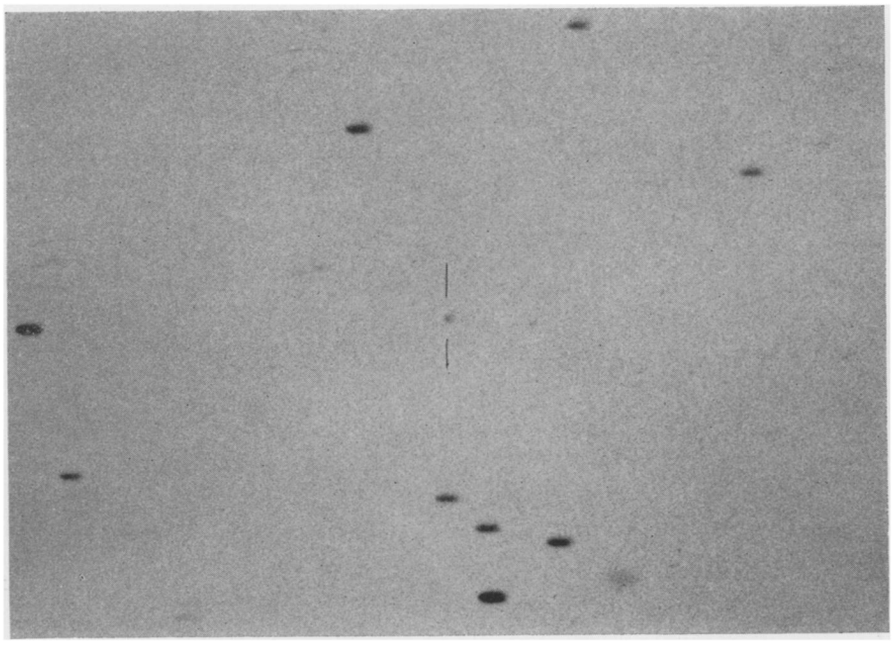
The moon's mass is one eighty-first of the mass of the earth, much greater than that of any other satellite in relation to its parent planet. The largest of the other satellites, and planets which serve as satellites to the sun, is less than one thousandth of its parent body.

The 30 other satellites probably were created as off-shoots of their parent planets. Some 19 of them have continued to swing around their planets, moving in fairly circular orbits and going in the same direction as the planets rotate. But a dozen or so escaped in their youth.

## Some Satellites Recaptured

Those satellites that tore loose probably continued to move around the sun along pretty much the same path as their parent bodies, Dr. Kuiper believes. Sooner or later some of them were bound to come close to their parent planets and be recaptured.

After their recapture, about half the satellites moved in a direction opposite to that in which they originally circled the planets. This is the reason that today some of the moons of Jupiter, Saturn and Neptune circle



*MOST RECENT FIND—Part of the discovery plate of Jupiter XII, enlarged five times from the original. Because the plate was oriented parallel to the ecliptic, the apparent path of the sun, the star trails appear horizontal. The photograph was taken with the 100-inch Hooker telescope by Dr. Seth B. Nicholson of Mount Wilson and Palomar Observatories.*

their planet in one direction while others go the opposite way.

Though seven irregular satellites are now known for Jupiter, they may actually represent only two recaptures. Two moons may have split into several parts to form the tiny satellites seen circling that giant planet today.

### Some May Be Asteroids

Some of the other satellites Jupiter shed in its youth may never have been recaptured, Dr. Kuiper states. They may still circle the sun as the outermost asteroids. A dozen such bodies move around the sun as far away from it as Jupiter. One peculiar object, Hidalgo, the most distant of the asteroids, travels between the orbits of Jupiter and Saturn.

Only one satellite has ever been known to move around the earth, but some day the earth may have a second moon, created by scientists. The possibility of sending a satellite missile some 600 miles or so above the earth's surface to swing continually around our planet has been considered seriously.

Such a missile would carry scientific instruments needed to collect data about the rarefied atmosphere surrounding the earth. Once started, no fuel would be needed to keep it circling around our planet.

Life as we know it is considered impossible on any of the 31 moons. Only one of them, Saturn's Titan, is known to have an atmosphere and that is composed of methane.

Our moon is the sun's nearest granddaughter because no satellites have ever been found moving around Mercury and Venus, the two planets nearest the sun. This is because tidal friction by the sun kept them from acquiring the necessary rapid motion, Dr. Kuiper's work on the origin of the solar system shows.

Mars, our near-neighbor in space, has two tiny satellites. One is ten miles across, the other about five. The one nearer the planet skims around keeping within 4,000 miles of the surface of Mars. It travels around Mars several times each day, and thus rises in the west and sets in the east. The other moon keeps almost 15,000 miles away from Mars and travels so slowly two Martian days pass between its rising in the east and setting in the west.

Jupiter has more satellites, gigantic and tiny, than any other planet. Seven of the full dozen now known were spotted on photographs within the last 50 years.

Saturn also has a large number of moons. It has nine in all. Its inner five move in nearly circular orbits and travel almost in the same plane as its rings.

### Five Moons for Uranus

The planet Uranus was discovered in 1781 by William Herschel, and within ten years he spotted two of its moons. One is about 1,000 miles across and the other 800 miles in diameter. Two other satellites for Uranus, smaller and nearer the planet, were found some 65 years later. A fifth was discovered by Dr. Kuiper about three years ago.

Neptune was located in 1846 because Uranus seemed to be pulled by an invisible object out of its calculated path around the sun. In less than a month after the planet had been discovered, W. Lassell, an English astronomer, found its large satellite, probably as large as our moon. Another satellite was spotted by Dr. Kuiper in May, 1949.

Pluto, itself not known until two decades ago, has no known moon in spite of recent searches with large telescopes.

It is not impossible, however, that one or two very faint satellites may still be added to the 31 known moons of our solar family.

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GENETICS

# Rabbit Egg Transplants

▶ MORE KNOWLEDGE of factors affecting cancer and other kinds of growth is expected from a rabbit egg transplantation method developed at the Jackson Memorial Laboratory, Bar Harbor, Me.

The method makes it possible for the first time to transplant fertilized eggs from one female rabbit to another without sacrificing the donor animal. It was worked out by Frederick R. Avis, director of the secondary training school program of the Jackson Laboratory and head of the science department at St. Marks School, and Dr. Paul B. Sawin, research associate at Jackson Laboratory.

Because the rabbits are all inbred to produce certain inherited characteristics, it will be easier to determine what changes occur in the uterus during the embryo's development. In addition, scientists will be able to tell how factors in the uterus, apart from inherited factors, affect the animal. Whether cancer susceptibility results from a trait in the fertilized egg or whether it comes from factors in the uterus during the embryo's development, for example, might be determined through this new technique.

The method, as reported to fellow scientists in the JOURNAL OF HEREDITY (Sept.-Oct., 1951), is to perform a Caesarian operation on the pregnant rabbit, remove the fertilized eggs and transfer them to a doe which has been prepared for proper reception of the eggs by a previous dose of gonado-trophic hormone which produces ovulation. The transplanted eggs develop in the host uterus. Normal rabbits develop from 81.3% of the transplants. The donor does can be saved for further study.

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