

SKY FACTS

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TORONTO

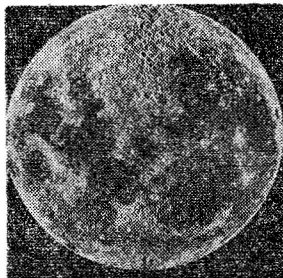
1966-1967

AN INTRODUCTION to the wonders of astronomy, published by
THE ROYAL ASTRONOMICAL SOCIETY OF CANADA (TORONTO CENTRE)
and distributed free to visitors at the Society's open-air meetings and Exhibition display; also at the Saturday public evenings at the David Dunlap Observatory.

What Is Astronomy?

ASTRONOMY is the science which treats with the celestial bodies, their positions, distances, motions, physical condition and constitutions. It deals with stars (including the Sun), planets (the Earth), satellites (the Moon), comets and meteors, and the vast conglomerations of stellar matter known as galaxies and nebulae.

While "professional" astronomy is an exact science requiring use of a comprehensive knowledge of mathematics and physics, there is much of interest to the "amateur" astronomer, who needs no knowledge of higher mathematics to enjoy this study of the heavens as a most intriguing hobby.



Our Nearest Neighbour

The Moon

Nearest of all the heavenly bodies to Earth is our satellite, the Moon — only 239,000 miles away. Earth has only one moon. Mars has two, while giant Jupiter has 12 and ringed Saturn has nine. Our Moon appears to be a dead world, without a trace of air or water. It is seen by us only when sunlight, falling on its rocky surface, is reflected towards our eyes. Thus its phases change as it shifts position relative to Earth and Sun while it revolves around Earth once in about four weeks (a month or "moonth"). Because it rotates on its axis in the same period, it presents the same "face" to Earth at all times. With a diameter of 2,160 miles, or about one-quarter that of Earth, it weighs only about 1/80th as much as our world. The gravitational force on the Moon is one-sixth that on Earth.

Seen in a telescope, the Moon's surface is revealed as extremely rugged, with towering mountain ranges and thousands of roughly circular craters of various sizes, some more than 100 miles across. Then, too, there are vast dark plains which have the appearance of old sea basins. Some areas are densely pock-marked with craters, many with small craterlets and sharp-pointed cones within their

walls. Seen with the naked eye, these varied lunar features combine to create what is really an optical illusion, the so-called "Man in the Moon." Only the telescope can reveal the true grandeur of the lunar landscape, the massive ramparts of peaks which compare with Earth's loftiest mountains, despite the Moon's much smaller size. Perhaps the absence of air and water has allowed them to remain through the ages while similar features which may have existed on Earth in distant ages have long since been eroded away by the action of wind, rain and ice.

On the Moon, where day and month are equal in length, there are 14 earthly days of daylight, when the temperature goes as high as 275 degrees F., far above the boiling point of water, and then another 14 days of night, when it drops to 243 degrees below zero.

The Sun is a Star!

Because it emits its own light and heat, the Sun is classed as a star, one of fairly average size and temperature. Only because it is so close — a mere 93 million miles — does it occupy such an important place in our lives, the source of Earth's life and energy. The Sun's light, travelling 186,000 miles a second (or six million million miles in a year), takes eight minutes to reach Earth. The light of the next nearest star requires more than four years for the trip. Most stars seen with the unaided eye are upwards of 100 "light-years" distant, and the telescope reveals objects so far off that the light which left them millions of years ago is only now reaching our eyes.

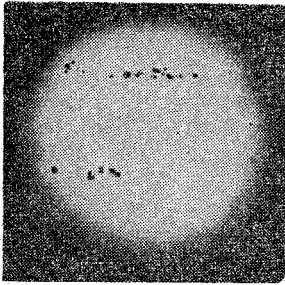
The Sun is one of an estimated 200 billion stars in our galaxy (the Milky Way) and our own galaxy is just one of 150 millions of these great star-systems known to exist in the universe. Analysis of starlight by the spectroscope indicates all the bodies in the universe

are made of the same chemical elements known on Earth.

The Sun with a diameter of 860,000 miles (compared to Earth's 7,900 miles), has a volume 1,300,000 times that of our tiny world. But because the solar matter is mostly in a gaseous state, the Sun's mass or weight is only 330,000 times that of our planet. Surface gravity on the massive Sun is so great, however, that a person weighing 150 pounds on Earth would weigh more than two tons if he could stand the 11,000-degree temperature and land on the solar surface.

The Sun's Family

The Earth is one of nine planets, dark solid bodies which revolve in elliptical (roughly circular) orbits around the Sun. Even in ancient times five of these planets or "wanderers" among the stars were recognized because of their changing positions among the "fixed" stars which form the constellations. Planets shine only by reflected sunlight.



Sun

Mercury and Venus are closest to the Sun. Earth is third. Beyond Earth, in order, come Mars, Jupiter and Saturn (all sometimes visible as bright "stars") and Uranus, Neptune and Pluto (seen only in telescopes). Between Mars and Jupiter lie the orbits of hundreds of minor planets or asteroids, possibly the remnants of a 10th large planet which in the distant past became disintegrated.

Mercury, innermost and smallest of the planets, is usually too close to the Sun to be seen but occasionally, as it swings around the solar orbit in its year of 88 days, it is visible for a few days just after sunset or just before sunrise. We may see it as an "evening star" in the western sky for a few days at the times of its greatest elongations east of the Sun on June 30 and Oct. 26, 1966 and Feb. 16, 1967, the elongation in February being most easily observed. Mercury will be at its greatest elongations west of the Sun, appearing as a

"morning star", on Aug. 16 and Dec. 4, 1966 and Mar. 31, 1967, that in December being most favourable.

Earth Has a Twin

Second planet from the Sun, Venus is in size and weight almost a twin to Earth. About 67 million miles from the Sun, it has a year of 225 days. With the exception of the Sun and Moon, Venus is the brightest object in the sky when suitably placed for observation. The brilliance is due largely to its dense atmosphere and cloud blanket, which, while it reflects the sunlight well, prevents astronomers on Earth from ever seeing the Venusian surface itself. Because of its nearness to the Sun, Venus receives about twice as much light and heat as we do. Venus is a "morning star" for most of the first part of 1966, but, after greatest elongation west on April 6, moves closer to the Sun, reaching superior conjunction on Nov. 8, 1966. Then slowly moving to the east of the Sun, Venus is too close to the Sun until the beginning of 1967 to be easily observed as an "evening star".

Next beyond Earth is Mars. With an average distance of 140 million miles from the Sun, it sometimes approaches within 35 million miles of Earth, while at its farthest point it is 235 million miles away. When nearest it is a conspicuous fiery red color, but when farthest it is no brighter than the Pole Star. Unlike Venus, Mars' atmosphere is very thin and the features on its surface are distinctly visible. Its diameter, 4,200 miles, is little more than half the Earth's. The Martian day is about the same as ours, but its year is equal to 867 earthy days. Mars has two tiny moons, only 18 and 23 miles in diameter.

After being in conjunction with the Sun in April, 1966, Mars moves slowly to the west of the Sun but is too close until August to be seen as a "morning star" of second magnitude. As it moves through Gemini, Cancer, Leo, and Virgo, Mars rises earlier each night until April, 1967 when it can be seen all night with a stellar magnitude of -1.3. It is stationary March 8, in opposition to the Sun on April 10 and nearest to the earth on April 21, 55,900,000 miles away.

Jupiter, the Giant

Jupiter is the giant of the Sun's family. With a diameter of 87,000 miles, it has volume about 1,300 times that of Earth, but weighs only 318 times as much. This is still nearly three times as much as all the other planets put together. It revolves around the Sun in just under 12 of our years, and spins on its axis in less than 10 hours; hence its day is much shorter than ours, and there are 10,484 days in the Jovian year. The velocity of rotation at Jupiter's equator — 27,800 miles an hour — is more than 26 times as fast as Earth's. Jupiter's dense atmosphere contains deadly methane and ammonia gases. Because of its distance from the Sun, an average of 483 million miles, Jupiter receives only about 1/27th as much light and heat as Earth, and its surface is intensely cold.

THE DAVID DUNLAP OBSERVATORY of the University of Toronto

at Stop 24 Yonge St., south of Richmond Hill, is open to visitors without charge Saturday evenings from April to October. If weather permits, the 74-inch telescope is used to observe the heavens. Telephone Richmond Hill Turner 4-2112 for schedule of open hours and reservations.

THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

The Society, organized in Toronto in 1890, now has local groups known as Centres in 17 cities across Canada, from Halifax to Victoria. Centres in Ontario, besides Toronto, are located at Ottawa, Hamilton, London, Niagara Falls and Windsor. Membership is open to any person interested in Astronomy professionally or as a hobby, and there are no academic requirements or age limits.

The Society publishes a bi-monthly *Journal* with articles on astronomical topics and reports of the Society's meetings; also the annual *Observer's Handbook* which presents a vast amount of information of particular interest to the amateur astronomer.

The Toronto Centre holds regular lecture meetings from October through April, and sponsors a special group for members interested in making their own telescopes. It also sponsors monthly summer "Star Nights" with telescopes on the University of Toronto Campus, and extra public observation meetings in parks and at the Canadian National Exhibition. Occasional meetings for members are held at the David Dunlap Observatory at Richmond Hill. There is a well-stocked Library and reading-room for members at the Society's national headquarters at 252 College Street, Toronto.

Annual dues of \$7.50 for the membership year commencing October 1 include subscription to both the Society's *Journal* and *Observer's Handbook* for the next calendar year, as well as privilege of attending all meetings, use of the Library and, if desired, membership in the Telescope Makers Group. Junior membership, including all privileges, is available at \$3.00 a year to those under 16 years of age, and to full-time students in secondary schools or university above that age. Non-members may obtain the *Observer's Handbook* for \$1.00. Application-for-membership forms may be obtained upon request addressed to:

Lester S. Locke, Treasurer, 298 Douglas Drive, Toronto 5.

Of Jupiter's 12 moons, the four largest — Io, Europa, Ganymede and Callisto (all except Europa being larger than Earth's moon) — may be seen readily in small telescopes, and their changing positions in relation to the planet make an interesting study for the amateur. Some nights all four are on one side, sometimes three on one side and one on the other, sometimes paired. At other times they are eclipsed by the planet or are seen passing across Jupiter's disc, casting a tiny shadow on the cloudy surface. Noticeable also in the telescope is the banded effect revealed by the colored cloud envelope which hides the planet's actual surface.

Jupiter is an "evening star" in the first part of 1966, but moves closer to the Sun until conjunction on July 5. Then a "morning star", it becomes more favourably placed and reaches opposition on Jan. 20, 1967 with stellar magnitude of -2.2. From Nov. 21, 1966 to Mar. 21, 1967, its motion is retrograde, i.e., it is moving westward among the stars from Cancer to Gemini.

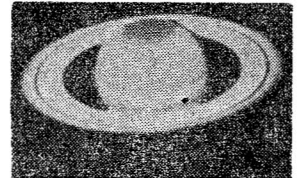
Saturn's Rings Unique

Saturn, with its unique ring system, is one of the most interesting objects for the amateur astronomer with a small telescope. Saturn, at an average distance of 886 million miles from the Sun, takes nearly 30 years to complete one revolution. Second only to Jupiter in size, it is 72,000 miles in diameter and weighs about 95 times as much as Earth. Like Jupiter, it spins on its axis very swiftly, its day being about 10½ hours long. Of Saturn's nine satellites or moons, only one, Titan, is readily seen in a small telescope. Saturn's exquisite ring system may, astronomers be-

lieve, be the remnants of one or more moons which have disintegrated and the matter spread out in a circular band.

After conjunction on March 10, 1966, Saturn appears in Pisces as a "morning star" and gradually becomes more favourably placed until opposition on Sept. 19 when it has a stellar magnitude of +0.8. It then approaches the Sun in the evening sky until conjunction on March 23, 1967.

Every 16 years Saturn's rings are presented edgewise to the Earth, when they are scarcely visible. This phenomenon will occur during 1966, with edge-on conditions existing in early April and again in late October. However, proximity to the Sun will hamper observations in the spring.



Saturn

Comets and Shooting Stars

Comets are visible briefly sometimes for a few weeks, often for months, as they swim by in space, the bright nucleus usually surrounded by nebulous material often extended as a "tail" in the direction away from the Sun. Some are periodic, returning at regular intervals and known to be permanent members of the Solar System; others make only a single appearance and pass off again to distant space. Few comets attain enough brightness to be seen with the naked eye.

Meteors are much more common. A few may be seen almost any clear night, but at certain times of the year they come in "showers."

Ordinarily, shooting stars are very tiny bits of matter, like grains of sand, which are rendered briefly visible as they are drawn towards Earth by its gravitational pull and burned up by the heat generated as they swiftly pass through our upper atmosphere. Usually they are completely melted and transformed into a briefly lingering streak of vapor. Very rarely a larger meteoric body enters Earth's atmosphere and partially survives the fiery ordeal, and a portion of the solid mass falls to Earth. Two notable meteor showers are the Perseids (about Aug. 12 each year) and the Leonids (about Nov. 16).

Beyond the Sun's Ken

Under exceptionally good conditions, the naked eye may see as many as 2,000 stars at one time, but the larger telescopes reveal there are billions of these distant suns in our galaxy. Many stars are twins — known to astronomers as "binaries." Other stars appear as doubles, merely because one lies behind the other in the line of sight, although they are separated by vast distances. Albireo or Beta Cygni, the star at the foot of the Northern Cross (not far from the bright star Vega), is an especially interesting binary, one of the twins being whitish-blue, a very hot star, and the other a beautiful golden or orange color, a star of lower temperature.

Star-clusters, such as the highly condensed conglomeration of suns to be seen in the con-

stellation Hercules, or the widely separated group, the Pleiades, are examples of interest.

Other telescopic objects of beauty are the nebulae — of which one type is the huge chaotic mass of glowing gas to be seen in Orion's sword and the other the galactic nebulae or "island universes" such as that in Andromeda. The latter, although more than a half-million light-years distant, is sometimes visible to the unaided eye as a fuzzy patch, the farthest thing the naked eye can see — more than four million million miles off in space.

Two Kinds of Telescopes

Telescopes used by astronomers — professional and amateur — fall into two main groups, depending on their optical systems. The refracting telescope is a single long tube with sets of lenses at each end. The reflecting type, which can be easily made by the amateur in a home workshop — with inexpensive materials but much loving care — uses a silvered or aluminized mirror (coated on the top surface) to gather in the light which then is reflected through a magnifying eyepiece lens to the observer's eye or camera. Most of the bigger telescopes in the largest observatories are of the reflecting type, such as those at Palomar Mountain and Mount Wilson in California, and at the David Dunlap Observatory of the University of Toronto, at Richmond Hill, Ont.

ROYAL ASTRONOMICAL SOCIETY OF CANADA — TORONTO CENTRE

Dates and Locations of Summer Sky-Gazing Nights — 1966

- Wednesday, May 25** — EGLINTON PARK, North Toronto. Eglinton Ave. West at Oriole Parkway
- Friday, May 27** — ETOBICOKE MUNICIPAL OFFICES — Highway 27 at Burnhamthorpe Road
- Friday, June 24** — SCARBOROUGH, THOMPSON MEMORIAL PARK, Brimley Road, north of Lawrence Avenue (First of two)
- Monday, June 27** — NORTH YORK, BROADLANDS PARK, 19 Castlegrove, west of Victoria Park and north of Lawrence. Drive west on Clintwood, north on Broadlands and west on Castlegrove
- Friday, July 22** — NORTH YORK, GOULDING PARK, 45 Goulding Ave. West side of Yonge Street, south of Steeles Avenue.
- Monday, July 25** — HIGH PARK — Bloor Street West at High Park
- Friday, Aug. 19 to Sept. 5** — C.N.E. — EXHIBITION PARK, South of Province of Ontario Building
- Wednesday, Sept. 21** — NORTH YORK, ASSEMBLY PARK, 1507 Lawrence Avenue west of Keele Street, on south side of Lawrence Avenue
- Friday, Sept. 23** — SCARBOROUGH, THOMPSON MEMORIAL PARK
See above for location. (Second of two)

IF CLEAR, members will set up telescopes shortly after dusk. Films will start on outdoor screen at dark and run to approximately 10:30 or 11 p.m. depending on time of start.

IF CLOUDY but no rain — Films go on at dark.

IF RAINING, program cancelled for night.