

ASTRONOMY FOR YOUNG FOLKS

Northern Portion of the Moon at Last Quarter

**Taken with 100-inch Hooker Telescope of the Mt. Wilson
Observatory (See Chapter XXI)**

ASTRONOMY *for* YOUNG FOLKS

BY

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[v]

CONTENTS

CHAPTE R	PAG E
Preface	xiii
I. The Constellations	3
II. January	15

III.	<u>February</u>	21
IV.	<u>March</u>	28
V.	<u>April</u>	35
VI.	<u>May</u>	41
VII.	<u>June</u>	49
VIII.	<u>July</u>	56
IX.	<u>August</u>	64
X.	<u>September</u>	71
XI.	<u>October</u>	78
XII.	<u>November</u>	84
XIII.	<u>December</u>	90
XIV.	<u>Stars of the Southern Hemisphere</u>	96
XV.	<u>The Milky Way or Galaxy</u>	107
XVI.	<u>The Surface of the Sun</u>	113
XVII.	<u>The Solar System</u>	119
XVIII.	<u>The Origin of the Earth</u>	127
XIX.	<u>Jupiter and His Nine Moons</u>	139
XX.	<u>The Rings and Moons of Saturn</u>	148
XXI.	<u>Is the Moon a Dead World</u>	156
XXII.	<u>Comets</u>	165
		[vi]
XXIII.	<u>Meteorites</u>	173
XXIV.	<u>The Earth As a Magnet</u>	183
XXV.	<u>Some Effects of the Earth's Atmosphere Upon Sunlight</u>	193
XXVI.	<u>Keeping Track of the Moon</u>	207
XXVII.	<u>The Motions of the Heavenly Bodies</u>	216
	<u>The Evolution of the Stars—From Red Giants to Red</u>	
XXVIII.	<u>Dwarfs</u>	225
XXIX.	<u>Double and Multiple Stars</u>	230
XXX.	<u>Astronomical Distances</u>	241
XXXI.	<u>Some Astronomical Facts Worth Remembering</u>	250

ILLUSTRATIONS

	PAGE
<u>Northern Portion of the Moon at Last Quarter</u>	<i>Frontispiece</i>
<u>The Great Hercules Cluster—A Universe of Suns</u>	<i>facing page</i> 56
<u>A Dark Nebula: The Dark Bay or Dark Horse Nebula in Orion</u>	<i>facing page</i> 110
<u>A. Venus. B. Mars. C. Jupiter. D. Saturn</u>	<i>facing page</i> 122
<u>Spiral Nebula in Canes Venatici</u>	<i>facing page</i> 216
<u>Spiral Nebula in Andromeda Viewed Edgewise</u>	<i>facing page</i> 222

[viii]
[ix]

LIST OF TABLES

	PAGE
I. <u>The Principal Elements of the Solar System</u>	261
I I. <u>The Satellites of the Solar System</u>	262
I I. <u>The Twenty Brightest Stars in the Heavens</u>	263
I. I	
V <u>A List of the Principal Constellations</u>	264-
.	265
V <u>Pronunciations and Meanings of Names of Stars and Constellations</u>	266-
.	267

PREFACE

Astronomy, it has been said, is the oldest and the noblest of the sciences. Yet it is one of the few sciences for which most present-day educators seem to find little, if any, room in their curriculum of study for the young, in spite of its high cultural value. It is, we are told, too abstruse a subject for the youthful student. This is doubtless true of theoretical or mathematical astronomy and the practical astronomy of the navigator, surveyor and engineer, but it is not true of general, descriptive astronomy. There are many different aspects of this many-sided science, and some of the simplest and grandest truths of astronomy can be grasped by the intelligent child of twelve or fourteen years of age.

Merely as a branch of nature study the child should have some knowledge of the sun, moon, stars and planets, their motions and their physical features, for they are as truly a part of nature as are the birds, trees and flowers, and the man, woman or child who goes forth beneath the star-lit heavens at night absolutely blind to the wonders and beauties of the universe of which he is a part, loses as much as the one who walks through field or forest with no thought of the beauties of nature that surround him.

The astronomer is the pioneer and explorer of today

[xii]

in realms unknown just as the pioneers and explorers of several centuries ago were to some extent astronomers as they sailed unknown seas and traversed unexplored regions. As the years pass by the astronomer extends more and more his explorations of the universe and brings back among the fruits of discovery measures of giant suns and estimates of the form and extent of the universe, views of whirling, seething nebulae, mysterious dark clouds drifting through space, tremendous solar upheavals or glimpses of

strangely marked surfaces of nearby planets.

In the following pages the author has endeavored to tell in words not beyond the comprehension of the average fourteen-year-old child something of the nature of the heavenly bodies. In Part I an effort is made to make the child familiar with the stars by indicating when and where they can be found in the early evening hours. In addition to identifying the principal constellations and their brightest stars by means of diagrams an attempt has been made to acquaint the child with the most interesting recent discoveries that have been made concerning the principal stars or objects in each group as well as with some of the stories and legends that have been associated with these groups of stars for centuries, and that have been handed down in the folk-lore of all nations.

Chapters 2-13, inclusive, appeared originally with diagrams similar to those shown here, under the department of Nature and Science for Young Folk in *St. Nicholas* from May, 1921, to April, 1922, inclusive. The Introductory Chapter and Chapters 14 and 15,

[xiii]

on the Milky Way and Stars of the Southern Hemisphere, respectively, are published here for the first time, as is also the chapter in Part II on the Evolution of the Stars from Red Giants to Red Dwarfs, which gives the order of the evolution of the stars as now accepted as a result of the brilliant astronomical researches of Dr. Henry Norris Russell of the United States and Prof. A. S. Eddington, of England.

The remaining chapters in Part II have been chosen from a series of articles that have appeared in *Science and Invention*, formerly *The Electrical Experimenter*, in the past four years, and have been considerably revised and in some parts rewritten to adapt them to the understanding of more youthful readers. These chapters deal with a variety of astronomical subjects of general popular interest and an effort has been made to select subjects that would cover as

wide an astronomical field as possible in a limited space.

The author's aim has not been to write a text-book of astronomy or to treat in detail of any one aspect of this extensive science, but simply to give the average child some general knowledge of the nature of the heavenly bodies, both those that form a part of our own solar system and those that lie in the depths of space beyond.

It has been necessary to write very briefly, and we feel inadequately, of many topics of special interest such as the sun and moon. Books have been written on these two subjects alone as well as upon such subjects as Mars, eclipses, comets, meteors, etc., but the

[xiv]

object has been to acquaint the child with the outstanding features of a variety of celestial objects rather than to treat of a few in detail.

If the writer succeeds in arousing the child's interest in the stars so that he may look forth with intelligence at the heavens and greet the stars as friends and at the same time grasps some of the simplest and most fundamental of astronomical truths such as the distinction between stars and planets, the motions of the heavenly bodies and their relative distances from us and the place of our own planet-world in the universe, this book will have served its purpose.

ASTRONOMY FOR YOUNG FOLKS

"The heavens declare the glory of God, and the firmament showeth
His handiwork."

Psalm XIX.

I THE CONSTELLATIONS

"Canst thou bind the sweet influences of the Pleiades
Or loose the bands of Orion?
Canst thou bring forth Mazzaroth in his season
Or canst thou guide Arcturus with his sons?"

—BOOK OF JOB.

Who would not like to know the stars and constellations by their names and in their seasons as we know the birds and the trees and the flowers, to recognize at their return, year by year, Sirius and Spica, Arcturus and Antares, Vega and Altair, to know when Ursa Major swings high overhead and Orion sinks to rest beneath the western horizon, when Leo comes into view in the east or the Northern Crown lies overhead?

Often we deprive ourselves of the pleasure of making friends with the stars and shut our eyes to the glories of the heavens above because we do not realize how simple a matter it is to become acquainted with the various groups of stars as they cross our meridian, one by one, day after day and month after month in

[4]

the same orderly sequence. When the robin returns once more to nest in the same orchard in the spring time, Leo and Virgo may be seen rising above the eastern horizon in the early evening hours. When the first snow flies in the late fall and the birds have all gone southward the belt of Orion appears in the east and Cygnus dips low in the west. When we once come to know brilliant blue-white Vega, ruddy Arcturus, golden Capella and sparkling Sirius we watch for them to return each in its proper season and greet them as old friends.

In the following pages we give for each month the constellations or star-groups that are nearest to our meridian, that is, that lie either

due north or due south or exactly overhead in the early part of the month and the early part of the evening.

We do not need to start our study of the constellations in January. We may start at any month in the year and we will find the constellations given for that month on or near the meridian at the time indicated.

In using the charts or diagrams of the constellations, we should hold them in an inverted position with the top of the page toward the north or else remember that the left-hand side of the page is toward the *east* and the right-hand side of the page toward the *west*, which is the opposite of the arrangement for charts and maps of the earth's surface.

We should also bear in mind that the constellations are all continually shifting westward for the stars and the moon and the planets as well as the sun rise

[5]

daily in the east and set in the west. This is due to the fact that the earth is turning in the opposite direction on its axis, that is from west to east. In twenty-four hours the earth turns completely around with respect to the heavens or through an angle of 360° , so in one hour it turns through an angle of $360^\circ \div 24$ or 15° . As a result the stars appear to shift westward 15° every hour. This is a distance about equal in length to the handle of the Big Dipper, which I am sure we all know, even if we do not know another constellation in the heavens.

If, then, we look at the heavens at a later hour than that for which the constellations are given we will find them farther westward and if our time of observation is earlier in the evening than the hour mentioned we will find them farther eastward.

In the course of a year the earth makes one trip around the sun and faces in turn all parts of the heavens. That is, it turns through an angle of 360° with respect to the heavens in a year or through an

angle of $360^\circ \div 12$ or 30° in one month. So as a result of our revolution around the sun, which is also in a west to east direction, we see that all the constellations are gradually shifting westward at the rate of 30° a month. It is for this reason that we see different constellations in different months, and it is because of the turning of the earth on its axis that we see different constellations at different hours of the night.

If we should sit up from sunset to sunrise and watch the stars rise in the east, pass the meridian and set

[6]

in the west—as the sun does by day—we should see in turn the same constellations that are to pass across the heavens in the next six months. This is because in twelve hours' time we are carried through the same angle with respect to the heavens by the earth's rotation on its axis that we are in the next six months by the motion of the earth around the sun.

Let us suppose then that the time we choose for our observation of the heavens is the last of the month while our charts are given for the first of the month. We must look then farther westward for our constellations just as we must look farther westward if we chose a later hour in the evening for our observations. Let us suppose that we choose for our time of observation half-past eight in the early part of December. On or close to the meridian we will find the constellations outlined in the charts for December. To the east of the meridian we will find the constellations that are given for January and February, and to the west of the meridian the constellations that are given for November and October. So if we are particularly ambitious or wish to become acquainted with the constellations more rapidly we may study at the same time the constellations for the preceding months now west of the meridian and the constellations for the following months now east of the meridian as well as the constellations for the month which will be due north or south or directly overhead as the case may be.

If we were able to see the stars by day as well as

[7]

by night we would observe that as the days go by the sun is apparently moving continuously eastward among certain constellations. This is a result of the earth's actual motion around the sun in the same direction.

The apparent path of the sun among the stars is called the ecliptic and the belt of the heavens eight degrees wide on either side of the ecliptic is called the zodiac. The constellations that lie within this belt of the zodiac are called zodiacal constellations. The zodiac was divided by the astronomer Hipparchus, who lived 161-126 B.C., into twelve signs 30° wide, and the signs were named for the constellations lying at that time within each of these divisions. These zodiacal constellations are Aries, Taurus, Gemini, Cancer, Leo, Virgo, Libra, Scorpio, Sagittarius, Capricornus, Aquarius and Pisces. With the exception of Libra, the Scales, all of these constellations are named for people or animals and the word zodiac is derived from the Greek word meaning "of animals."

Each month the sun moves eastward 30° through one of these zodiacal constellations. In the days of Hipparchus the sun was in Aries at the beginning of spring, at the point where the ecliptic crosses the celestial equator—which lies directly above the earth's equator. This point where the ecliptic crosses the equator was then known as the First Point in Aries. The autumnal equinox was 180° distant in Aquarius and the two points were called the equinoxes because when the sun is at either equinox the day and night are equal in

[8]

length all over the world. Now for certain reasons which we will not explain here the equinoctial points are not fixed in position but shift gradually westward at the rate of 1° in 70 years. It is as if the equinoxes were advancing each year to meet the sun on its return and their westward motion is therefore called "The Precession of

the Equinoxes."

Since the days of Hipparchus this motion has amounted to about 30° so that the constellations no longer occupy the signs of the zodiac that bear their names.

The sun is now in Pisces instead of Aries at the beginning of spring and in Virgo instead of Aquarius at the beginning of fall.

Not only the sun but the moon and planets as well move through the zodiacal constellations. In fact a limit for the zodiac of 8° on either side of the ecliptic was chosen because it marks the extent of the excursions of the moon and planets from the ecliptic. Neither moon nor planets will be found at a greater distance than 8° on either side of the ecliptic.

For convenience in determining the positions of the heavenly bodies the astronomer assumes that they lie upon the surface of a celestial sphere that has its center at the center of the earth.

The north pole of the celestial sphere lies directly above the north pole of the earth and the south pole of the celestial sphere directly above the south pole

[9]

of the earth. The celestial equator is the great circle of the celestial sphere that lies midway between its north and south poles and directly above the earth's equator. The ecliptic is also a great circle of the celestial sphere and cuts the celestial equator at an angle of $23\frac{1}{2}^\circ$ in the two points 180° apart known as the equinoctial points, of which we have already spoken.

The zodiacal constellations lie nearly overhead within the tropics and can be seen to advantage all over the world except in polar regions.

For every position of the earth's surface except at the equator we have also our circumpolar constellations which are the ones that never pass below the horizon for the place of observation.

In 40° N. Latitude the Big Dipper is a circumpolar constellation for it is above the horizon at all hours of the day and night and all times of the year. If our latitude is 40° N., all stars within 40° of the north pole of the heavens are circumpolar and never set, while stars within 40° of the south pole of the heavens never rise. All other stars rise and set daily.

If we were at the north pole all stars within 90° of the north pole of the heavens would be circumpolar and would describe daily circuits of the pole parallel to the horizon remaining always above it.

If we were at the equator all stars within *zero* degrees of either pole would be circumpolar, that is *no*

[10]

stars would be circumpolar, all stars rising and setting daily.

As a general rule, then, we may say that stars within an angular distance of the nearest pole of the heavens equal to the latitude never set and stars within an equal distance of the opposite pole never rise while all stars outside of these limits rise and set daily.

The beginner who attempts to make the acquaintance of the principal stars and constellations occasionally may find a bright star in a constellation that is not noted in the diagrams. In this case he has probably happened upon one of the bright planets.

It is not possible to include the planets in our diagrams for the reason that they are not fixed in position but apparently wander among the stars. The name planet is, in fact, derived from a Greek word meaning "wanderer." The stars shine by their own light but the planets shine only by reflected light from the sun. Of the seven planets in the solar system additional to our own planet earth, there are two, Uranus and Neptune that we need not consider for Neptune is not visible without the aid of a telescope and Uranus is fainter than any of the stars included in our diagrams.

Mercury will never appear except in the morning or evening

twilight, when none but the very brightest stars are visible, since it never departs far from the sun. It will only be seen under certain favorable conditions, and usually it will escape our notice altogether

[11]

unless we know exactly where to look for it although there are but two or three stars in the heavens that surpass it in brightness.

Venus, we will probably never mistake for any star in the heavens for it far surpasses all stars in brightness. It will always be seen in the west after sunset or in the east before sunrise and it is never seen more than three hours before or after the sun.

This leaves us but three planets, Jupiter, Saturn and Mars that we may mistake for bright stars. There is little chance that Jupiter will be thus mistaken for it also is far brighter than all of the stars except Sirius which differs greatly from Jupiter in color. Sirius is a brilliant white and Jupiter is a golden yellow. The planets do not twinkle as the stars do and this is particularly true of Jupiter which is remarkable for the quiet steadiness of its yellow light. This alone would serve to identify it.

Saturn is probably mistaken for a star oftener than any of the other planets. It moves so slowly among the stars that we would have to watch it for a number of successive evenings before we could discover that it is moving with respect to the stars. Saturn is yellowish in color and we can probably best distinguish it by the steadiness of its light. If we find in one of the zodiacal groups of stars—for the planets appear among no other constellations—a bright yellowish star where no bright star is indicated on the diagram we may be

[12]

reasonably certain that we have found the planet Saturn.

Mars is the only planet that is reddish in color. Once in fifteen or seventeen years, when it is particularly near to the earth, it

surpasses even Jupiter in brightness, but ordinarily it appears no more brilliant than one of the brighter stars. There are only two stars with which we are likely to confuse Mars,—Aldebaran and Antares—which are very similar to it in color, and, at times, in brightness. Moreover, both of these stars are zodiacal stars and Mars frequently passes through the constellations to which they belong. There should be no trouble about identifying Aldebaran and Antares, however, from their distinctive positions in the diagrams so that any other reddish star appearing in any of the zodiacal groups we may feel certain is the planet Mars.

In the following diagrams of the constellations the brightest and most conspicuous stars, called first-magnitude stars, are represented by white stars. These are the stars we should all be able to recognize and call by name and in every instance the name of a first-magnitude star is given on the diagram. All other stars are represented by circles, and the size of the circle is an indication of the brightness of the star.

Stars visible without the aid of a telescope are referred to usually as "naked-eye stars." They are classed as first, second, third, fourth, fifth or sixth magnitude stars, according to their relative brightness.

[13]

A star of the first magnitude is about two and one-half times brighter than a star of the second magnitude, which in turn is two and one-half times brighter than a star of the third magnitude and so on. A first-magnitude star is, then, one hundred times brighter than a sixth magnitude star which is the faintest star that can be seen without the aid of the telescope.

This ratio between successive magnitudes continues among the telescopic stars. A star of the sixth magnitude is one hundred times brighter than a star of the eleventh magnitude which in turn is one hundred times brighter than a star of the sixteenth magnitude.

The faintest stars that can be seen visually in the greatest

telescopes are of the seventeenth or eighteenth magnitude, though stars two or three magnitudes fainter can be photographed.

The faintest stars shown in the diagrams are fifth-magnitude stars and stars of this magnitude as well as stars of the fourth magnitude are only given when needed to fill out the distinctive outlines of the constellations which have been formed by connecting the principal stars in each group by dotted lines.

All stars of first, second and third magnitude are given in the diagrams without exceptions as such stars are visible to everyone on clear nights.

The constellations given in the following pages include practically all of the constellations that can be seen in 40° N. Latitude. A diagram is given for each constellation.

[14]

In this latitude it is impossible to see the constellations of the southern hemisphere that lie within 40° of the south pole of the heavens. A brief chapter with diagram treats of these constellations that are invisible in mid-latitudes of the northern hemisphere.

[15]

II JANUARY

One of the most easily recognized constellations in the heavens is Taurus, The Bull, a zodiacal group which lies just south of the zenith in our latitudes in the early evening hours about the first of January.

Taurus is distinguished by the V-shaped group of The Hyades, which contains the bright, red, first-magnitude star Aldebaran, representing the fiery eye of the bull. It also contains the famous cluster of faint stars known as The Pleiades, lying a short distance

northwest of The Hyades.

No group of stars is more universally known than The Pleiades. All tribes and nations of the world, from the remotest days of recorded history up to the present time, have sung the praises of The Pleiades. They were "The Many Little Ones" of the Babylonians, "The Seven Sisters" of the Greeks, "The Seven Brothers" of the American Indians, "The Hen and Chickens" of many nations of Europe, "The Little Eyes" of the South Sea Islanders. They were honored in the religious ceremonies of the Aztecs, and the savage tribes of Australia danced in their honor. Many early tribes of men began their year with November, the Pleiad

[16]

month; and on November 17th, when The Pleiades crossed the meridian at midnight, it was said that no petition was ever presented in vain to the kings of ancient Persia.



January—Taurus

Poets of all ages have felt the charm of The Pleiades. Tennyson gives the following beautiful description of The Pleiades in *Locksley Hall*:

"Many a night I saw the Pleiades, rising through the mellow shade,
Glitter like a swarm of fireflies tangled in a silver braid."

[17]

A well-known astronomer, not so many years ago, also felt the mysterious charm of The Pleiades and seriously expressed the belief that Alcyone, the brightest star of The Pleiades, was a central sun about which all other stars were moving. But we know that there is no foundation whatever for such a belief.

A fairly good eye, when the night is clear and dark, will make out

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