★ PRACTICAL ★ ASTRONOMY

Hector Macpherson, Jun., F·R·A·S

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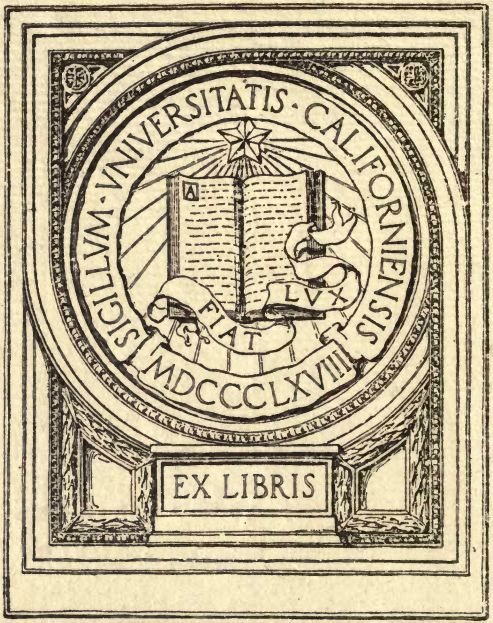
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PRACTICAL ASTRONOMY

WITH THE UNAIDED EYE

By HECTOR MACPHERSON, Jun., F.R.A.S.

MEMBER OF THE SOCIÉTÉ ASTRONOMIQUE DE FRANCE, ETC.
AUTHOR OF "THE ROMANCE OF MODERN ASTRONOMY," "ASTRONOMERS OF TO-DAY," "A CENTURY'S PROGRESS IN ASTRONOMY"

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PRACTICAL ASTRONOMY

CHAPTER I

INTRODUCTORY

When we cast our eyes to the heavens on any clear and, by preference, moonless night, our attention is attracted by apparently innumerable points of light, of all degrees of brightness. These are the stars, which in all ages have drawn to themselves the attention of mankind. Mr. E. W. Maunder, in a previous volume of this series, has shown how man's attention was first directed to the heavenly bodies, and how the mere recognition of the phases of the Moon, the varying positions of the planets and the seasonal changes of the stars has developed stage by stage into the science of astronomy as we know it at the present day.

Perhaps of all the sciences, modern astronomy is the most awe-inspiring, the most wonderful, the most instructive. The average man reads of the marvels which the telescope and spectroscope reveal, of the great depths and spaces, the rapid velocities, the eternal working of evolution, and he wonders. He has little or no knowledge of the methods used by the astronomers in ascertaining the facts of the science; and he is not familiar with the stars or constellations. Let us suppose that there is something unusual in the astronomical

world. The newspapers are full of the "opposition of Mars." The average man has read about Mars and he is anxious to see the planets for himself. The almanacs tell him that it is in a certain constellation, say, Virgo, and the newspapers repeat the statements of the almanacs. The would-be observer of Mars is as puzzled as ever. He knows nothing of the constellation Virgo. He does not know where to look for it, and even if he did, he would probably be unable to recognise it. He is paying the penalty for not having made himself acquainted with what we may call the topography of the heavens.

Again, let us suppose that a bright comet is to be seen or that a meteoric shower is expected from a certain constellation, say, Leo. The would-be observer is in the same position as in the case previously mentioned. His ignorance of the topography of the sky is at the root of his inability to see the comet or to witness the meteoric shower.

So much for the utility of knowing the names of the various stars and constellations; but a knowledge of this kind is more than merely useful. No one can really enter into what may be called the spirit of astronomy without having an acquaintance, however slight, with the planets and stars individually. As a contemporary astronomer has well remarked: "How great an interest is given to any object by the fact that we know its name. Take some town children out into the country and set them to gather wild flowers, how instantly they ask their names." It is the same in the case of the stars. When in a clear night we "consider the heavens" and behold apparently countless points of light, we are confused and overwhelmed by the number of the stars and by the complexity of their

distribution. One star appears to be almost the same as another except for the differences in brightness, and we look away from the sky again with neither interest nor curiosity. But if we learn that such and such a star is Aldebaran, and such and such is Sirius, and such and such a constellation is Orion, then our interest in the stars is aroused and as a result we are desirous of tracing out the star groups and of identifying the stars themselves.

"But," the would-be astronomer asks at this time, "how is it possible for me to learn the names of the stars and trace the outlines of the constellations without being taught?" Carlyle in his old age lamented "Why did not somebody *teach* me the constellations and make me at home in the starry heavens?" But in reality it is not necessary for anyone to be *taught* the constellations. It is best for everyone to *learn* them for himself.

When the would-be astronomer begins his task it may seem almost impossible of attainment, and some of the hints which are given in astronomical books only make the task more difficult. For instance, when we are told to draw imaginary lines through such and such stars in the Plough, and that these will lead us to such and such stars in Bootes and will form triangles and quadrilaterals with such and such stars in Draco, we feel baffled with the magnitude of the task. Again, on some maps and guides to the heavens there are represented what are known as "the constellation figures." On such maps we find the Plough represented by the figure of a bear covered with stars, Cygnus by a star-spangled swan, Orion by a human figure dotted with stars. The stars of all magnitudes are inserted and named, but they are confused and

individually lost through the introduction of the constellation figures. These figures of course are of extreme interest to the historian of astronomy and to the antiquarian. They throw a flood of light on important questions connected with the beginnings of astronomical science, but on star maps intended for the beginner who desires to obtain a knowledge of the topography of the heavens, they are utterly out of place.

The best method of acquiring a knowledge of the stars is to study them as they are, and to obtain a knowledge of the most important constellations in the heavens which it is impossible to mistake. From this it is comparatively easy to trace out the other constellations; to simplify this task by explanation and direction is the aim of the following pages.

Once the observer has become familiar with the various constellations and their seasonal changes a new charm is added to his interest in the stars. As an able astronomer has remarked, the task of learning the stars "has a charm of its own. The silent watchers from heaven soon become each a familiar friend, and to any imaginative mind the sense that he is treading the same path as that traversed by the first students of Nature will have a strange charm."

Our Place in the Universe.—Before entering on the task of describing the topography of the heavens, it is necessary to consider briefly our position in the Universe and the bearing of the position and motions of our planet on the appearance of the heavens, and on the apparent motions of sun, moon, planets and stars.

We live on the Earth, a globe almost 8000 miles in diameter. This globe is not, as the ancient astronomers believed, suspended in space. It is in ceaseless motion; it turns on its axis once in twenty-four hours, and in

addition it revolves round the Sun in 365¼ days. The mean distance of the Earth from the Sun is 93,000,000 miles, so the pathway traversed by our world is about 186,000,000 miles in diameter. In order to travel round this great orbit in a year, the Earth whirls through space at the amazing rate of eighteen miles in one second.

But the Earth does not travel alone. It is accompanied on its journey by its faithful satellite the Moon. The Moon revolves round the Earth in a little over twenty-seven days at an average distance of 238,000 miles. Just as we get our unit of time, a *day*, from the rotation of the Earth on its axis, and a *year* from the Earth's revolution round the Sun, we derive our other unit, the *month*, from the Moon's revolution round the Earth.

The Earth is not, however, the only body which revolves round the Sun. The orb of day holds sway over a large system of bodies—planets, comets and meteors. The five larger planets are very conspicuous and have been known from prehistoric times—Mercury and Venus within the orbit of the Earth; Mars, Jupiter and Saturn without. In addition there are two distant planets, Uranus, almost invisible to the unaided eye, and Neptune, completely so; and many small planets, between the orbits of Mars and Jupiter, but invisible to the unaided eye on account of their great distance. There are also numerous comets and their kindred bodies, meteors, revolving round the Sun and coming within the reach of human vision from time to time.

The Solar System, so far as we know at present, is a little under 5,000,000,000 miles in diameter, the orbit of Neptune being the known boundary. In this system the Earth is merely one planet among others; and it

is by no means the largest. It comes fifth in order of size, being much smaller than Jupiter, Saturn, Uranus and Neptune, and slightly larger than Venus, Mars and Mercury.

Let us suppose that the Solar System, which is both absolutely and relatively of so vast an extent, were co-extensive with the visible universe—in other words, let us imagine for the sake of clearness that the Universe were no larger than the Solar System. It would be indeed a very large universe, much larger than we are able to comprehend. The Sun would rise and set as at present; it would ascend to its highest point in summer and descend to its lowest point in winter. The Moon would pass through its cycle of changes in its revolution round the Earth. The planets would make their periodical appearances, shining brilliantly on an inky black sky. Usually there would be some object visible in this black sky; on moonless nights one or two planets would probably be seen, but there would be evenings on which the heavens would be absolutely black. For there would be no stars.

Thus by imagining the heavens without stars, we are enabled at once to assign to the stars their true position in the order of nature. The stars are luminaries far outside of the Solar System; the stars in fact are not worlds in any way analogous to the planets; they are themselves suns similar to the central body of the Solar System. It is true that when we see a planet on the background of stars it appears much more brilliant. Jupiter, for instance, shines many times more brightly than Sirius, the brightest of the stars; and yet Jupiter in comparison with even the faintest star which we see twinkling in the field of the telescope is utterly insignificant. It belongs altogether to an inferior order

of bodies; it is merely the attendant of a star. Thus we see that one effect of the great distance of the stars is to make them seem very insignificant bodies.

Another effect of their distance is that their motions are to the ordinary observer absolutely imperceptible. One of the great truths of modern astronomy is that the so-called "fixed" stars are in motion in various directions and with different velocities; but so great is their distance that these motions can only be noted after the lapse of many years, with the aid of powerful instruments and exact measurements. Were Homer or Hesiod or the author of the Book of Job alive to-day, they would see the same constellations and stars with which they were familiar. They would behold apparently unchanged the "bands" of Orion and the Pleiades and "the Bear with her train."

Thus to us the stars are the background of the Solar System—the setting to the drama of the planetary motions. And as such the stars were treated for many years. They were observed mainly as convenient reference-points for the observation of the positions of the Moon and planets. Since the days of Sir William Herschel, however, the stars have been observed and studied for their own sake.

The stars then are the distant background of the Solar System. Thus when we read in astronomical almanacs or in the newspaper press that "Mars is in Aries" or "Jupiter is in Taurus," it is necessary for us to remember that seen from the Earth, Mars is in the same line of vision as the stars in the constellation Aries; that the constellation Taurus is the background against which Jupiter is seen.

We must also bear in mind that the stars are not a real background, but only an apparent one. The con-

stellation Taurus, for instance, is not a collection of bodies all at the same distance from the Solar System. Some of the stars in the constellation form connected groups and systems, but the constellation is not necessarily a unity. In other words, the stars are at different distances. Sirius, for instance, the brightest star in the sky, is much closer to the Earth than Rigel in the neighbouring constellation.

The stars are at various distances. To make this clear, a simple illustration may be given. Two stars, let us say of equal brightness, appear close together in the heavens. They may form a connected system, but not necessarily. One may be much closer to the Solar System than the other and they may appear close together merely because they happen to lie in the same line of vision. It is quite a mistake to suppose that the brightest stars are necessarily the nearest. Sometimes they are so, sometimes they are not. For instance, an insignificant star of the fifth magnitude in the constellation Cygnus is nearer to the Earth than Sirius, the brightest star in the sky.

Distance of the Stars.—Something remains to be said of the distance and magnitude of the stars. We have seen that the diameter of the Solar System is a little under 5,000,000,000 (five thousand million) miles. The principle of the measurement of star-distance has been explained by Mr. Maunder in another volume of this series, and it is only necessary to give one or two examples of the distances of the stars. The nearest star is only visible in the southern hemisphere. It is the brightest star of the constellation Centaurus and is known as Alpha Centauri, and the distance of this orb is about twenty-five billions of miles. It is almost impossible to realise this vast distance, but an idea

may be gained from consideration of the fact that if the distance from the Sun to Neptune, the most distant planet of the Solar System, were represented by 10 feet, the nearest star would be fourteen miles away. The nearest star in the northern hemisphere is a little insignificant object in the constellation Cygnus—designated as 61 Cygni—distant fifty-seven billions of miles. The great distance of the stars may be better realised in another way. The rays of light, which travel from the Moon to the Earth in a second and a half, with a velocity of 186,000 miles per second, cross the diameter of the Solar System in eight hours. Four years are required for light to travel from the nearest star and thousands of years from the more distant suns of the Universe.

Magnitudes of the Stars.—The stars, as we have seen, are situated at all distances from the Solar System, and probably they are of all sizes. Yet their apparent brilliance does not on the whole depend on distance or size alone, but on both. One bright star may be comparatively near and of moderate size, another may be very distant and of immense dimensions. The stars are divided into *magnitudes* according to their apparent brightness; and six magnitudes of stars are within reach of the unaided eye. There are about twenty stars of the first magnitude and sixty of the second. Some of the constellations, as will be explained, are very rich in bright stars, others very poor.

The brightest stars have proper names. Thus the brightest star of Canis Major is known as Sirius, and the brightest star of Taurus is known as Aldebaran. These proper names were given to the stars by the early astronomers, Greek and Arabian. When the stars came to be catalogued and charted it was neces-

sary to designate them individually. Accordingly the brighter stars in each constellation are known by the letters of the Greek alphabet. Thus Aldebaran is also Alpha Tauri (literally Alpha of Taurus, "Tauri" being the Latin genitive), Sirius is Alpha Canis Majoris. When the Greek letters become exhausted, numbers are used.

Some of the constellations are very conspicuous, such as Ursa Major, Orion, the "great square" of Pegasus, the "great cross" of Cygnus. Ursa Major is not the most brilliant constellation in the heavens, but it is always to be seen. Therefore it is Ursa Major, also known as "the Plough" and "Charles's Wain," that we shall adopt as our starting-point in an exploration of the heavens.

CHAPTER II

THE NORTHERN STARS

THE positions of the stars in the sky are subject to two periodical changes—the hourly change and the seasonal change. The former is due to the rotation of the Earth on its axis and the latter is due to its revolution round the Sun. Even the casual observer can see that the stars rise and set like the Sun and that different stars are visible at different seasons.

Owing to the rotation of the Earth on its axis the entire star-sphere appears to move round our world once in twenty-four hours; and owing to the revolution of the Earth round the Sun, the orb of day appears to move among the stars, or rather, the stars appear to drift westward into the sunset, rising and setting four minutes earlier each night.