Chapter 4 - Naked-eye Astronomy.

Before we go on to specifics, it is necessary for us first to get some general idea about the universe and the sky above, with its countless millions of bright worlds.

It is a mistake to suppose that a telescope, especially a large one, is necessary. Maunder says that one is able to be a good astronomer with no more help than one's own eyes; the first and oldest instrument is the human eye, and there is an inexhaustible number of fields for which there is no more suitable instrument than the naked eye. Large telescopes are indispensible for certain purposes, like studying the nebulae, but the naked eye is better for studying more extensive fields of the sky. For many purposes it is better without the telescope, and there were many very talented and successful astronomers before the telescope was ever invented.

Where can we begin, then, to attempt to give some understanding of the boundless Creation of the Almighty? And where do we and our little earth stand amidst it all? And what is our relationship with the whole great composition?

Suppose we are, on a clear, cloudless, moonless night, strolling out under the dark sky, and looking up. O what a sight! O how our attention is drawn, our mind allured, our wonder and our admiration excited! Is there any thoughtful and contemplative man who does not feel his whole nature on fire, yearning to know more about the beautiful picture?

Picture us now, then, standing under the dark sky. It is useful for us to remember that we are standing on the earth, a little round ball, relatively unimportant and insignificant, which is entirely ignored even by some of the worlds in our own solar system. Out of all the millions of worlds in existence, we can count on our fingers the worlds which are able to see our little earth at all! Well, now, look up, and what do we see? (Remember that we have set the sun and the moon aside for the time being, in order for us to be able to see the other lights more clearly). There's the sky completely bespeckled with lights dancing and twinkling up above, one bowing to the other across the expanses. O the enchanting bright beauty of the stars – lamps of the night – the fair flowers, forget-me-nots of the angels! We stare more closely, and what do we see? Some bigger and some smaller; a bit of variety in the colour as well; some lone stars, and others in swarms; some winking, sending out brilliant light rays of varying colour, and others, namely the planets, staring us straight in the eye without ever opening or closing their eyelids; there, a great layer like a belt extending across the sky, where the lights have crowded together thicker than in other places – which shows us that the sky is like the earth in this, namely that the population is much more numerous in certain places. That's the scene, and may I be suffered to explain a little bit about it.

Hector Macpherson observes that the common man does not know, in the least measure, where to look for any object, and if he is looking in the right direction he is not then able to recognize the object. Well, then, remember that the great majority of the lights we see are stars – 'fixed stars' as they are commonly called; that is, they are to our perception fixed relative to each other, although they are not so in truth for each one of them is turning and travelling with an incomprehensible velocity. Well, every one of them is a sun, many of them bigger than our own sun. The fact is that our sun is a star, one of the stars of the Milky Way, albeit the star closest to us. Every star shines with its own light, and doubtless has worlds orbiting about it like our own sun; and also like our sun, each is a pyre of white-hot fire, of such an indescribable heat that the hottest

conflagration in our earth's possession is nought but a lump of ice, and molten iron poured onto the surface of one of the stars would appear like a river of ice!

We see again that they vary in size and brilliance. It is their distance or nearness, as well as their true magnitude, that explains this. One of the first things every astronomer should realize is this: when gazing upon the clear darkness of the firmament, one is looking at *nothing* – looking into the immeasurable and boundless void.

I supposed when I was a child that I was looking at some great dark canvas hung across the heavens, and that the whole myriad of lights had their backs up against this screen, and thus were all at the same distance from us. That was the idea of the ancients for thousands of years, but it is a grave error. The late Mr. T. E. Heath, of Penarth, has explained to us how to apply the stereoscope to the purpose of seeing the stars exactly as they are hanging across the expanse – an exquisitely simple and valuable scheme, and of invaluable practical worth. One should realize, thus, and remember constantly, that the great worlds above vary immensely in their distance from us and from each other. For example, suppose we are looking towards the north, and perceiving two stars very close to each other. Perhaps they are not close to each other at all, but only lie along the same line of sight from our standpoint. Let us turn now away from the two stars close to each other, and with our backs to them look to the south. There is a lone star. It's possible that that star is closer to one of the two stars we've just been discussing, than is the other star which appeared to us to be right next to it.

Let us turn our attention now to the constellations. The astronomer must arrange the stars into groupings. This is indispensable – the earliest astronomer would have perceived its importance. It is necessary to remember each assemblage, or grouping, on its own. Nearly everyone will have noticed the 'Twrr Tewdws' ['The Close Pack'], which is known also by the names 'Twrser' in north Wales, and 'Trwpser' in the south. This is the Pleiades, and all the children know it. Also, the Great Bear, Plough, or Churl's Wain. This is where it is necessary to begin. The two final stars in the Great Bear point almost directly to the North Star, and for that reason they are called 'the Pointers'. After once coming to recognize the North Star, do not lose sight of it. It stands nearly on the North Celestial Pole. (There is no star that marks the South Pole.) The other stars all appear to us to turn around it, and they are always the same distance from it. (Remember of course that it is the earth that is turning.)

If we extend the line of the Pointers on to the other side through the North Star, we come close to Cassiopeia, which appears similar to a 'W'; and if we extend the line further still we reach the Great Square in the Winged Horse, Pegasus. Let us draw a straight line again from the North Star through Capella and we will come to Orion, the Giant, with the three stars as his belt, Betelgeuse as his shoulder, and Rigel as his foot. A little bit away from Cassiopeia we find Cepheus, and on the other side of Cassiopeia from Cepheus we find Perseus and Andromeda. Also, it will be found that there is a line from Capella, through the Twins (Gemini) and Procyon (the Little Dog), to Sirius (the Great Dog), forming a half-circle with Orion inside it. There is also a line through the Pointers in the opposite direction from the North Star that leads to the Lion (Leo). It will also be perceived that there is a line from the North Star past Cor Caroli leading to Spica, with Arcturus on one side and Denebola, the second brightest star in Leo, on the other side.

Gaze closely at the pictures – they explain themselves. It is impossible to deal with the constellations satisfactorily without a star atlas, or someone knowledgeable in the

subject to guide us. But to start with, gain a knowledge of the constellations and the brightest stars; there's no great difficulty in that.

Generally about 48 constellations, or groupings, are made out, although there are many additional ones. Twelve of those are in the first division, namely the twelve Signs of the Zodiac – the constellations through which runs the Ecliptic, i.e. the apparent path of the sun and the planets. These are: the Ram (Aries), the Bull (Taurus), the Twins (Gemini), the Crab (Cancer), the Lion (Leo), the Maiden (Virgo), the Balance (Libra), the Serpent (Scorpio), the Archer (Sagittarius), the Goat (Capricorn), the Water-Carrier (Aquarius), and the Fish (Pisces). These were known to the ancients in Egypt, Arabia, Babylon, Persia, and India.

In the second division, that is the constellations *above* the ecliptic, are found among others: the Great Bear (Ursa Major), the Little Bear (Ursa Minor), Perseus, Cepheus, Andromeda, the Eagle (Aquila), the Swan (Cygnus), Hercules, the Harp (Lyra), etc.

In the third division, that is those *below* the ecliptic, are found among others: Orion, the Great Dog (Canis Major), the Little Dog (Canis Minor), Centaurus, etc.

It is appropriate to ask here, how many stars can be seen with the naked eye? And approximately how many stars can be seen with the telescope?

People suppose that millions of stars can be seen with the naked eye. This is a grave error. The stars are classified into different categories according to their 'magnitude'. This term means size, distance (or nearness), and brightness, combined to make up this characteristic – 'magnitude'. If one's sight is good it is possible to see stars up to the sixth magnitude with the naked eye, and here is the classification according to the famous French astronomer Flammarion:

Class I – 19 (namely, in order starting with the brightest: Sirius, Canopus*, Capella, Arcturus, Vega, α Centauri*, Rigel, Achernar*, Procyon, β Centauri*, Betelgeuse, Altair, α Crucis*, Aldebaran, Spica, Antares, Pollux, Regulus, Fomalhaut*. Note: those marked with a '*' are not visible in our country.)
Class II – 59.
Class III – 182.
Class IV – 530.
Class V – 1600.
Class VI – 4800.

It is estimated that it is possible to see about 3500 with the naked eye in our half of the sky, and thus about 7000 in total. But it is believed that no one is able, even with the keenest eye, to see more than 3000 stars from one place at one time.

The telescope takes up the task from that point where the naked eye fails. Class VII, 13,000; Class VIII, 40,000; and so on up to Class XV, 80,00,000 – which all together makes about 140,000,000 stars up to the 15th magnitude, but we do not stop there. After the most powerful and sharp-sighted telescope fails, there are still worlds upon countless worlds lying beyond, and were we to come to the extreme limit of imagining, and stand on what we suppose to be the farthest brink, millions of other suns would leap into sight from every direction.

Before finishing this chapter, let us note two particular characteristics belonging to the stars. We have said that they vary as regards *colour*. This depends on the elements in their composition, and also, perhaps, on their age. The theory that there is a close relationship between the colour of a star and its age has captured immense attention over the past three years. The most considered opinion of astronomers now is that the colour as well as the composition of any star depends on its temperature, and that its temperature depends partly on its age and partly on its size. Sirius (the Dog Star) is the greatest in the heavens, and is very much bigger than our sun. It is a brilliant white star like Vega, and hydrogen for the most part is its fuel. Aldebaran and Arcturus are orange, and contain a great quantity of sodium and iron. Antares and Betelgeuse are even redder. It is thus the materials of their composition that are partly, or perhaps chiefly responsible for their colours. But in addition to that, isn't it likely that variance in age to some extent explains the variance in colour? We know that a fire or a candle burns more clearly when it is in its prime, and is more yellow and faint when it is on the brink of burning out. Our sun is a yellow star; we see how it turns Nature to its own colour towards the autumn, after leaving its mark on it in the heat of summer. If this is true, then our sun is beginning to wear out – beginning to get old.

And here is another great marvel. Many stars are double, triple, or double-double – that is, although we see only one star with the naked eye, the telescope shows that one as two, three, or four, and frequently those are of different colours. Imagine for a moment what splendid sights we would see if, instead of being a member of our sun's family, our earth were a member of one of the double-double systems of great varying-coloured suns. A red sun would rise at six in the morning, a blue-white sun at nine, a yellow sun at mid-day, and a green sun in the afternoon – and all of those would be shining overhead at the same time!