CHAPTER V

IN SUMMER STAR-LANDS

"I heard the trailing garments of the night
  Sweep through her marble halls,
I saw her sable skirts all fringed with light
  From the celestial walls."--H. W. LONGFELLOW.

In the soft air of a summer night, when fireflies are flashing their lanterns over the fields, the stars do not sparkle and blaze like those that pierce the frosty skies of winter. The light of Sirius, Aldebaran, Rigel, and other midwinter brilliants possesses a certain gemlike hardness and cutting quality, but Antares and Vega, the great summer stars, and Arcturus, when he hangs westering in a July night, exhibit a milder radiance, harmonizing with the character of the season. This difference is, of course, atmospheric in origin, although it may be partly subjective, depending upon the mental influences of the mutations of Nature.

The constellation Scorpio is nearly as striking in outline as Orion, and its brightest star, the red Antares (alpha in map No. 12), carries concealed in its rays a green jewel which, to the eye of the enthusiast in telescopic recreation, appears more beautiful and inviting each time that he penetrates to its hiding place.

We shall begin our night's work with this object, and the four-inch glass will serve our purpose, although the untrained observer would be more certain of success with the five-inch. A friend of mine has seen the companion of Antares with a three-inch, but I have never tried the star with so small an aperture. When the air is steady and the companion can be well viewed, there is no finer sight among the double stars. The contrast of colors is beautifully distinct--fire-red and bright green. The little green star has been seen emerging from behind the moon, ahead of its ruddy companion. The magnitudes are one and seven and a half or eight, distance 3", p. 270°. Antares is probably a binary, although its binary character has not yet been established.

A slight turn of the telescope tube brings us to the star sigma, a wide double, the smaller component of which is blue or plum-colored; magnitudes four and nine, distance 20", p. 272°. From sigma we pass to beta, a very beautiful object, of which the three-inch gives us a splendid view. Its two components are of magnitudes two and six, distance 13", p. 30°; colors, white and bluish. It is interesting to know that the larger star is itself double, although none of the telescopes we are using can split it. Burnham discovered that it has a tenth-magnitude companion; distance less than 1", p. 87°.

And now for a triple, which will probably require the use of our largest glass. Up near the end of the northern prolongation of the constellation we perceive the star xi. The three-inch shows us that it is double; the

five-inch divides the larger star again. The magnitudes are respectively five, five and a half, and seven and a half, distances 0.94", p. 215°, and 7", p. 70°.

A still more remarkable star, although one of its components is beyond our reach, is nu. With the slightest magnifying this object splits up into two stars, of magnitudes four and seven, situated rather more than 40" apart. A high power divides the seventh-magnitude companion into two, each of magnitude six and a half, distance 1.8", p. 42°. But (and this was another of Burnham's discoveries) the fourth-magnitude star itself is double, distance 0.8", p. about 0°. The companion in this case is of magnitude five and a half.

Next we shall need a rather low-power eyepiece and our largest aperture in order to examine a star cluster, No. 4173, which was especially admired by Sir William Herschel, who discovered that it was not, as Messier had supposed, a circular nebula. Herschel regarded it as the richest mass of stars in the firmament, but with a small telescope it appears merely as a filmy speck that has sometimes been mistaken for a comet. In 1860 a new star, between the sixth and seventh magnitude in brilliance, suddenly appeared directly in or upon the cluster, and the feeble radiance of the latter was almost extinguished by the superior light of the stranger. The latter disappeared in less than a month, and has not been seen again, although it is suspected to be a variable, and, as such, has been designated with the letter T. Two other known variables, both very faint, exist in the immediate neighborhood.

According to the opinion that was formerly looked upon with favor, the variable T, if it is a variable, simply lies in the line of sight between the earth and the star cluster, and has no actual connection with the latter. But this opinion may not, after all, be correct, for Mr. Bailey's observations show that variable stars sometimes exist in large numbers in clusters, although the variables thus observed are of short period. The cluster 4183, just west of Antares, is also worth a glance with the five-inch glass. It is dense, but its stars are very small, so that to enjoy its beauty we should have to employ a large telescope. Yet there is a certain attraction in these far-away glimpses of starry swarms, for they give us some perception of the awful profundity of space. When the mind is rightly attuned for these revelations of the telescope, there are no words that can express its impressions of the overwhelming perspective of the universe.

The southern part of the constellation Ophiuchus is almost inextricably mingled with Scorpio. We shall, therefore, look next at its attractions, beginning with the remarkable array of star clusters 4264, 4268, 4269, and 4270. All of these are small, 2' or 3' in diameter, and globular in shape. No. 4264 is the largest, and we can see some of the stars composing it. But these clusters, like those just described in Scorpio, are more interesting for what they signify than for what they show; and the interest is not diminished by the fact that their meaning is more or less of a mystery. Whether they are composed of pygmy suns or of great solar globes like that one which makes daylight for the earth, their association in spherical groups is equally suggestive.

There are two other star clusters in Ophiuchus, and within the limits of map No. 12, both of which are more extensive than those we have just been looking at. No. 4211 is 5' or 6' in diameter, also globular, brighter at the center, and surrounded by several comparatively conspicuous stars. No. 4346 is still larger, about half as broad as the moon, and many of its scattered stars are of not less than the ninth magnitude. With a low magnifying power the field of view surrounding the cluster appears powdered with stars.

There are only two noteworthy doubles in that part of Ophiuchus with which we are at present concerned: 36, whose magnitudes are five and seven, distance 4.3", p. 195°, colors yellow and red; and 39, magnitudes six and seven and a half, distance 12", p. 356°, colors yellow or orange and blue. The first named is a binary whose period has not been definitely ascertained.

The variable R has a period a little less than three hundred and three days. At its brightest it is of magnitude seven or eight, and at minimum it diminishes to about the twelfth magnitude.

The spot where the new star of 1604 appeared is indicated on the map. This was, with the exception of Tycho's star in 1572, the brightest temporary star of which we possess a trustworthy account. It is frequently referred to as Kepler's star, because Kepler watched it with considerable attention, but unfortunately he was not as good an observer

as Tycho was. The star was first seen on October 10, 1604, and was then brighter than Jupiter. It did not, however, equal Venus. It gradually faded and in March, 1606, disappeared. About twelve degrees northwest of the place of the star of 1604, and in that part of the constellation Serpens which is included in map No. 12, we find the location of another temporary star, that of 1848. It was first noticed by Mr. Hind on April 28th of that year, when its magnitude was not much above the seventh, and its color was red. It brightened rapidly, until on May 2d it was of magnitude three and a half. Then it began to fade, but very slowly, and it has never entirely disappeared. It is now of the twelfth or thirteenth magnitude.

In passing we may glance with a low power at nu Serpentis, a wide double, magnitudes four and nine, distance 50", p. 31°, colors contrasted but uncertain.

Sagittarius and its neighbor, the small but rich constellation Scutum Sobieskii, attract us next. We shall first deal with the western portions of these constellations which are represented on Map No. 12. The star in Sagittarius is a wide triple, magnitudes three and a half, nine and a half, and ten, distances 40", p. 315°, and 45", p. 114°. But the chief glory of Sagittarius (and the same statement applies to Scutum Sobieskii) lies in its assemblage of star clusters. One of these, No. 4361, also known as M 8, is plainly visible to the naked eye as a bright spot in the Milky Way. We turn our five-inch telescope, armed with a low magnifying power, upon this subject and enjoy a rare spectacle. As we

allow it to drift through the field we see a group of three comparatively brilliant stars advancing at the front of a wonderful train of mingled star clusters and nebulous clouds. A little northwest of it appears the celebrated trifid nebula, No. 4355 on the map. There is some evidence that changes have occurred in this nebula since its discovery in the last century. Barnard has made a beautiful photograph showing M 8 and the trifid nebula on the same plate, and he remarks that the former is a far more remarkable object than its more famous neighbor. Near the eastern border of the principal nebulous cloud there is a small and very black hole with a star poised on its eastern edge. This hole and the star are clearly shown in the photograph.

Cluster No. 4397 (M 24) is usually described as resembling, to the naked eye, a protuberance on the edge of the Milky Way. It is nearly three times as broad as the moon, and is very rich in minute stars, which are at just such a degree of visibility that crowds of them continually appear and disappear while the eye wanders over the field, just as faces are seen and lost in a vast assemblage of people. This kind of luminous agitation is not peculiar to M 24, although that cluster exhibits it better than most others do on account of both the multitude and the minuteness of its stars.

A slight sweep eastward brings us to yet another meeting place of stars, the cluster M 25, situated between the variables U and V. This is brilliant and easily resolved into its components, which include a number of double stars.

The two neighboring variables just referred to are interesting. U has a period of about six days and three quarters, and its range of magnitude runs from the seventh down to below the eighth. V is a somewhat mysterious star. Chandler removed it from his catalogue of variables because no change had been observed in its light by either himself, Sawyer, or Yendell. Quirling, the discoverer of its variability, gave the range as between magnitudes 7.6 and 8.8. It must, therefore, be exceedingly erratic in its changes, resembling rather the temporary stars than the true variables.

In that part of Scutum Sobieskii contained in map No. 12 we find an interesting double, Sigma 2325, whose magnitudes are six and nine, distance 12.3", p. 260°, colors white and orange. Sigma 2306 is a triple, magnitudes seven, eight, and nine, distances 12", p. 220°, and 0.8", p. 68°. The third star is, however, beyond our reach. The colors of the two larger are respectively yellow and violet.

The star cluster 4400 is about one quarter as broad as the moon, and easily seen with our smallest aperture.

Passing near to the region covered by map No. 13, we find the remaining portions of the constellations Sagittarius and Scutum Sobieskii. It will be advisable to finish with the latter first. Glance at the clusters 4426 and 4437. Neither is large, but both are rich in stars. The nebula 4441 is a fine object of its kind. It brightens toward the center, and

Herschel thought he had resolved it into stars. The variable R is remarkable for its eccentricities. Sometimes it attains nearly the fourth magnitude, although usually at maximum it is below the fifth, while at minimum it is occasionally of the sixth and at other times of the seventh or eighth magnitude. Its period is irregular.

Turning back to Sagittarius, we resume our search for interesting objects there, and the first that we discover is another star cluster, for the stars are wonderfully gregarious in this quarter of the heavens. The number our cluster bears on the map is 4424, corresponding with M 22 in Messier's catalogue. It is very bright, containing many stars of the tenth and eleventh magnitudes, as well as a swarm of smaller ones. Sir John Herschel regarded the larger stars in this cluster as possessing a reddish tint. Possibly there was some peculiarity in his eye that gave him this impression, for he has described a cluster in the constellation Toucan in the southern hemisphere as containing a globular mass of rose-colored stars inclosed in a spherical shell of white stars. Later observers have confirmed his description of the shape and richness of this cluster in Toucan, but have been unable to perceive the red hue of the interior stars.

The eastern expanse of Sagittarius is a poor region compared with the western end of the constellation, where the wide stream of the Milky Way like a great river enriches its surroundings. The variables T and R are of little interest to us, for they never become bright enough to be seen without the aid of a telescope. In 54 we find, however, an interesting

double, which with larger telescopes than any of ours appears as a triple. The two stars that we see are of magnitudes six and seven and a half, distance 45", p. 42°, colors yellow and blue. The third star, perhaps of thirteenth magnitude, is distant 36", p. 245°.

Retaining map No. 13 as our guide, we examine the western part of the constellation Capricornus. Its leader alpha is a naked-eye double, the two stars being a little more than 6' apart. Their magnitudes are three and four, and both have a yellowish hue. The western star is alpha^1, and is the fainter of the two. The other is designated as alpha^2. Both are double. The components of alpha^1 are of magnitudes four and eight and a half, distance 44", p. 220°. With the Washington twenty-six-inch telescope a third star of magnitude fourteen has been found at a distance of 40", p. 182°. In alpha^2 the magnitudes of the components are three and ten and a half, distance 7.4", p. 150°. The smaller star has a companion of the twelfth or thirteenth magnitude, distance 1.2", p. 240°. This, of course, is hopelessly beyond our reach. Yet another star of magnitude nine, distance 154", p. 156, we may see easily.

Dropping down to beta, we find it to be a most beautiful and easy double, possessing finely contrasted colors, gold and blue. The larger star is of magnitude three, and the smaller, the blue one, of magnitude six, distance 205", p. 267°. Between them there is a very faint star which larger telescopes than ours divide into two, each of magnitude eleven and a half; separated 3", p. 325°.

Still farther south and nearly in a line drawn from alpha through beta we find a remarkable group of double stars, sigma, pi, rho, and omicron. The last three form a beautiful little triangle. We begin with sigma, the faintest of the four. The magnitudes of its components are six and nine, distance 54", p. 177°. In pi the magnitudes are five and nine, distance 3.4", p. 145°; in rho, magnitudes five and eight, distance 3.8", p. 177° (a third star of magnitude seven and a half is seen at a distance of 4', p. 150°); in omicron, magnitudes six and seven, distance 22", p. 240°.

The star cluster 4608 is small, yet, on a moonless night, worth a glance with the five-inch.

We now pass northward to the region covered by map No. 14, including the remainder of Ophiuchus and Serpens. Beginning with the head of Serpens, in the upper right-hand corner of the map, we find that beta, of magnitude three and a half, has a ninth-magnitude companion, distance 30", p. 265°. The larger star is light blue and the smaller one yellowish. The little star nu is double, magnitudes five and nine, distance 50", p. 31°, colors contrasted but uncertain. In delta we find a closer double, magnitudes three and four, distance 3.5", p. 190°. It is a beautiful object for the three-inch. The leader of the constellation, alpha, of magnitude two and a half, has a faint companion of only the twelfth magnitude, distance 60", p. 350°. The small star is bluish. The variable R has a period about a week short of one year, and at maximum exceeds the sixth magnitude, although sinking at minimum to

less than the eleventh. Its color is ruddy.

Passing eastward, we turn again into Ophiuchus, and find immediately the very interesting double, lambda, whose components are of magnitudes four and six, distance 1", p. 55°. This is a long-period binary, and notwithstanding the closeness of its stars, our four-inch should separate them when the seeing is fine. We shall do better, however, to try with the five-inch. Sigma 2166 consists of two stars of magnitudes six and seven and a half, distance 27", p. 280°. Sigma 2173 is a double of quite a different order. The magnitudes of its components are both six, the distance in 1899 0.98", p. 331°. It is evidently a binary in rapid motion, as the distance changed from about a quarter of a second in 1881 to more than a second in 1894. The star tau is a fine triple, magnitudes five, six, and nine, distances 1.8", p. 254°, and 100", p. 127°. The close pair is a binary system with a long period of revolution, estimated at about two hundred years. We discover another group of remarkable doubles in 67, 70, and 73. In the first-named star the magnitudes are four and eight, distance 55", p. 144°, colors finely contrasted, pale yellow and red.

Much more interesting, however, is 70, a binary whose components have completed a revolution since their discovery by Sir William Herschel, the period being ninety-five years. The magnitudes are four and six, or, according to Hall, five and six, distance in 1894 2.3"; in 1900, 1.45", according to Maw. Hall says the apparent distance when the stars are closest is about 1.7", and when they are widest 6.7". This star is one

of those whose parallax has been calculated with a reasonable degree of accuracy. Its distance from us is about 1,260,000 times the distance of the sun, the average distance apart of the two stars is about 2,800,000,000 miles (equal to the distance of Neptune from the sun), and their combined mass is three times that of the sun. Hall has seen in the system of 70 Ophiuchi three stars of the thirteenth magnitude or less, at distances of about 60", 90", and 165" respectively.

The star 73 is also a close double, and beyond our reach. Its magnitudes are six and seven, distance 0.7", p. 245°. It is, no doubt, a binary.

Three star clusters in Ophiuchus remain to be examined. The first of these, No. 4256, is partially resolved into stars by the five-inch. No. 4315 is globular, and has a striking environment of bystanding stars. It is about one quarter as broad as the full moon, and our largest aperture reveals the faint coruscation of its crowded components. No. 4410 is a coarser and more scattered star swarm--a fine sight!

Farther toward the east we encounter a part of Serpens again, which contains just one object worth glancing at, the double theta, whose stars are of magnitudes four and four and a half, distance 21", p. 104°. Color, both yellow, the smaller star having the deeper hue.

Let us next, with the guidance of map No. 15, enter the rich star fields of Hercules, and of the head and first coils of Draco. According to Argelander, Hercules contains more stars visible to the naked eye than

any other constellation, and he makes the number of them one hundred and fifty-five, nearly two thirds of which are only of the sixth magnitude. But Heis, who saw more naked-eye stars than Argelander, makes Ursa Major precisely equal to Hercules in the number of stars, his enumeration showing two hundred and twenty-seven in each constellation, while, according to him, Draco follows very closely after, with two hundred and twenty stars. Yet, on account of the minuteness of the majority of their stars, neither of these constellations makes by any means as brilliant a display as does Orion, to which Argelander assigns only one hundred and fifteen naked-eye stars, and Heis one hundred and thirty-six.

We begin in Hercules with the star kappa, a pretty little double of magnitudes five and a half and seven, distance 31", p. 10°, colors yellow and red. Not far away we find, in gamma, a larger star with a fainter companion, the magnitudes in this case being three and a half and nine, distance 38", p. 242°, colors white and faint blue or lilac. One of the most beautiful of double stars is alpha Herculis. The magnitudes are three and six, distance 4.7", p. 118°, colors orange and green, very distinct. Variability has been ascribed to each of the stars in turn. It is not known that they constitute a binary system, because no certain evidence of motion has been obtained. Another very beautiful and easily separated double is delta, magnitudes three and eight, distance 19", p. 175°, colors pale green and purple.

Sweeping northwestward to zeta, we encounter a celebrated binary, to separate which at present requires the higher powers of a six-inch

glass. The magnitudes are three and six and a half, distance in 1899, 0.6", p. 264°; in 1900, 0.8", p. 239°. The period of revolution is thirty-five years, and two complete revolutions have been observed. The apparent distance changes from 0.6" to 1.6". They were at their extreme distance in 1884.

Two pleasing little doubles are Sigma 2101, magnitudes six and nine, distance 4", p. 57°, and Sigma 2104, magnitudes six and eight, distance 6", p. 20°. At the northern end of the constellation is 42, a double that requires the light-grasping power of our largest glass. Its magnitudes are six and twelve, distance 20", p. 94°. In rho we discover another distinctly colored double, both stars being greenish or bluish, with a difference of tone. The magnitudes are four and five and a half, distance 3.7", p. 309°. But the double 95 is yet more remarkable for the colors of its stars. Their magnitudes are five and five and a half, distance 6", p. 262°, colors, according to Webb, "light apple-green and cherry-red." But other observers have noted different hues, one calling them both golden yellow. I think Webb's description is more nearly correct. Sigma 2215 is a very close double, requiring larger telescopes than those we are working with. Its magnitudes are six and a half and eight, distance 0.7", p. 300°. It is probably a binary. Sigma 2289 is also close, but our five-inch will separate it: magnitudes six and seven, distance 1.2", p. 230°.

Turning to , we have to deal with a triple, one of whose stars is at present beyond the reach of our instruments. The magnitudes of the two

that we see are four and ten, distance 31", p. 243°. The tenth-magnitude star is a binary of short period (probably less than fifty years), the distance of whose components was 2" in 1859, 1" in 1880, 0.34" in 1889, and 0.54" in 1891, when the position angle was 25°, and rapidly increasing. The distance is still much less than 1".

For a glance at a planetary nebula we may turn with the five-inch to No. 4234. It is very small and faint, only 8" in diameter, and equal in brightness to an eighth-magnitude star. Only close gazing shows that it is not sharply defined like a star, and that it possesses a bluish tint. Its spectrum is gaseous.

The chief attraction of Hercules we have left for the last, the famous star cluster between eta and zeta, No. 4230, more commonly known as M 13. On a still evening in the early summer, when the moon is absent and the quiet that the earth enjoys seems an influence descending from the brooding stars, the spectacle of this sun cluster in Hercules, viewed with a telescope of not less than five-inches aperture, captivates the mind of the most uncontemplative observer. With the Lick telescope I have watched it resolve into separate stars to its very center--a scene of marvelous beauty and impressiveness. But smaller instruments reveal only the in-running star streams and the sprinkling of stellar points over the main aggregation, which cause it to sparkle like a cloud of diamond dust transfused with sunbeams. The appearance of flocking together that those uncountable thousands of stars present calls up at once a picture of our lone sun separated from its nearest stellar

neighbor by a distance probably a hundred times as great as the entire diameter of the spherical space within which that multitude is congregated. It is true that unless we assume what would seem an unreasonable remoteness for the Hercules cluster, its component stars must be much smaller bodies than the sun; yet even that fact does not diminish the wonder of their swarming. Here the imagination must bear science on its wings, else science can make no progress whatever. It is an easy step from Hercules to Draco. In the conspicuous diamond-shaped figure that serves as a guide-board to the head of the latter, the southernmost star belongs not to Draco but to Hercules. The brightest star in this figure is gamma, of magnitude two and a half, with an eleventh-magnitude companion, distant 125", p. 116°. Two stars of magnitude five compose nu, their distance apart being 62", p. 312°. A more interesting double is , magnitudes five and five, distance 2.4", p. 158°. Both stars are white, and they present a pretty appearance when the air is steady. They form a binary system of unknown period. Sigma 2078 (also called 17 Draconis) is a triple, magnitudes six, six and a half, and six, distances 3.8", p. 116°, and 90", p. 195°. Sigma 1984 is an easy double, magnitudes six and a half and eight and a half, distance 6.4", p. 276°. The star eta is a very difficult double for even our largest aperture, on account of the faintness of one of its components. The magnitudes are two and a half and ten, distance 4.7", p. 140°. Its near neighbor, Sigma 2054, may be a binary. Its magnitudes are six and seven, distance 1", p. 0°. In Sigma 2323 we have another triple, magnitudes five, eight and a half, and seven, distances 3.6", p. 360°, and 90", p. 22°, colors white, blue, and reddish. A fine double is

epsilon, magnitudes five and eight, distance 3", p. 5°.

The nebula No. 4373 is of a planetary character, and interesting as occupying the pole of the ecliptic. A few years ago Dr. Holden, with the Lick telescope, discovered that it is unique in its form. It consists of a double spiral, drawn out nearly in the line of sight, like the thread of a screw whose axis lies approximately endwise with respect to the observer. There is a central star, and another fainter star is involved in the outer spiral. The form of this object suggests strange ideas as to its origin. But the details mentioned are far beyond the reach of our instruments. We shall only see it as a hazy speck. No. 4415 is another nebula worth glancing at. It is Tuttle's so-called variable nebula.

There are three constellations represented on map No. 16 to which we shall pay brief visits. First Aquila demands attention. Its doubles may be summarized as follows: 11, magnitudes five and nine, distance 17.4", p. 252°; pi, magnitudes six and seven, distance 1.6", p. 122°; 23, magnitudes six and ten, distance 3.4", p. 12°--requires the five-inch and good seeing; 57, magnitudes five and six, distance 36", p. 170°; Sigma 2654, magnitudes six and eight, distance 12", p. 234°; Sigma 2644, magnitudes six and seven, distance 3.6", p. 208°.

The star eta is an interesting variable between magnitudes three and a half and 4.7; period, seven days, four hours, fourteen minutes. The small red variable R changes from magnitude six to magnitude seven and a

half and back again in a period of three hundred and fifty-one days.

Star cluster No. 4440 is a striking object, its stars ranging from the ninth down to the twelfth magnitude.

Just north of Aquila is the little constellation Sagitta, containing several interesting doubles and many fine star fields, which may be discovered by sweeping over it with a low-power eyepiece. The star zeta is double, magnitudes five and nine, distance 8.6", p. 312°. The larger star is itself double, but far too close to be split, except with very large telescopes. In theta we find three components of magnitudes seven, nine, and eight respectively, distances 11.4", p. 327°, and 70", p. 227°. A wide double is epsilon, magnitudes six and eight, distance 92", p. 81°. Nebula No. 4572 is planetary.

Turning to Delphinus, we find a very beautiful double in gamma, magnitudes four and five, distance 11", p. 273°, colors golden and emerald. The leader alpha, which is not as bright as its neighbor beta, and which is believed to be irregularly variable, is of magnitude four, and has a companion of nine and a half magnitude at the distance 35", p. 278°. At a similar distance, 35", p. 335°, beta has an eleventh-magnitude companion, and the main star is also double, but excessively close, and much beyond our reach. It is believed to be a swiftly moving binary, whose stars are never separated widely enough to be distinguished with common telescopes.