CHAPTER IV

VIRGO AND HER NEIGHBORS

... "that region
Where still by night is seen
The Virgin goddess near to bright Boötes."--POSTE'S ARATUS.

Following the order of right ascension, we come next to the little constellations Crater and Corvus, which may be described as standing on the curves of Hydra (map No. 8). Beginning with Crater, let us look first at alpha, a yellow fourth-magnitude star, near which is a celebrated red variable R. With a low power we can see both alpha and R in the same field of view, like a very wide double. There is a third star of ninth magnitude, and bluish in color, near R on the side toward alpha. R is variable both in color and light. When reddest, it has been described as "scarlet," "crimson," and "blood-colored"; when palest, it is a deep orange-red. Its light variation has a period the precise length of which is not yet known. The cycle of change is included between the eighth and ninth magnitudes.

While our three-inch telescope suffices to show R, it is better to use the five-inch, because of the faintness of the star. When the color is well seen, the contrast with alpha is very pleasing.

There is hardly anything else in Crater to interest us, and we pass over the border into Corvus, and go at once to its chief attraction, the star delta. The components of this beautiful double are of magnitudes three and eight; distance 24", p. 211°; colors yellow and purple.

The night being dark and clear, we take the five-inch and turn it on the nebula 3128, which the map shows just under the border of Corvus in the edge of Hydra. Herschel believed he had resolved this into stars. It is a faint object and small, not exceeding one eighth of the moon's diameter.

Farther east in Hydra, as indicated near the left-hand edge of map No. 8, is a somewhat remarkable variable, R Hydræ. This star occasionally reaches magnitude three and a half, while at minimum it is not much above the tenth magnitude. Its period is about four hundred and twenty-five days.

While we have been examining these comparatively barren regions, glad to find one or two colored doubles to relieve the monotony of the search, a glittering white star has frequently drawn our eyes eastward and upward. It is Spica, the great gem of Virgo, and, yielding to its attraction, we now enter the richer constellation over which it presides (map No. 9). Except for its beauty, which every one must admire, Spica, or alpha Virginis, has no special claim upon our attention. Some evidence has been obtained that, like beta Aurigæ and Capella, it revolves with an invisible companion of great mass in an orbit only six million miles in diameter. Spica's spectrum resembles that of Sirius. The faint star which our larger apertures show about 6' northeast of Spica is of the tenth magnitude.

Sweeping westward, we come upon Sigma 1669, a pretty little double with nearly equal components of about the sixth magnitude, distance 5.6", p. 124°. But our interest is not fully aroused until we reach gamma, a star with a history. The components of this celebrated binary are both nearly of the third magnitude, distance about 5.8", p. 150°. They revolve around their common center in something less than two hundred years. According to some authorities, the period is one hundred and seventy years, but it is not yet certainly ascertained. It was noticed about the beginning of the seventeenth century that gamma Virginis was double. In 1836 the stars were so close together that no telescope then in existence was able to separate them, although it is said that the disk into which they had merged was elongated at Pulkowa. In a few years they became easily separable once more. If the one-hundred-and-seventy-year period is correct, they should continue to get farther apart until about 1921. According to Asaph Hall, their greatest apparent distance is 6.3", and their least apparent distance 0.5"; consequently, they will never again close up beyond the separating power of existing telescopes.

There is a great charm in watching this pair of stars even with a three-inch telescope--not so much on account of what is seen, although they are very beautiful, as on account of what we know they are doing.

It is no slight thing to behold two distant stars obeying the law that makes a stone fall to the ground and compels the earth to swing round the sun.

In theta we discover a fine triple, magnitudes four and a half, nine, and ten; distances 7", p. 345°, and 65", p. 295°. The ninth-magnitude star has been described as "violet," but such designations of color are often misleading when the star is very faint. On the other hand it should not be assumed that a certain color does not exist because the observer can not perceive it, for experience shows that there is a wide difference among observers in the power of the eye to distinguish color. I have known persons who could not perceive the difference of hue in some of the most beautifully contrasted colored doubles to be found in the sky. I am acquainted with an astronomer of long experience in the use of telescopes, whose eye is so deficient in color sense that he denies that there are any decided colors among the stars. Such persons miss one of the finest pleasures of the telescope. In examining theta Virginis we shall do best to use our largest aperture, viz., the five-inch. Yet Webb records that all three of the stars in this triple have been seen with a telescope of only three inches aperture. The amateur must remember in such cases how much depends upon practice as well as upon the condition of the atmosphere. There are lamentably few nights in a year when even the best telescope is ideally perfect in performance, but every night's observation increases the capacity of the eye, begetting a kind of critical judgment which renders it to some extent independent of atmospheric vagaries. It will also be found that the idiosyncrasies of the observer are reflected in his instrument, which seems to have its fits of excellence, its inspirations so to speak, while at other times it behaves as if all its wonderful powers had departed.

Another double that perhaps we had better not try with less than four inches aperture is 84 Virginis. The magnitudes are six and nine; distance, 3.5", p. 233°. Colors yellow and blue. Sigma 1846 is a fifth-magnitude star with a tenth-magnitude companion, distance only 4", p. 108°. Use the five-inch.

And now we approach something that is truly marvelous, the "Field of the Nebulæ." This strange region, lying mostly in the constellation Virgo, is roughly outlined by the stars beta, eta, gamma, delta, and epsilon, which form two sides of a square some 15° across. It extends, however, for some distance into Coma Berenices, while outlying nebulæ belonging to it are also to be found in the eastern part of Leo. Unfortunately for those who expect only brilliant revelations when they look through a telescope, this throng of nebulæ consists of small and inconspicuous wisps as ill defined as bits of thistle-down floating high in the air. There are more than three hundred of them all told, but even the brightest are faint objects when seen with the largest of our telescopes. Why do they congregate thus? That is the question which lends an interest to the assemblage that no individual member of it could alone command. It is a mystery, but beyond question it is explicable. The explanation, however, is yet to be discovered.

The places of only three of the nebulæ are indicated on the map. No. 2806 has been described as resembling in shape a shuttle. Its length is nearly one third of the moon's diameter. It is brightest near the center, and has several faint companions. No. 2961 is round, 4' in diameter, and is accompanied by another round nebula in the same field of view toward the south. No. 3105 is double, and powerful telescopes show two more ghostly companions. There is an opportunity for good and useful work in a careful study of the little nebulæ that swim into view all over this part of Virgo. Celestial photography has triumphs in store for itself here.

Scattered over and around the region where the nebulæ are thickest we find eight or nine variable stars, three of the most remarkable of which, R, S, and U, may be found on the map. R is very irregular, sometimes attaining magnitude six and a half, while at other times its maximum brightness does not exceed that of an eighth-magnitude star. At minimum it sinks to the tenth or eleventh magnitude. Its period is one hundred and forty-five days. U varies from magnitude seven or eight down to magnitude twelve or under and then regains its light, in a period of about two hundred and seven days. S is interesting for its brilliant red color. When brightest, it exceeds the sixth magnitude, but at some of its maxima the magnitude is hardly greater than the eighth. At minimum it goes below the twelfth magnitude. Period, three hundred and seventy-six days.

Next east of Virgo is Libra, which contains a few notable objects (map No. 10). The star alpha has a fifth-magnitude companion, distant about 230", which can be easily seen with an opera glass. At the point marked A on the map is a curious multiple star, sometimes referred to by its number in Piazzi's catalogues as follows: 212 P. xiv. The two principal stars are easily seen, their magnitudes being six and seven and a half; distance 15", p. 290°. Burnham found four other faint companions, for which it would be useless for us to look. The remarkable thing is that these faint stars, the nearest of which is distant about 50" from the largest member of the group and the farthest about 129", do not share, according to their discoverer, in the rapid proper motion of the two main stars.

In iota we find a double a little difficult for our three-inch. The components are of magnitudes four and a half and nine, distance 57", p. 110°. Burnham discovered that the ninth-magnitude star consists of two of the tenth less than 2" apart, p. 24°.

No astronomer who happens to be engaged in this part of the sky ever fails, unless his attention is absorbed by something of special interest, to glance at beta Libræ, which is famous as the only naked-eye star having a decided green color. The hue is pale, but manifest.[3]

[3] Is the slight green tint perceptible in Sirius variable? I am sometimes disposed to think it is.

The star is a remarkable variable, belonging to what is called the Algol type. Its period, according to Chandler, is 2 days 7 hours, 51 minutes, 22.8 seconds. The time occupied by the actual changes is about twelve hours. At maximum the star is of magnitude five and at minimum of magnitude 6.2.

We may now conveniently turn northward from Virgo in order to explore Boötes, one of the most interesting of the constellations (map No. 11). Its leading star alpha, Arcturus, is the brightest in the northern hemisphere. Its precedence over its rivals Vega and Capella, long in dispute, has been settled by the Harvard photometry. You notice that the color of Arcturus, when it has not risen far above the horizon, is a yellowish red, but when the star is near mid-heaven the color fades to light yellow. The hue is possibly variable, for it is recorded that in 1852 Arcturus appeared to have nearly lost its color. If it should eventually turn white, the fact would have an important bearing upon the question whether Sirius was, as alleged, once a red or flame-colored star.

But let us sit here in the starlight, for the night is balmy, and talk about Arcturus, which is perhaps actually the greatest sun within the range of terrestrial vision. Its parallax is so minute that the consideration of the tremendous size of this star is a thing that the imagination can not placidly approach. Calculations, based on its assumed distance, which show that it outshines the sun several thousand times, may be no exaggeration of the truth! It is easy to make such a calculation. One of Dr. Elkin's parallaxes for Arcturus is 0.018". That is to say, the displacement of Arcturus due to the change in the observer's point of view when he looks at the star first from one side and then from the other side of the earth's orbit, 186,000,000 miles across, amounts to only eighteen one-thousandths of a second of arc. We can appreciate how small that is when we reflect that it is about equal to the apparent distance between the heads of two pins placed an inch apart and viewed from a distance of a hundred and eighty miles!

Assuming this estimate of the parallax of Arcturus, let us see how it will enable us to calculate the probable size or light-giving power of the star as compared with the sun. The first thing to do is to multiply the earth's distance from the sun, which may be taken at 93,000,000 miles, by 206,265, the number of seconds of arc in a radian, the base of circular measure, and then divide the product by the parallax of the star. Performing the multiplication and division, we get the following:

19,182,645,000,000 / .018 = 1,065,702,500,000,000.

The quotient represents miles! Call it, in round numbers, a thousand millions of millions of miles. This is about 11,400,000 times the distance from the earth to the sun.

Now for the second part of the calculation: The amount of light received on the earth from some of the brighter stars has been experimentally compared with the amount received from the sun. The results differ rather widely, but in the case of Arcturus the ratio of the star's light to sunlight may be taken as about one twenty-five-thousand-millionth--i. e., 25,000,000,000 stars, each equal to Arcturus, would together shed upon the earth as much light as the sun does. But we know that light varies inversely as the square of the distance; for instance, if the sun were twice as far away as it is, its light would be diminished for us to a quarter of its present amount. Suppose, then, that we could remove the earth to a point midway between the sun and Arcturus, we should then be 5,700,000 times as far from the sun as we now are. In order to estimate how much light the sun would send us from that distance we must square the number 5,700,000 and then take the result inversely, or as a fraction. We thus get 1 / 32,490,000,000,000, representing the ratio of the sun's light at half the distance of Arcturus to that at its real distance. But while receding from the sun we should be approaching Arcturus. We should get, in fact, twice as near to that star as we were before, and therefore its light would be increased for us fourfold. Now, if the amount of sunlight had not changed, it would exceed the light of Arcturus only a quarter as much as it did before, or in the ratio of 25,000,000,000 / 4 = 6,250,000,000 to 1. But, as we have seen, the sunlight would diminish through increase of distance to one 32,490,000,000,000th part of its original amount. Hence its altered ratio to the light of Arcturus would become 6,250,000,000 to 32,490,000,000,000, or 1 to 5,198.

This means that if the earth were situated midway between the sun and Arcturus, it would receive 5,198 times as much light from that star as it would from the sun! It is quite probable, moreover, that the heat of Arcturus exceeds the solar heat in the same ratio, for the spectroscope shows that although Arcturus is surrounded with a cloak of metallic vapors proportionately far more extensive than the sun's, yet, smothered as the great star seems in some respects to be, it rivals Sirius itself in the intensity of its radiant energy.

If we suppose the radiation of Arcturus to be the same per unit of surface as the sun's, it follows that Arcturus exceeds the sun about 375,000 times in volume, and that its diameter is no less than 62,350,000 miles! Imagine the earth and the other planets constituting the solar system removed to Arcturus and set revolving around it in orbits of the same forms and sizes as those in which they circle about the sun. Poor Mercury! For that little planet it would indeed be a jump from the frying pan into the fire, because, as it rushed to perihelion, Mercury would plunge more than 2,500,000 miles beneath the surface of the giant star. Venus and the earth would melt like snowflakes at the mouth of a furnace. Even far-away Neptune, the remotest member of the system, would swelter in torrid heat.

But stop! Look at the sky. Observe how small and motionless the disks of the stars have become. Back to the telescopes at once, for this is a token that the atmosphere is steady, and that "good seeing" may be expected. It is fortunate, for we have some delicate work before us. The very first double star we try in Boötes, Sigma 1772, requires the use of the four-inch, and the five-inch shows it more satisfactorily. The magnitudes are sixth and ninth, distance 5", p. 140°. On the other side of Arcturus we find zeta, a star that we should have had no great difficulty in separating thirty years ago, but which has now closed up beyond the reach even of our five-inch. The magnitudes are both fourth, and the distance less than a quarter of a second; position angle changing. It is apparently a binary, and if so will some time widen again, but its period is unknown. The star 279, also known as Sigma 1910, near the southeastern edge of the constellation, is a pretty double, each component being of the seventh magnitude, distance 4", p. 212°. Just above zeta we come upon pi, an easy double for the three-inch, magnitudes four and six, distance 6" p. 99°. Next is xi, a yellow and purple pair, whose magnitudes are respectively five and seven, distance less than 3", p. 200°. This is undoubtedly a binary with a period of revolution of about a hundred and thirty years. Its distance decreased about 1" between 1881 and 1891. It was still decreasing in 1899, when it had become 2.5". The orbital swing is also very apparent in the change of the position angle.

The telescopic gem of Boötes, and one of "the flowers of the sky," is epsilon, also known as Mirac. When well seen, as we shall see it to-night, epsilon Boötis is superb. The magnitudes of its two component stars are two and a half (according to Hall, three) and six. The distance is about 2.8", p. 326°. The contrast of colors--bright orange yellow, set against brilliant emerald green--is magnificent. There are very few doubles that can be compared with it in this respect. The three-inch will separate it, but the five-inch enables us best to enjoy its beauty. It appears to be a binary, but the motion is very slow, and nothing certain is yet known of its period.

In delta we have a very wide and easy double; magnitudes three and a half and eight and a half, distance 110", p. 75°. The smaller star has a lilac hue. We can not hope with any of our instruments to see all of the three stars contained in , but two of them are easily seen; magnitudes four and seven, distance 108", p. 172°. The smaller star is again double; magnitudes seven and eight, distance 0.77", p. 88°. It is clearly a binary, with a long period. A six-inch telescope that could separate this star at present would be indeed a treasure. Sigma 1926 is another object rather beyond our powers, on account of the contrast of magnitudes. These are six and eight and a half; distance 1.3", p. 256°.

Other doubles are: 44 (Sigma 1909), magnitudes five and six, distance 4.8", p. 240°; 39 (Sigma 1890), magnitudes both nearly six, distance 3.6", p. 45°. Smaller star light red; iota, magnitudes four and a half and seven and a half, distance 38", p. 33°; kappa, magnitudes five and a half and eight, distance 12.7", p. 238°. Some observers see a greenish tinge in the light of the larger star, the smaller one being blue.

There are one or two interesting things to be seen in that part of Canes Venatici which is represented on map No. 11. The first of these is the star cluster 3936. This will reward a good look with the five-inch. With large telescopes as many as one thousand stars have been discerned packed within its globular outlines.

The star 25 (Sigma 1768) is a close binary with a period estimated at one hundred and twenty-five years. The magnitudes are six and seven or eight, distance about 1", p. 137°. We may try for this with the five-inch, and if we do not succeed in separating the stars we may hope to do so some time, for the distance between them is increasing.

Although the nebula 3572 is a very wonderful object, we shall leave it for another evening.

Eastward from Boötes shines the circlet of Corona Borealis, whose form is so strikingly marked out by the stars that the most careless eye perceives it at once. Although a very small constellation, it abounds with interesting objects. We begin our attack with the five-inch on Sigma 1932, but not too confident that we shall come off victors, for this binary has been slowly closing for many years. The magnitudes are six and a half and seven, distance 0.84", p. 150°. Not far distant is another binary, at present beyond our powers, eta. Here the magnitudes are both six, distance 0.65", p. 3°. Hall assigns a period of forty years to this star.

The assemblage of close binaries in this neighborhood is very curious. Only a few degrees away we find one that is still more remarkable, the star gamma. What has previously been said about 42 Comæ Berenicis applies in a measure to this star also. It, too, has a comparatively small orbit, and its components are never seen widely separated. In 1826 their distance was 0.7"; in 1880 they could not be split; in 1891 the distance had increased to 0.36", and in 1894 it had become 0.53", p. 123°. But in 1899 Lewis made the distance only 0.43". The period has been estimated at one hundred years.

While the group of double stars in the southern part of Corona Borealis consists, as we have seen, of remarkably close binaries, another group in the northern part of the same constellation comprises stars that are easily separated. Let us first try zeta. The powers of the three-inch are amply sufficient in this case. The magnitudes are four and five, distance 6.3", p. 300°. Colors, white or bluish-white and blue or green.

Next take sigma, whose magnitudes are five and six, distance 4", p. 206°. With the five-inch we may look for a second companion of the tenth magnitude, distance 54", p. 88°. It is thought highly probable that sigma is a binary, but its period has simply been guessed at.

Finally, we come to nu, which consists of two very widely separated stars, nu^1 and nu^2, each of which has a faint companion. With the five-inch we may be able to see the companion of nu^2, the more southerly of the pair. The magnitude of the companion is variously given as tenth and twelfth, distance 137", p. 18°.

With the aid of the map we find the position of the new star of 1866, which is famous as the first so-called temporary star to which spectroscopic analysis was applied. When first noticed, on May 12, 1866, this star was of the second magnitude, fully equaling in brilliancy alpha, the brightest star of the constellation; but in about two weeks it fell to the ninth magnitude. Huggins and Miller eagerly studied the star with the spectroscope, and their results were received with deepest interest. They concluded that the light of the new star had two different sources, each giving a spectrum peculiar to itself. One of the spectra had dark lines and the other bright lines. It will be remembered that a similar peculiarity was exhibited by the new star in Auriga in 1893. But the star in Corona did not disappear. It diminished to magnitude nine and a half or ten, and stopped there; and it is still visible. In fact, subsequent examination proved that it had been catalogued at Bonn as a star of magnitude nine and a half in 1855. Consequently this "blaze star" of 1866 will bear watching in its decrepitude. Nobody knows but that it may blaze again. Perhaps it is a sun-like body; perhaps it bears little resemblance to a sun as we understand such a thing. But whatever it may be, it has proved itself capable of doing very extraordinary things.

We have no reason to suspect the sun of any latent eccentricities, like those that have been displayed by "temporary" stars; yet, acting on the principle which led the old emperor-astrologer Rudolph II to torment his mind with self-made horoscopes of evil import, let us unscientifically imagine that the sun could suddenly burst out with several hundred times its ordinary amount of heat and light, thereby putting us into a proper condition for spectroscopic examination by curious astronomers in distant worlds.

But no, after all, it is far pleasanter to keep within the strict boundaries of science, and not imagine anything of the kind.