ASTRONOMY

Orion Comes Into View

Glorious Constellation Aids Location of Many Brilliant Heavenly Bodies That Decorate December Evening Skies

By JAMES STOKLEY

MARKING the last month of the year, the glorious constellation of Orion, perhaps the finest in the heavens, comes into view in the southeastern evening sky. Even persons who are not students of the constellations will probably recognize the familiar row of three stars that form the heavenly warrior's belt. To the ancients, Orion was a mighty hunter, who, with upraised club and lion skin thrown over one arm, was about to smite the bull, Taurus, represented in a neighboring constellation.

This evening in the southeast, if it is clear, you can see these stars, the belt almost upright and the warrior in the somewhat undignified position of lying on his back. To the north of the belt is the brilliant star Betelgeuse, to the south, Rigel, and above, Bellatrix.

The stars of the belt also have names. The lowest is called Alnitak, the middle Anilam and the top Mintaka. Like Bellatrix, these stars are of the second magnitude, Betelgeuse and Rigel being of the first.

Beautiful Object

Extending southward from Alnitak is a curved row of fainter stars that forms the warrior's sword. In this sword is one of the most beautiful objects revealed by the telescope, the great nebula of Orion. A vast cloud of glowing gas so huge that a beam of light requires 600 years to cross it, this nebula is estimated to contain ten thousand times the sun's mass. Even a small telescope will show it as a hazy patch around theta Orionis, one of the stars in the sword.

Above Orion is the bull, Taurus, which the warrior is about to strike. Follow a line upward through the belt and Bellatrix, and you come to a bright reddish star. This is Aldebaran, the eye of the bull.

Taurus is one of the constellations marking the ecliptic, the path of the planets, the sun and the moon. Four thousand years ago, Taurus was at the vernal equinox, the position of the sun on the first day of spring. But by means of the phenomenon called precession (often misprinted "procession") the entire celestial sphere, with all the constellations, slips around the ecliptic once in about 26,000 years. Two thousand years ago, the vernal equinox had moved into the next constellation of Aries, and today it is in the next one, Pisces.

Astrologers Neglect Precession

Astrologers, who think they can tell fortunes by studying the stars, pay no attention to that fact. They still talk about the position of the planets in the various signs, and the signs are not in accord with the way the constellations are today, but the way they were two thousand years ago.

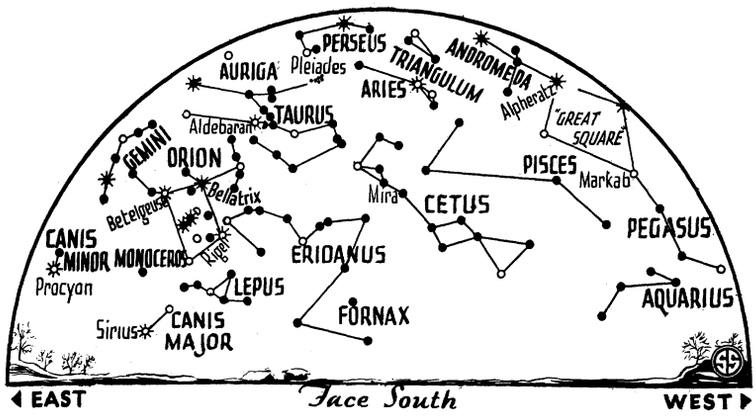
Aldebaran belongs to a loose V-shaped cluster of stars called the Hyades. In the same constellation, Taurus, there is an even more famous loose cluster, which can be seen above the Hyades, nearly directly overhead. This is the Pleiades. Six stars can be seen with the naked eye, but even a pair of opera glasses increases the number, and, with a small telescope, as many as a hundred become visible. Photographs with great telescopes show thousands, and also reveal that the group is enveloped in a nebulous cloud which seems to shine by reflected starlight. The distance of the cluster is supposed to be about 350 light years, and it is about 35 light years in diameter.

Now look below Orion, and you will see the most brilliant star in the sky, Sirius, the dog star, marking Canis Major, one of the two dogs accompanying the hunter. The other, Canis Minor, is farther north, and is marked by the bright star Procyon. Sirius is of magnitude minus 1.58, so that it is about 325 times as brilliant as a sixth magnitude star, the faintest that we can see with the unaided eye. Though it is about 27 times as brilliant as our sun, which is also a star, it is not really of exceptional brilliance, for many other stars have far greater candlepower. Rigel, for example, is of about 14,000 times the sun's intrinsic brilliance though it looks considerably fainter than Sirius.

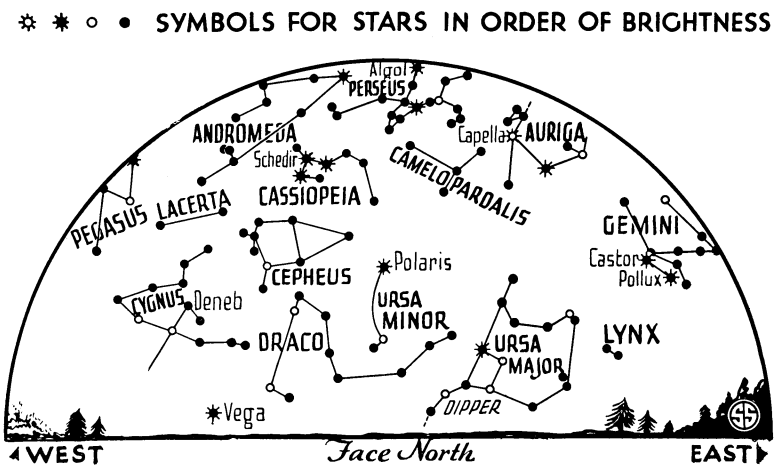
But Rigel is so distant that its light takes 460 years to reach us, travelling all the time at a speed sufficient to take it across the United States in a sixtieth of a second. Sirius is a close neighbor, however, only 8.7 light years distant. Expressed in miles, which are really rather meaningless when applied to such vast distances, this is about 52 trillion. No other naked-eye star that we can see from the latitude of most of the United States is so near.

"By Jiminy"

Procyon, in Canis Minor, is low in the east, and above it is the constellation of Gemini, the twins. Castor and Pollux are the names of the youngsters. Pollux, the brighter of the two, is nearer the horizon. Gemini is another of the constellations marking the ecliptic, and like Taurus it dates back to very early times. Castor and Pollux were favorite Roman deities; among the best known of Roman ruins are their tem-



Sirius, low in the southeast, is the most brilliant star in the sky.



The star Capella in the constellation Auriga is the most northerly of first magnitude stars this month. Though its two bodies cannot be distinguished through even the largest telescope, astronomers have found that this is a double star.

ples at Rome and Girgenti. Ancient mariners used to swear by them, and a corruption of this ancient oath survives in our modern "by jiminy."

Above the twins is the charioteer, Auriga, in which we find the brilliant Capella, most northerly of the first magnitude stars, and visible from these latitudes at some time every night. It is 150 times as bright as the sun, and 47 light years distant. Capella is the best known of a large class of stars called spectroscopic binaries. Something like six per cent. of the stars in the sky are shown by existing telescopes to be double, that is, to consist of two separate bodies which revolve around their common center. Besides, there are many other doubles so close to each other that no existing telescope is able to reveal directly the two bodies of the system. Only by analyzing their light through the prisms of the spectroscope is their true nature revealed.

Everyone knows how, when a fire engine races down the street, its bell or siren sounds of a higher pitch when approaching than when receding. The same thing can be noticed with the bell or whistle of a locomotive. The pitch of a bell depends on the distance between the sound waves entering our ears. When they are close together, the sound is high-pitched, or shrill, and when the waves are farther apart, it is deep, or low-pitched. But if the source of the sound, the fire engine siren, for instance, is rapidly approaching us, one wave leaves the siren, and then, before the next one has left, even though it is only a fraction of a second later, the engine has moved a little closer, and consequently the next wave reaches us a little sooner than it would have otherwise. Thus, the distance between the waves of an approaching source of sound is shortened, while if it is receding, the waves are spaced farther apart.

Exactly the same thing happens with light, and for the same reason. Only instead of changing the pitch, there is a shift in the dark lines crossing its spectrum that can be photographed with the spectroscope. This fact is used for measuring the speed of approach or recession of the stars. If the star is approaching, these lines are moved to the blue end of the spectrum, while if it is receding, they are shifted towards the red end. The greater the shift, the faster the motion of the star.

Hidden Doubleness

The spectrum of Capella changes in a singular way. Its lines are sometimes single, and sometimes double. Astronomers interpret this as meaning that the star is really double, the two components being too close to be seen with any telescope. But as they revolve around each other there is a time when the two stars are in line with the earth, and hence neither one is approaching or receding. Then the lines are single. Later there comes a period when, if we could see the stars, they would appear side by side, one star going from us, the other toward us. The former then causes the red shift, and the latter the blue, so that the single line splits into two. This process repeats periodically, and from it astronomers have found that a complete revolution of one star about the other is completed in 104 days.

Still higher than Auriga, close to the zenith, is the group of Perseus, representing the famous champion who slew Medusa. The stars of Perseus are arranged in the shape of a V, with its point now directed to the north. The eastern part of the V is curved over towards the eastern horizon, while the western line is more nearly straight. Next to the southernmost star on the western side is the famous variable star Algol, which is usually of the 2.1 magnitude, fairly bright. But look at this star at any of the following times: December 10, 2:10 a. m.; December 12, 11:00 p. m.; December 15, 7:50 p. m.; or December 30, 3.50 a. m. (all Eastern Standard). Then you will find it much fainter, of magnitude 3.2.

If you watch it steadily you will observe that about five hours before the times mentioned it starts to diminish in brightness, and five hours afterwards it has returned to its normal brilliance. The reason for this is that Algol is also a double star, but instead of the two components being of approximately the same brightness, one is much darker than the other. Once every 69 hours, the fainter star partially eclipses the brighter one. Of course, the star is so distant that we can not see part of the disc of one star covered by the other, but the light is reduced; and the studies of astronomers have left no possible doubt that this is the true explanation of the variation of this star. Many other variable stars are known, but not all of them are of this "eclipsing double" type.

Directly west of Perseus is Andromeda, the chained lady. And next to her is Pegasus, the winged horse upon which Perseus rode to her rescue. The Great Square in Pegasus, a familiar guide to the stars, is now resting on one corner, high in the western sky.

The eighth and ninth of the first magnitude stars to be seen in the evening sky this month can be found low in the northwest. The northern cross, in Cygnus, the swan, stands upright, close to the horizon, with Deneb at the top. Lower and farther north is Vega, in Lyra, soon to vanish from the evening sky for a few months.

Planets Retire Early

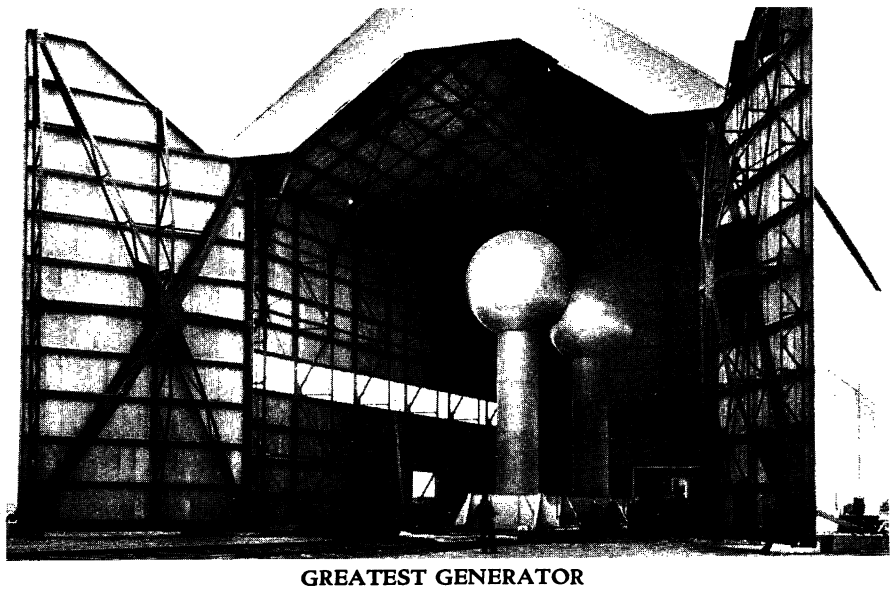
Though no planets are up late enough to be visible at the time that the maps represent (10:00 p. m., December 1; 9:00 p. m., December 15, and 8:00 p. m., December 31), three of them can be seen earlier in the evening. Brightest of all is Venus, which

sets about three hours after the sun, and can be seen before that low in the southwest. On December 31 it will reach its greatest brightness. Then it will be of magnitude minus 4.4, far more brilliant than any other star or planet. Farther west, and considerably fainter, can be seen Mars. Saturn is farther to the east of Venus in the early part of the month. On December 21, at 5:00 a. m., the two planets pass, at which time Venus will be 20 seconds, about two thirds the moon's diameter, to the south. But, of course, at that hour they will not be visible from any part of the United States. On the previous evening, however, they will be close together, with Venus to the west, and on the next day they will be close, but with their relative positions reversed. It will be interesting to watch them night by night through the month as they draw close together, then spread apart.

In addition, the moon enters the picture. On the twentieth, at 2:04 a. m., it passes to the north of Venus, at a distance about a third greater than its own diameter. A little more than an hour later, at 3:15 a. m., it passes north of Saturn, at a distance of about two-thirds of its diameter. This also will be invisible to Americans, but the three bodies so close together, on the nights before and after, will form a beautiful spectacle in the west. Coming just before Christmas, it will remind us of the legend of the star which the Wise Men followed to Bethlehem; for one explanation of that object was a conjunction of three planets in the western sky which occurred at about that time.

Sun Farthest South

During December, the moon goes through its phases as follows: on December 1 it is full, on the tenth at last quarter, on the sixteenth new, on the twenty-third at first quarter, and full again on the thirty-first. This will mean moonlit evenings from the first to about the third, and during the last ten days of the month. On December 22, at 1:58 a. m., Eastern Standard Time, the sun, in the course of its annual journey around the sky, reaches its farthest south position, the winter solstice, and this marks the beginning of winter. At this time, also, the sun rises latest and sets earliest, for us in the northern hemisphere. In the southern hemisphere conditions are reversed. There summer begins on this day, which is for them the longest of the year.



GREATEST GENERATOR

An airship hangar was needed to house the Van de Graaff generator.

PHYSICS

Scientists Unleash Largest Atom-Attacking Machine

SEVEN MILLION volts, man's closest approach to the voltage of nature's lightning, flashed across the gigantic ball terminals of science's greatest generator, erected by Massachusetts Institute of Technology physicists in Col. E. H. R. Green's airship hangar at Round Hill, Mass., and operated Tuesday for the first time at so great an electric potential.

Sparks forty feet long were sent arcing between the two huge metal spheres of the generator. Though the seven million volts achieved is three times the highest direct current potential heretofore attained, it is less than the generator's full designed voltage by three million volts. A full voltage test was not attempted because high wind prevented taking the machine into the open, but the designer feels confident that ten million volts will be produced on the first outdoor attempt.

This is the opening report in an investigation of some of the most important and fundamental of nature's secrets and it may have far reaching consequences in even the commercial generation of electric power.

A few years ago there was a young Rhodes scholar at that old English university, Oxford. Puzzling upon the problem of power for smashing the atom and studying its internal structure, Dr. Robert J. Van de Graaff went back to the idea of the old-fashioned static generator for electricity, the sort of electrical machine used by Ben Franklin, pioneer American scientist.

Modern electrical generation had developed along the line of electro-magnetism and Dr. Van de Graaff revived the other principle and built it into a modern machine. He went to Princeton University as a National Research Fellow, and built a small laboratory model of his generator at the cost of a few hundred dollars. It produced between 1,000,000 and 1,500,000 volts, the highest direct voltage current ever attained up to that time. Much more expensive apparatus, upon which other scientists had worked for years had been able to produce only 800,000 volts direct current.

Working with Dr. Karl T. Compton, then professor of physics at Princeton, Dr. Van de Graaff joined the M. I. T. staff when Dr. Compton became president of that school.

With the aid of associates, they visualized a giant generator, the electricity producing machine that in its tests has fulfilled their expectations.

No conventional building at the Massachusetts In- *(Turn to Page 366)*