lutions being increased to 142 per minute. The coal supply, owing to the increased displacement, has been raised from 220 to 500 tons, and a number of minor changes have been made which give the boat an up to date appearance. The coasting cruisers, when thus transformed, will be able to take an active part with the remainder of the fleet, and there is no doubt that the whole series will be thus treated. To transform the eight vessels will cost about five millions, according to calculations, this representing the cost of a single modern battleship, and the advantage is at once apparent.

THE HEAVENS IN JULY.

BY HENRY NORRIS RUSSELL, PH.D.

The brightest stars in the summer skies are the ruddy Arcturus and the bluish Vega. At 9 P. M. on July 15 the former is some distance west of the zenith, and the latter somewhat nearer on the east. Between them lie the constellations of Corona Borealis and Hercules, the first of which consists of a semicircle of inconspicuous stars, and the second of a keystone-shaped group directly overhead, with outliers on both sides. South of these a large area is filled by the intermingled forms of Ophiuchus and Serpens, whose most characteristic configuration is a kite-shaped figure a little west of the meridian.

Close above the southern and southeastern horizon are Scorpio and Sagittarius. The bright red star Antares, and the long, curving line below it which forms the Scorpion's tail, cannot be mistaken; and Sagittarius, which is anyhow one of the more conspicuous zodiacal constellations, now includes within its borders both Jupiter and Saturn.

Aquila, marked by the brilliant Altair, with a fainter attendant on each side, is well up in the southeast. Below it is Capricornus, whose two brightest stars both show double in a field-glass. Cygnus is conspicuous in the Milky Way below Vega. Farther down on the right is the little group of Delphinus, often called "Job's Coffin." Pegasus and Andromeda are rising in the northeast. Of the circum-polar constellations, Cassiopeia is below and to the right of the pole, Cepheus higher up, Draco and Ursa Minor above the pole-star, and Ursa Major on the left. Leo, Virgo and Libra fill most of the western and southwestern sky.

The present is a good opportunity for the study of some interesting variable stars. First among these may be mentioned Beta Lyrae, which is the nearest to Vega of a pair of small stars which lie on the line joining it with Altair, about one-quarter as far as the latter. The changes of its brightness may be easily observed by comparing it with its neighbor, Gamma Lyrae. They are completed in 12 days 21¾ hours, during which time there are two equal maxima of brightness, separated by two unequal minima. Beginning at the first maximum, its magnitude is 3.4, about equal to Gamma. Then it falls nearly to the fourth magnitude, rises again to its original brightness, and descends once more to the 4½ magnitude, returning finally at the end of the period to its initial condition. The star's spectrum also shows remarkable peculiarities, containing both dark and bright lines, which are periodically displaced with reference to one another in such a way as to show that they are produced by two different bodies revolving about one another in a period equal to that of the light-variation.

The following explanation of the star's variability, deduced from the above-mentioned facts, is taken from an article by Mr. Myers, published some time ago in the Astrophysical Journal. Beta Lyrae consists of two stars, one about three-quarters the diameter of the other, revolving about one another, in a circular orbit, so close together that they almost touch. The plane of this orbit is inclined very little to the line of sight, so that the stars alternately eclipse one another. The smaller star is nearly twice as bright as the larger one.

At the principal minimum, the small star is behind the larger one, and only the light of the latter reaches us. Three days later it is on one side, and the combined light of both stars produces a maximum. After about three days more the small star is in front of the large one, hiding most of it. All the light of the small star and part of that of the large one reaches us, so that, though the star does not appear to us as bright as at maximum, it is much brighter than at the principal minimum. When the small star has moved off on the other side we have a second maximum. The actual velocities of the stars in miles per second can be determined from the spectroscopic observations, and thus it is found that the centers of the two stars are about 30,000,000 miles apart. The larger star is over 30,000,000 miles in diameter, and is about 21 times as heavy as our sun The diameter of the smaller one is about 23,000,000 miles, and its mass nearly 10 times that of the sun. Their bulk, in proportion to their mass, is enormous, so that they must be entirely gaseous and hardly denser than the earth's atmosphere at sea-level.

Two other short-period variables are now in good position for observation. On the upper edge of the Milky Way, about midway between Cygnus and Cassiopeia, is a triangle of small stars. The nearest one to Cassiopeia is Delta Cephei, which varies between the magnitudes 3.7 and 4.9 in 5 days, 8 hours and 48 minutes. The other two stars of the triangle are good "comparison stars."

To find the other variable, start with Altair. A line drawn from the small star above it through the fainter one below it, and continued as far again, bending sharply to the right, points out Eta Aquilae. The period of this star is 7 days, 4 hours and 14 minutes, its maximum magnitude is 3.5, and its minimum 4.7.

The variation of both these stars is of the same type. The brightness changes continuously, rising rapidly to the maximum, and falling off much more slowly toward the minimum. In the case of Eta Aquilae a slight rise to a secondary maximum interrupts the falling phase. Such variation evidently cannot be due to eclipses, as the times of fall and rise would in that case be nearly equal, since the eclipsing star would move off about as fast as it moved on.

The variation of both these stars is of the same problem. Both stars show variable velocity in the line of sight, and by study of this it has been found that each of them is revolving in a highly eccentric orbit about a dark body—or rather about the common center of gravity of itself and the dark body—in the same period as that of the light-variation. The minimum does not occur when the dark star is between us and the bright one, and so we have additional proof that it is not due to an eclipse. It is also clear that the orbit must be inclined to the line of sight so that the dark star passes to one side of the bright one instead of directly in front of it, as otherwise we should have an eclipse and a second minimum.

The accepted explanation of the variability of these stars is that it is due to tidal action. The attraction of the dark companion must produce enormous tides in the liquid—or, most probably, gaseous—mass of the central star. Owing to the eccentricity of its orbit (which is about the same in both cases under consideration), the least distance of the dark body is but one-third of its greatest, and, since the tide-raising force varies inversely as the cube of the distance, it is 27 times greater at one time than at the other.

As the two bodies approach one another, the increasing disturbance of the atmosphere of the luminous one increases its brightness, the effect reaching its maximum shortly after the passage of the nearest point, or periastron. With the decrease of the tidal force the bright star gradually cools down, rising again only when the return of its satellite stirs up once more its central fires.

THE PLANETS.

Mercury is in Gemini, and is evening star till the 12th, when he passes between us and the sun, and becomes morning star. He can only be seen in the last days of the month, just before sunrise.

Venus is evening star, and is gradually coming out from behind the sun into a more conspicuous position, remaining above the horizon more than an hour after sunset.

Mars is evening star, being well past the meridian at sunset. He is more than twice as far from us as he was in February and only about one-sixth as bright, and is still retreating and growing fainter as he moves eastward from Leo into Virgo.

Jupiter is just past opposition, and at his nearest for the year. He is by far the most brilliant object in the southern sky, and his disk and satellites are easily visible with a field-glass.

Saturn is in Sagittarius, close to Jupiter. He is in opposition on the 5th. His rings are seen at the greatest possible angle and form a splendid telescopic sight, in spite of his low altitude.

Uranus is in Scorpio, about 8 degrees northeast of Antares. Neptune is in Gemini, too near the sun to be visible.

Full moon occurs on the morning of the 1st, last quarter on that of the 8th, new moon on that of the 15th, first quarter on the night of the 22d, and full moon once more on that of the 30th. The moon is nearest us on the 11th, and farthest on the 23d.

She is in conjunction with Jupiter on the afternoon of the 1st, Saturn the next morning, Mercury on the 14th, Neptune on the 15th, Venus near moon on the 17th, Mars on the morning of the 21st, Uranus on the night of the 26th, and Jupiter and Saturn once more on the night of the 28th and morning of the 29th.

DEATH OF T. C. CLARKE.

Mr. Thomas Curtis Clarke, one of the best-known civil engineers and bridge-builders, died in New York, June 15, in his seventy-fourth year. He was trained to be a civil engineer and early in life engaged in various kinds of railroad work, but finally made bridge engineering a specialty, and his name is identified with many of the most important bridges built in the United States. One of the first of his works in this line was the building of the C., B. & Q. bridge at Quincy, Ill. In the piers and foundations of this bridge, Mr. Clarke was among the first of American engineers to use concrete upon a large scale. Mr. Clarke was the senior member of the firm which afterward became the Phoenix Bridge Company. Among the famous works on which he was engaged was the erection of the Kinzua Viaduct. In 1884 Mr. Clarke became one of the members of the Union Bridge Company, which soon became the largest concern devoted to bridge-building in the world. While Mr. Clarke was connected with this company they built the famous Hawkesbury Bridge in Australia, which is one of the first cases where a bridge was built in a foreign country by an American concern. He also had special charge of the Poughkeepsie Bridge. It is stated that Mr. Clarke had been concerned in the building of over eighty miles of bridges and viaducts. He was well known as a writer upon professional subjects.

SCIENCE NOTES.

The Baldwin-Ziegler polar expedition will start shortly for the north.

Mr. Morris K. Jesup has perfected an arrangement by which the American Museum of Natural History and the South Kensington Museum will exchange exhibits.

The Arnold Arboretum, in the suburbs of Boston, has carried on its highly interesting and important work on a very slender income. Steps are now being taken to raise $300,000 in addition to the present endowment.

The Massachusetts Institute of Technology has held examinations in London for the entrance of pupils to the Boston institution. The London Engineer says: "It would seem that American competition is not to be confined to commerce in the future."

Prof. Nicols Finsen, the inventor of the light cure for lupus, has been summoned to London by the Queen of England to superintend the administration of the apparatus which her Majesty presented to the London Hospital. The Belgian government also proposes to install the cure at Brussels, and Prof. Dubois has been dispatched to Copenhagen, to become acquainted with its application.

The invention of the mariner's compass by Flavio Gioja is to be celebrated this summer at Amalfi, Italy. Gioja came from Positano in the hills back of Amalfi. There have not been wanting those who contend that the invention, like most others, was gradual, and that the tendency of the magnetized needle to point north was known long before Gioja's time, it even having been familiar to the Chinese.

Prof. Henry Truman Henry Safford, an eminent mathematician and astronomer, died recently at Williamstown, Mass. He was born in 1836 and was known in his early youth as the "Vermont boy calculator." In 1866 he was appointed Director of the Astronomical Observatory at Chicago. From 1869 to 1871 he was engaged upon the great catalogue of stars then in course of preparation by the co-operation of European and American astronomers. This work was interrupted by the Chicago fire of 1871. He prepared a star catalogue which was published by the War Department. He did considerable work in relation to latitude and longitude.

John D. Rockefeller has given $200,000 to found "The Rockefeller Institution for Medical Research." The gift is not for an endowment fund, but for immediate expenditure. Mr. Rockefeller has for some time been consulting with eminent medical men as to the need of such an institution, and he has had the best of advice. Facilities for original investigation are to be provided, especially in such problems in medicine and hygiene as have a practical bearing on the prevention and treatment of disease. The first work of those connected with the institution will be that of co-operating with the Board of Health in studying its work and the problems confronting it, particularly that of milk supply. Work of a more ambitious nature will be begun in the fall under the guidance of experienced investigators.

In Europe it has been found rather difficult to introduce the circuit-system for the transmission of meteorological messages for a time after each observation. In the United States this is very easily accomplished, but in Europe, where the control of the wires is in the hands of different governments, the difficulty of introducing a similar method is almost unsurmountable. The system recommended by the Deutsche Seewarte is called the radial system, in which the observations pass through the central offices. Special observations have been made for nearly a year at eight A. M., mid-European time, at some thirty-five stations in various countries, including several in the British Isles, and forwarded to the Deutsche Seewarte, which enables the Hamburg office to issue reports as early as nine A. M., and the early publication of this information has been found to lead to such satisfactory results as to warrant a considerable extension of the plan in the near future.