cial classes: red hematite, brown hematite, magnetite, and carbonate. In 1903 the quantity of red hematite mined in the United States was 86.6 per cent of the total for the country, and of that Minnesota contributed over one-half. Alabama was the most important contributor of brown hematite. The three principal States that mined magnetite in 1903 were New Jersey, New York, and Pennsylvania. The red hematite showed a decrease of about 1 per cent from the production of 1902, the brown hematite and the magnetite a decrease each of 7 per cent. Only the carbonate ores, the least important class, showed an increase over the output of 1902. That increase amounted to no less than 26 per cent. As in 1902, all of this class of ore was obtained in Ohio and Maryland.

The Lake Superior district stands pre-eminent as a producer of iron ore. Its annual output exceeds that of any foreign country, and the average character of its ore is excellent. In the year 1903 the Mesabi and Vermilion ranges in Minnesota, the Marquette range in Michigan, and the Menominee and Gogebic ranges in Michigan and Wisconsin produced a total of 26,573,271 long tons of iron ore. Of this ore the Mesabi range alone produced 51 per cent. In addition to the above-named ranges in the United States, a sixth, the Michipicoten range, was opened in Canada in the year 1900, but its product in 1903, 223,976 long tons, is not included in the above data.

Of special interest in connection with the production of Wisconsin is the fact that the year 1903 witnessed the initial output of iron ore in the new Baraboo iron range, near the town of Freedom, in the southern part of the State. These deposits of Bessemer ore, which are within convenient railroad haul of the blast furnaces at Chicago, Ill., may furnish important additions to the ore supply of these furnaces.

The State of Pennsylvania showed a decline of 22 per cent from the total of 1902. This decline is due almost entirely to the diminished output of one of the large mines, the Cornwall Ore Hills, to which Pennsylvania has been mainly indebted for its position as a prominent producer of iron ores. New Jersey, on the other hand, showed an increase of nearly 10 per cent over its 1902 production. The construction of several modern furnaces was the chief cause of the increased output in New Jersey, and it is probable that an augmented production may be expected in the near future.

The total value at the mines of the 35,019,308 long tons of iron ore produced in the United States in the year 1903 was $66,328,415, or $1.89 a ton, an increase of 5 cents a ton, or 3 per cent, over the value per ton in 1902, viz., $1.84. In 1903 the highest average value at the mine was placed on the Colorado iron ores, viz., $3.12 a ton, and the lowest on Texas ores, $1 a ton.

Iron ore to the amount of 980,440 long tons, valued at $2,261,008, or $2.31 a ton, was imported into this country in 1903 from Cuba, Canada, Spain, Newfoundland, Algeria, the United Kingdom, British Columbia, Belgium, and Germany. It is evident from the relatively high value placed on the ores from some countries that the estimate is based on some other constituent than the iron contained in the ore. The total export of iron ore in the year 1903 was 80,611 tons, valued at $255,728. The greater portion of this went to blast furnaces located in the Province of Ontario, Canada.

THE HEAVENS IN SEPTEMBER.

BY HENRY NORRIS RUSSELL, PH.D.

The principal item of astronomical news for the past month comes from the Harvard Observatory. It may be remembered that in 1899 the announcement was made that a faint satellite of Saturn had been discovered upon photographs taken at the Harvard station at Arequipa, Peru. So long a time has passed since then that astronomers were beginning to fear that the satellite had been "lost," because it had not been possible to obtain enough observations to determine its orbit. But a short note from Harvard, which appeared a few weeks ago, sets these doubts at rest.

The satellite has been photographed on many occasions in the last five years, and a long series of observations obtained this spring has made it possible to calculate the orbit, and predict the satellite's motion accurately. The details of this are to be published in the "Harvard Annals," but have not yet reached us.

The following facts have, however, already been published: The period of the satellite is about a year and a half and its distance from Saturn is nearly 8,000,000 miles. It is an exceedingly faint object, its magnitude being about 15½, and it requires a telescope of two feet aperture to see it at all—though it can be better observed photographically. Judging by its brightness, its actual diameter is about 200 miles.

This satellite, the faintest known in the solar system, has been named Phoebe by its discoverer, Prof. W. H. Pickering. Phoebe was a sister of Saturn, and as three of his other sisters, Rhea, Deone, and Tethys, as well as two brothers, Hyperion and Iapetus, are already commemorated among his satellites, she will find herself in good company.

In addition to its extreme faintness, the new satellite is remarkable for its very long period—six times as long as that of any other satellite in the solar system. The calculation of the changes produced in its orbit by the Sun's attraction will furnish a problem of great intricacy, which will keep the theoretical astronomers busy, while to secure accurate observations of so faint an object will demand great technical skill.

The astronomers of the Harvard Observatory are greatly to be congratulated upon this very interesting discovery—especially Prof. W. H. Pickering, who discovered the satellite by a comparison of photographs, and Dr. Stewart, who took the plates at Arequipa.

The European delegates to the Astronomical Conference at the St. Louis Exposition are now in America. The English delegate, Prof. Turner, of Oxford—the present president of the Royal Astronomical Society—has visited America several times, and requires no introduction; but the name of his colleague, Prof. Kapteyn, of the University of Groningen, in Holland, may be less familiar.

He is probably unique among astronomers in being the director, not of an observatory, but of a laboratory—an institution whose business is not the making of observations, but the working up of observations made by other people.

With a modern photographic telescope, it is possible to take so many plates in one night that weeks are required for their measurement and reduction. Very few such instruments can therefore be worked to anything like their full power, simply because few, if any, observatories have a large enough staff to handle the enormous amount of material that would be obtained.

Prof. Kapteyn, who had no large telescope at his disposal, conceived the idea of working in co-operation with some one who had one, and entered into an arrangement with Sir David Gill, by which a great number of plates taken at the Cape of Good Hope were forwarded to Holland for discussion. The result of twelve years' work appears in the three bulky volumes of the "Cape Photographic Durchmusterung," containing a catalogue of the places of more than 450,000 stars in the southern sky.

Since the completion of this great work, there have appeared a series of the "Publications of the Astronomical Laboratory of Groningen," some of which deal with the parallaxes of stars and clusters determined from measures of plates taken at other observatories, and forwarded to Groningen for reduction, while others, treating of mere general topics, such as the average distance of stars of a given magnitude, or the relative numbers of stars of different degrees of actual brightness, are perhaps the most important contributions that have been recently made to our knowledge of the sidereal universe.

All this work is of the highest scientific value, and the fact that it has been done with relatively very inexpensive apparatus points a useful moral.

There is no way in which an American amateur astronomer, or a professor in a small college, could do more useful astronomical work than by following Prof. Kapteyn's example, and working up photographs in co-operation with some great observatory.

A good deal of work of this kind has been done at Columbia University, as its long list of publications dealing with the Rutherford photographs testifies; and recently this work has been taken up at some other observatories—for example, at Vassar—but there is still plenty of room for more workers.

This sort of work is admirably fitted for the smaller colleges. A measuring machine of the highest accuracy costs only a few hundred dollars, and if used in co-operation with one of the great observatories, work of the highest quality could be done with a relatively small outlay. There is no doubt that photographs would be available for any one who knew how to use them.

This would be particularly good work for students, as its educational value is great, and it can be done at the student's own time, involving no night work, and being independent of the weather.

It is much to be hoped that a number of "astronomical laboratories" may soon be founded in the United States.

THE HEAVENS.

The brightest constellations now in sight lie in or near the Milky Way. Cygnus is directly overhead at nine o'clock in the evening in the middle of September, and Lyra is west of it. Aquila is south of Cygnus, just past the meridian, and Sagittarius is below it on the right.

Capricornus is due south. It contains no bright stars, but at present it includes Saturn, which is the brightest object in the southern sky. Aquarius and Pisces, which lie in the southeast, contain no bright stars, but Fomalhaut, which is south of them, in the constellation of the Southern Fish, is fairly conspicuous.

Pegasus lies above these, with Andromeda and Perseus on the left, and Aries below the two. Cassiopeia and Cepheus are in the Milky Way, between Perseus and Cygnus, and Auriga is rising in the northeast.

Boötes is low in the west, beginning to set. Corona and Hercules lie between it and Lyra. Ophiuchus and Serpeus fill the southwestern sky. Ursa Major is low in the northwest, with Draco and Ursa Minor above it.

THE PLANETS.

Mercury is evening star until the 15th, when he passes through inferior conjunction and becomes a morning star. He is invisible to the naked eye except for the last week of the month, when he rises about an hour before the Sun.

Venus is evening star in Virgo, setting about an hour after sunset. On the 23d she is quite near the bright star Spica.

Mars is morning star in Cancer and Leo, and is slowly moving out to the westward of the sun. He rises between 4.30 and 5 A. M. On the 28th he passes within a degree of the bright star Regulus.

Jupiter is on the borders of Pisces and Aries, and rises at about 8 P. M. in the middle of the month. His satellites afford a very interesting study for a telescope of three inches aperture or larger. On the evening of the 24th there is a specially interesting display, as the third and second satellites are successively eclipsed, and a little later the first satellite and its shadow cross the disk of the planet.

Saturn is evening star in Capricornus, southing at 10.30 P. M. on the 1st and at 8.30 on the 30th, and is well placed for evening observation.

Uranus is evening star in Sagittarius. On the 19th he is in quadrature, and comes to the meridian at 6 P. M.

Neptune is morning star in Gemini, and is observable before sunrise.

THE MOON.

Last quarter occurs at 10 P. M. on the 2d, new moon at 3 P. M. on the 9th, first quarter at 10 A. M. on the 16th, and full moon at 1 P. M. on the 24th. The moon is nearest us on the 9th, and farthest away on the 23d.

She is in conjunction with Neptune on the 4th, Mars on the 7th, Mercury and Venus on the 10th, Uranus on the 16th, Saturn on the 20th, and Jupiter on the 26th.

On the 9th of September there is a total eclipse of the sun. It is a remarkably long one—the duration of totality reaching six minutes—but, unfortunately, the track of the shadow, though 9,000 miles long by over 100 miles wide, lies entirely in the Pacific Ocean, without encountering any land at all, except at the extreme end. The eclipse can therefore only be observed on board ship, which precludes the use of telescopes and makes it improbable that any observations of much scientific value will be obtained.

Cambridge Observatory, England.

SCIENCE NOTES.

The relations between transparency, color, and temperature of the water are discussed by O. d'Aufsess in Ann. d. Physik.; the color affects the temperature, the temperature does not affect the color. It is not necessary to make comparative transparency observations always under the same conditions of the sky; the author found with his white disk, 1 meter in diameter, the same transparency value at noon with a cloudless sky, and after sunset. To study the influence of organic compounds which turn the color into yellow, he filtered water through vegetable earth, and determined the amount of soluble organic matter in the lake water.

For the meteorological service in German East Africa H. Maurer has devised a sun-dial which has proved useful at twenty stations whose magnetic declination is unknown and whose latitude is only known within half a degree. The instrument is disk-shaped. The dial forms a semi-cylindrical surface, the axis of the cylinder, the style, lying in the plane of the framing. When the style is mounted parallel to the earth's axis, a plummet rests against the quadrant plane and marks the latitude on it. There is a notch in the style, producing on the dial a spot of light, whose position is, by turning the instrument, adjusted to the sun's declination for the day according to a table.

At the International Hydrographical conference recently held at Copenhagen, the Scottish delegate, Mr. Robertson, of Dundee, described some recent and interesting new discoveries he had made concerning the Gulf Stream. It has heretofore been popularly believed that the section of the Gulf Stream which reaches the Faroe Islands goes direct to Norway. Mr. Robertson has discovered from the result of his investigations that the section, however, travels first to the Shetland Islands and then to Norway. He also pointed out that the Southern Gulf Stream sends a section to the North Sea which runs along the coast of Scotland and the North of England, touches Jutland, and then travels north. The high degree of saltness and the temperature in the North Sea this hydrographer has found to be purely attributable to this source.