devised and tested for insulating the plates from the bottom of the jar. All this took a great deal of time, as Mr. Edison was very thorough. Later, after he had solved the problem of capacity at varying rates of discharge, he took up again the question of rubber for insulating purposes, and finally succeeded in treating it so as to overcome the difficulties and so that it can now be used without any damage to the cell.

The "D" type cell showed a considerable advance over the "C" type. There was 35 per cent more surface area of active material in this type cell, which contained 18 positive plates of nickel and 18 negative plates of iron. When discharged at a 150-ampere rate, this cell gave only 4 ampere hours, or 2 per cent, less capacity than when discharged at a 10-ampere rate, and there was no difference in ampere hour capacity between a 30- and a 120-ampere discharge rate.

The present, or "E" type, cell is perfect as regards falling off in capacity at a high rate of discharge. This cell can be discharged at five times the norma' rate without any loss whatever in ampere-hour ca ıcity. This type of cell having 18 plates (6 iron and 12 nickel), weighs 47¾ and 54¼ pounds per horse-power-hour at a 30- and 120-ampere discharge rate respectively. At the former rate of discharge, the "E" cell gives 15.56 watt-hours per pound as against 14.7 watt-hours per pound—the figure given by Dr. Kennelly in his paper read in May, 1901. The comparison between the lead cell and the nickel-iron cell was neatly made by a photograph showing two of the latter cells in one pan of a balance, which was elevated by a single lead cell in the other pan. The lead cell weighed 27½ pounds against 25 pounds for the two Edison cells (which is equal to a net gain of 9 per cent in weight), and the latter had 34 per cent more energy, their watt-hour capacity being 375. The space they occupied, however, was only slightly greater than that taken up by the lead cell. The three sizes of cells that are now being manufactured are a 12½-pound, 18-plate, 110-ampere-hour cell; a 17¼-pound, 27-plate, 165-ampere-hour cell; and a 28-pound, 45-plate, 275-ampere-hour cell. These cells, by a considerable overcharging, can be made to give 140, 220, and 350 ampere-hours respectively. The first cost of an Edison battery is nearly double that of a lead battery of equal capacity, a fact mentioned not by Mr. Fliess, but by one of the audience who took part in the discussion. At a four-hour rate of charge, Mr. Fliess claimed for the Edison battery 55 to 60 per cent watt hour efficiency, while the watt hour efficiency of a good lead battery is about 75 per cent. Discharging the Edison cell at high rates for short periods decreases the energy output but slightly. Between the normal and five times the normal rate of discharge, the efficiency of an Edison cell varies between 55 and 44 per cent only, while the efficiency of a lead cell under the same conditions varies from 75 per cent to 38 per cent.

If the battery is charged in two hours at 75 amperes instead of in 3¾ hours at 40, the total loss in efficiency due to the use of this high rate is only 6.6 per cent, whereas the saving in time amounts to 46 2-3 per cent. At still higher rates of charge, such as 120 amperes for 2¼ hours instead of 30 amperes for 9 hours, the loss of efficiency in output increases in a slightly greater ratio than that of the saving in time. For instance, in the case just cited, there is a saving of 75 per cent in time, with a loss of 12 per cent in efficiency. The voltage on charge reaches 1.85 volts when the cell is about two-thirds charged. From that point on, the charge curve is a straight line, no matter how much longer the cell is charged. On this account there is no way of telling when the cell is charged, except by keeping account of the amount of current that has been put in. A recording ammeter for the discharge and charge will of course overcome this difficulty.

With regard to the durability of the cell, Mr. Fliess stated that a three month's test in a specially devised bumping apparatus, during all of which time the cell was being constantly charged and discharged, failed to show a loss of active material or capacity. Tests on the road covering over 5,000 miles under the most severe conditions failed to cause any deterioration. This would go to show that the life of the Edison cell is extremely long.

THE HEAVENS IN MAY.

BY HENRY NORRIS RUSSELL, PH.D.

Though the evening skies are not very brilliant at present, there is yet much worth seeing in them. In identifying the principal constellations, let us begin with Ursa Major, which, at our usual hour of 9 P. M. on the 15th, lies just north and west of the zenith, the Dipper being most nearly overhead. The star at the bend of the handle—Mizar—is a fine naked-eye double, having a companion of the 5th magnitude, at a distance of some 12 minutes of arc.

Following the curve of the dipper-handle to the southward, we pass several fainter stars in Boötes, and reach Arcturus, the brightest star in this part of the sky. Half way down from this to the horizon, and rather to the right, is the fainter Spica, the principal star of Virgo. Below it and to the right is the little group of Corvus.

Leo lies southwest of the zenith, and Hydra occupies the dull region below him and Virgo.

A series of brighter constellations lies along the course of the Milky Way, which skirts the horizon pretty closely from west through north to east.

Canis Minor is almost due west, Procyon being still an hour high. North of it is Gemini, and then Auriga. Perseus has almost set in the northwest, but Cassiopeia is still visible, right under the Pole. Cepheus comes next on the right, and then Cygnus, which is just rising. Lyra is higher up, so that Vega is the most conspicuous star in the northeastern sky.

Ophiuchus and Serpens are rising in the east, and Scorpio in the southeast. Hercules and Corona Borealis, which lie between Vega and Arcturus, and Draco, which is between them and the Pole, are the only other prominent constellations.

Observers south of latitude 30 deg., that is, in southern Florida and Texas and farther south, can see the Southern Cross at this season, low on the horizon, and, a little later, the two bright stars of Centaurus, which lie some 15 deg. east of the Cross, and point to it.

Certain recent observations relating to some of the asteroids are of sufficient interest to deserve mention here. It will be remembered that these small planets are, for the most part, too small to be seen as disks even in the most powerful telescopes. Only the four brightest ones have measurable diameters, and Prof. Barnard has found that these are from 200 to 500 miles in diameter. Many of the fainter ones must be less than 50 miles in diameter—probably less than 20; and telescopes several times more powerful than any now existing would only show them as star-like points.

There would seem to be no hope of finding out the time of rotation of such small bodies; but in some cases this can be done, as we shall soon see. The first asteroid to lend itself to such an investigation was Eros, already remarkable enough for its singular orbit and close approach to the earth. Early in 1901 it was discovered that the planet showed rapid variations in brightness, to the extent of more than a magnitude, so that at some times it was three or four times as bright as at others. Further observation showed that the changes repeated themselves in a period of 5¼ hours, during which there were two maxima of brightness, and two minima, which some observers found to be unequal in light.

As the planet changed its direction from the earth, the amount of the variation decreased, and in a few months it had become insensible.

Early in the present year it was announced from the Harvard Observatory that Iris, one of the brighter asteroids, showed similar fluctuations in light, but of much smaller range—only 3-10 of a magnitude, or about 25 per cent of the total light. In this case the period is 6¼ hours, with two maxima and two minima, as before.

Certain other asteroids have been observed to vary in brightness, but the extent and period of their variation is not yet determined.

The only available explanation of such changes in a planet's light seems to be to assume that the planet is rotating about an axis, and either that it is not spherical in form, or that some parts of its surface are much darker than others, or that both of these things happen together.

If the planet is of irregular form, and we are looking at it from the direction of its equator, we will evidently see it "end on" twice in each revolution, and broadside on twice.

The first position will give us a minimum of light, and the second a maximum. If we accept this explanation for the cause of the light-changes, the period of rotation of the planet must be twice the interval between consecutive maxima, that is, 5¼ hours for Eros, and 6¼ for Iris.

But if we assume that the variation is due to the presence of dark and light spots on a nearly spherical planet, the phases will in general occur only once in each revolution, so that we will be led to find values for this period just half as large as those quoted above. However, it is easily possible to imagine arrangements of spots which give rise to two maxima and two minima in each revolution, so that the time period remains uncertain. If we allow ourselves to assume that the planet is irregular both in shape and in the brightness of its surface, it would be possible to represent almost any observed light curve by a variety of different assumptions. Consequently, we cannot be sure of any details about the planet's surface (at least at present), though we can be certain that it rotates rapidly, and that the period is either that mentioned above for each planet, or else one-half of it. The longer periods appear on the whole to be more probable.

The rotation hypothesis affords also an explanation of the observed change in the range of the variation of Eros. If we looked at one of our hypothetical planets from the direction of its axis of rotation, the total amount of light it sent us would be constant, no matter how it was spotted, for we would always see the same side of it.

Consequently, if we assume that the planet's axis of rotation is so situated that at first the earth was nearly in the plane of its equator, but later got nearer and nearer to its pole, we can account for the decrease and final disappearance of its variations in brightness.

The idea that the asteroids may be irregular in shape recalls, and apparently confirms, the old "explosion hypothesis," which regarded them as the fragments of a disrupted planet. This theory has however been discredited by the proof that it would have required, not one, but many successive explosions to produce the present system of asteroid orbits, so that the wisest attitude appears to be to suspend judgment on the question.

THE PLANETS.

Mercury is evening star until the 13th, when he passes between us and the sun and becomes a morning star. He is usually nearly in line between us and the sun, and if he had been in conjunction a day earlier, he would have transited across the sun's disk. We need not regret this seriously, however, as there will be a transit in 1907. He is practically invisible to the naked eye throughout the month.

Venus is morning star, but is inconspicuous, as she is getting near the sun. On the 1st she rises about an hour before him, but the interval decreases to about half an hour at the end of the month, when she will be hardly visible.

Mars is evening star until the 30th, when he is in conjunction with the sun and becomes a morning star. He is entirely invisible throughout the month.

Jupiter is morning star in Pisces, rising at about 3 P. M. on the 15th, and is fairly conspicuous.

Saturn is morning star in Capricornus. On the 11th he is in quadrature with the sun, rises at 1 A. M., and comes to the meridian at 6 A. M.

Uranus is in Sagittarius, and comes to the meridian at 2:20 A. M. on the 15th.

Neptune is in Gemini, and sets about three hours after the sun.

THE MOON.

Last quarter occurs at 7 A. M. on the 7th, new moon at 6 A. M. on the 15th, first quarter at 5 A. M. on the 22d, and full moon at 4 A. M. on the 29th. The moon is nearest us on the 22d, and farthest away on the 8th. She is in conjunction with Uranus on the 3d, Saturn on the 7th, Jupiter on the 12th, Venus on the 13th, Mercury on the 14th, Mars on the 15th, Neptune on the 18th, and Uranus again on the 30th.

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ACTION OF RADIUM ON METALS.

Mr. N. Orloff, as stated in a recent communication to the Russian Phys. Chemical Society, covered in April, 1903, an ebonite capsule containing 0.03 gramme of radium bromide with an aluminium plate, 0.01 millimeter in thickness, instead of the mica generally used. In the course of July, the author, having opened the capsule, noted on the surface of the aluminium turned toward the radium some protuberances of the same aspect as the surrounding surface of the aluminium and resembling small drops of melted metal. These protuberances proved to be radio-active, producing a photographic image on acting for some minutes through black paper, and even after six months they were found to emit invisible radiations without any appreciable weakening. The author thinks that a stable alloy is formed by the accumulation of material particles given off from the atomic systems of radium, around small aluminium nuclei.

THE CURRENT SUPPLEMENT.

The current SUPPLEMENT, No. 1479, opens with an illustrated article on the "Old and New Railway Bridges Over the Susquehanna River at Rockville." The English correspondent of the SCIENTIFIC AMERICAN describes at length an engineering novelty in the form of a powerful gasoline locomotive. Pictures accompany his article. Dr. Erlwein's interesting discussion of the purification of potable water by means of ozone is concluded. Prof. C. F. Burgess and Mr. Carl Hambuechen recently read a paper at the Washington meeting of the Electro-Chemical Society on electrolytic iron, to which subject much attention has been devoted of late. The paper describes original work in an investigation, the primary object of which was to produce, if possible, pure iron in such quantities and at such cost as to make it an available material for further inquiry into its properties. The work shows that it is possible to obtain electrolytic iron in large quantities and at a reasonable cost. Mr. William A. Robertson writes interestingly on Pennsylvania's first mountain railroad. "Sofka and Blue Dumplings, a National Indian Dish," is the title of an instructive article by William R. Draper. Charles H. Coe discusses the subject of ginseng, its character, history, commerce, and medicinal value, with great thoroughness. In a *résumé* of recent studies of radio-activity, new information about radium is given.