ject was treated largely from the physiological standpoint. In it he brought out the fact that muscular activity changed the chemical composition of muscular tissue. Later (1847) he proved that muscles in action produce heat.

In the same year he wrote his famous work on "The Conservation of Force," a work which was in line with Robert Mayer's earlier publications of 1842 and 1845, but which was written in ignorance of Mayer's investigations. This was before physicists had accurately distinguished force and energy and before J. Clerk Maxwell had worked up the theory of dimensions of physical quantities. The new doctrine, which was so near an approach to the truth, was enthusiastically received. Faraday, feeling its inconsistencies, bowed to authority and accepted it. Later, when the doctrine was changed to "The Conservation of Energy," all difficulty disappeared, and it is now universally accepted.

He was about this time professor of anatomy in the Berlin Academy of Art and next received the chair of physiology and general pathology in Konigsberg. He applied direct experimentation to the problems of animal life and examined the rate of transmission of nerve impulses and the duration of muscular contractions. This was in 1850. He finally determined that the nerves telegraphed their signals at about the speed of an express train (26·4 meters)—far slower than the velocity of sound.

In 1851 he described the ophthalmoscope. This instrument opened the "windows of the soul" to everyday inspection, and the dark chamber of the eye is now every day explored by its aid for the treatment of the maladies of sight. This invention alone was enough to make the reputation of a life. He followed this achievement by investigations in physiological optics, and his great work on the subject, "Text Book of Physiological Optics," published in 1867, represents ten years of work. He was professor of anatomy and physiology at Bonn, 1855-1858, then he went to Heidelberg as professor of physiology. In 1862 his famous work on "The Doctrine of Tone Sensations as a Physiological Basis of the Theory of Music," was published at Brunswig, the third edition appearing in 1870. This was an epoch-making work. The true nature of sounds, the relations of fundamental notes and overtones in the production of vowel sounds, the physical analysis of sound and reproduction of the same by physical means, were treated by Helmholtz by methods and processes which laid the foundation of the science of acoustics. He also tried to find a basis for the action of the ear in harmonic vibration of its membrane. How far the ear can be accepted as a string instrument is, however, as yet a matter open to speculation.

His principal work in the realm of pure physics up to this period was these investigations on sound. Electricity and hydrodynamics occupied his attention after his acceptance of the professorship of physics in the University of Berlin, where he succeeded Magnus, who died in 1871. He applied experimentation to the investigation of the modern ether theory of electricity with signal success. Perceiving the analogy between vortex motions in fluids and electro-magnetism, he founded a mass of theory on the analogies, which has now been assimilated by modern physics of electricity. His work in electricity and the standing awarded him in it by electricians have given him a position in the electric world comparable to that which he holds in physiological science. His recent visit to this country, to attend the electric congress at the Columbian World's Fair, emphasized this fact.

into the laws of rain formation, of lightning discharge, of tides and of waves being classic.

In 1887 he accepted the presidency of the physical-technical institution in Berlin founded by the German Emperor, on the basis of a gift of one-half million marks (about $125,000) by Werner Siemens, at the same time taking the directorship of one section, the pure science department. In 1883 hereditary nobility was conferred upon him by the German Emperor.

It is futile to attempt within the limits of our space to give more than a mere skeleton of his work. His publications embrace not far from one hundred titles; some of them most abstruse, others so popular and interesting as to be veritable classics.

Aluminum Horseshoes.

Recent tests made in Arizona of aluminum horseshoes indicate that while the shoe, so far as perfected, will not wear quite a month when subjected to the severe mountain scouting in that section, Lieut. R. B. Wallace, 2d Cavalry, who made the test, found that the front shoes lasted some 28 days (306 miles) and the hind shoes 23 days (260 miles), through country covered with lava rock. As the country traversed was unusually rough even for Arizona this test may be taken as a fair indication that steel clad aluminum shoes will answer all ordinary requirements of the cavalry service. These shoes have particles of highly tempered steel pressed into the sole of the shoe by a pressure of some 100 tons, which makes the wearing surface practically steel-clad.

Scientific American.

ESTABLISHED 1845.

MUNN & CO., Editors and Proprietors.

PUBLISHED WEEKLY AT

No. 361 BROADWAY, NEW YORK.

O. D. MUNN. A. E. BEACH.

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One copy, one year, for the U. S., Canada or Mexico.................. $3 00
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One copy, one year, to any foreign country belonging to Postal Union. 4 00
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The Scientific American Supplement

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MUNN & CO., Publishers,
361 Broadway, New York.

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NEW YORK, SATURDAY, NOVEMBER 10, 1894.

Contents.

(Illustrated articles are marked with an asterisk.)

TABLE OF CONTENTS OF

SCIENTIFIC AMERICAN SUPPLEMENT

No. 984.

For the Week Ending November 10, 1894.

Price 10 cents. For sale by all newsdealers.

ASTRONOMICAL.

When unusual opportunities present themselves to astronomers for viewing certain objects or phenomena, and these events are commented on by the press, and brought to public notice by lectures, and in other ways, those who have never before given astronomical subjects a thought begin to look with purpose and a new interest at the heavenly bodies, while some such observers, almost before they know it, become habitual star gazers, and not a few look about them for some means of seeing more than the unaided vision will reveal. They press into service an opera glass, field glass, or, if available, a small army telescope, or telescope of larger dimensions, taking such works as Serviss' admirable book "Astronomy with an Opera Glass," Noble's "Hours with a Three Inch Telescope," Gibson's "Amateur Telescopist's Hand Book," Proctor's "Half Hours with a Telescope," or the charming book of Webb's, entitled "Objects for the Common Telescope," as a guide. They begin to make observations without any special knowledge of the objects viewed. The earliest lesson learned is that the hands make a very poor support for an optical instrument, and the first impulse is to secure some means of holding the instrument steadily, especially if it be one more powerful than an opera glass. After overcoming this difficulty, the next trouble arises from preconceived notions of magnification. When the telescope is directed toward a star, the star appears smaller than it does to the unaided eye, and when the moon is viewed through a telescope, it is with some disappointment at first, as regards size, because ideas of the size of the moon as seen with the naked eye are extravagant and erroneous; but let the observer view the moon with both eyes, with one through the telescope and the other without, and he will be able to superpose the image seen with the unaided eye upon that seen through the telescope. His ideas will then at once undergo a change, as, especially in the case of a small telescope magnifying fifteen or twenty times, he will see the moon fifteen or twenty times larger in the telescope than outside of it. Now the question arises as to why the moon is magnified while the star was not. The fact is the star is so far distant that, although its size may be many times that of our sun, it becomes a mere point of light, which no optical aid at our command can magnify to such an extent as to cause it to appear in the telescope like a planetary disk, and the amateur may have the satisfaction of knowing that even the largest telescope cannot show star images any larger, although it will show them brighter, on account of the superior light-gathering power of the larger instrument. A view of one of the planets reveals a disk of appreciable size even in a small telescope.

A three inch telescope mounted on a convenient stand is a desirable instrument for the amateur. It is very portable, and shows many of the beauties of the heavens to very good advantage. Seen though such an instrument, the stars have much of interest for the amateur astronomer—their color, whether they are single, double or multiple. Some of the star groups are a constant source of delight, as seen with a low power. In a good telescope, large or small, a star appears as a very minute disk of light, with two or three fine diffraction rings around it. Opticians tell us that the appearance of a star as a disk with diffraction rings is due to a radical defect which exists in all refracting telescopes. According to the correct theory, a star, in a telescope of any size, should appear only as a point of light.

How different the appearance of one of the planets! With the magnification of 160, Saturn appears larger than the full moon, as seen with the unaided eye. Jupiter with the same power appears with twice the diameter of the full moon, and with the power of 80 a very little larger than the moon. These statements can be readily verified by looking at the planet and the moon simultaneously, as suggested in the case of the telescopic image of the moon, superposed on its own image, as seen with the unaided eye, the telescopic image of Saturn or Jupiter being superposed on the naked eye image of the moon.

The illusion as to the apparent size of the moon may be said to be a secondary illusion. Some compare the size of the moon at the horizon to that of a small carriage wheel, others to that of a dinner plate; in fact, every observer has his own standard of size, but no one ever measured the moon by actual comparison with any object near at hand, like a wheel or plate, without having the illusion dispelled. A dime held at arm's length will eclipse the moon.

The difficulty lies in comparing the moon with objects at or near the horizon, which themselves being familiar are mentally recognized as appearing of the same size as they would if near by. A fairly tall chimney a quarter of a mile away when compared with a chimney across the street is less in height than three of the bricks of the near-by chimney; in fact, it might be said, as a rough approximation, that the distant chimney subtends a smaller angle of vision than would one of the bricks of which it is composed when placed across the street.

The observer says, perhaps, that the moon is larger than the chimney; but how large is the chimney? The illusion begins with mistaken ideas of the object with which the moon is compared.

THE HEAVENS IN NOVEMBER.

The present month is notable in astronomical annals for the occurrence of a transit of Mercury across the disk of the sun on Saturday, the 10th. The United States are specially favored in this case, since the event occurs in the middle of the day, so that not only will every one have an opportunity to witness it, but our astronomers will be able to study it under the best of circumstances. In Europe only part of the transit will be seen. It will begin here about 10:55 A. M., eastern standard time, and end about 4:12 in the afternoon. The little planet will cross the sun from east to west, considerably north of the center of the disk. Some optical aid will be needed to see it. A strong field glass will probably suffice to show it as a minute black spot on the sun, but a telescope will do better. In any case, the eye must be carefully shielded with a piece of smoked or black glass. The safest and most comfortable way to view the transit with a telescope, unless proper solar eye-pieces are at hand, is to project the image of the sun through the telescope upon a sheet of white paper held a foot or more from the eye-piece. Those who watch the transit with powerful instruments will be particularly attentive to observe whether, as the planet passes on and off the disk, it exhibits a ring of light, such as that seen surrounding Venus in similar circumstances, and the presence of which would be clear evidence of the existence of an extensive atmosphere on Mercury. Any peculiarity in the appearance of the planet as it crosses the sun should be noted. This event also offers an opportunity to improve our knowledge of the motion of Mercury in its orbit, of which certain unexplained anomalies recently led Prof. Newcomb to suggest the possible existence of a ring of planetoids revolving around the sun between Mercury and Venus. This is the thirteenth and last transit of Mercury for the nineteenth century.

Mars will continue to be conspicuous during November, although it is now receding from the earth. In the middle of the month it crosses the meridian about 20 minutes before 10 P. M. Some of its so-called continents and seas are still visible with telescopes of moderate size, but its south polar snow cap, conspicuous last summer, has disappeared. Apparently it has been an exceptionally hot summer in the southern hemisphere of Mars.

As Mars sinks toward the west, Jupiter will be seen rising in the east, a little to the left and north of Orion. The contrast between the two planets is striking and beautiful, Mars being decidedly reddish in tone and Jupiter white. As the former loses in brightness the latter gains, and by the end of the month Jupiter will have become the undisputed sovereign of the evening skies. Already it is a marvelous object for the telescope, being more brilliantly belted than during its last opposition, and displaying an unwonted profusion of color. Jupiter is in Gemini, rising on the 15th at 7 o'clock in the evening, and crossing the meridian about a quarter before 3 A. M.

The moon will reach first quarter on the 5th at 10:16 A. M., being then near the middle of the constellation Capricornus. It becomes full moon in Aries on the 13th at 2:49 A. M., and attains last quarter in Leo at 9:08 P. M. on the 19th. The new moon of the month occurs on the 27th at 3:54 A. M. It is in apogee on the 4th, and in perigee on the 16th. It is perhaps not generally understood that between apogee and perigee, the moon sometimes changes its distance from the earth by more than 31,000 miles, and that when it is nearest to the earth its attractive force upon our planet is about one-quarter greater than when it is farthest away; the apparent size of the moon also changes to the same extent.

The moon will be near Mars on the night of the 10th, near Neptune on the 14th, and near Jupiter on the 15th. Neptune, which to a practical eye, with any good astronomical telescope exceeding two inches in aperture, looks different from a star (although it is a mere point with such a glass), may be found rather more than 8 degrees northeast of Aldebaran and under the fifth magnitude star Iota in Taurus. Saturn, Uranus and Venus are too near the sun for observation this month.

There are many interesting objects in the stellar heavens conveniently placed during the evenings in November. Among these may be mentioned the great Andromeda nebula, which is nearly overhead at 9 P. M. about the middle of the month. It will be found instructive to turn the telescope—a three inch will do—from this nebula to the still greater and quite different one in Orion, which will be seen not far above the eastern horizon at the same hour. By waiting an hour or two later the comparison may be more satisfactorily made, as Andromeda will then have passed away from the zenith and Orion will have risen out of the mists.

The wonderful variable Algol in Peresus will be found some twenty-odd degrees east of the Andromeda nebula. This star, as many readers know, after maintaining its light at the second magnitude for more than two days, suddenly begins to fade, and in the course of about four hours sinks nearly to the fourth magnitude. In a few minutes it brightens again, and within three or four hours resumes its original brilliance. The cause of these remarkable changes, which are very regular, is believed to be the existence of an immense dark body, almost as large as Algol itself, and about the size of the sun, revolving around Algol so close that the distance between their surfaces does not exceed 2,300,000 miles! They swing around their common center of gravity, Algol flying twenty-six miles and its mysterious companion fifty-five miles per second. There will be a minimum of Algol on the 24th at midnight, Eastern Standard time. By adding 2 days, 20 hours and 49 minutes, the time of the next minimum may be calculated, and from that the next, and so on. If the theory of the cause of Algol's changes is correct, what those who watch that star on the 24th of this month will really see is an eclipse of Algol. Just at midnight on that date the huge black companion, whatever it is, will be exactly between us and the star, shutting off two-thirds of the latter's light.

There are also some fine double and multiple stars well placed this month. The location of those mentioned may be found by the aid of Proctor's star atlas. One of the most beautiful is Gamma in Andromeda. A small telescope suffices for this object, showing with a magnifying power of 50 or 75 diameters two stars only ten seconds of arc apart, the larger golden yellow and the smaller deep blue. The small star is again double, but only such a glass as the Lick telescope can at present separate it. Another beautiful double star which crosses the meridian about 10 P. M. in the middle of the month is Alpha in Pisces. The components in this case are much closer than those of Gamma Andromedæ, being separated by a space of only three seconds. The larger star is green and the smaller blue. A telescope of at least three inches aperture should be used for this star. In Cassiopeia, also favorably situated, will be found the star Eta, which is double, one of the components being straw colored and the other purple. Their distance apart is five seconds, but the purple star is so small that it may be difficult to get a satisfactory view of it with a telescope less than three and one-half inches in aperture.

Many other splendid objects adorn these mid-autumn evenings, but further reference to them must be omitted for the present. GARRETT P. SERVISS.

SMALL CALIBER PROJECTILES.

The recent movement in favor of small caliber arms for use in war has been inspired by several causes. The saving of weight, so that the soldier could carry more cartridges, is an important one. The production of a higher initial velocity is also made possible by the establishment of a heavier powder charge per unit of weight of bullet. To maintain a high average velocity in the face of diminished cross-section the bullet has been greatly elongated, so as to be almost a short arrow. Then, as rapid rotation has to be given it by strong rifling, a steel or other hard metal jacket is put on the bullet to prevent deformation by the lands and grooves, and the problem seems solved. The high initial velocity diminishes in flight so slowly that a low trajectory has been the result, and with one exception the arm is a great improvement on its predecessors of double its caliber. This exception is the lateral deviation due to wind. The ratio of weight to longitudinal section is so unfavorable that it is found that the new bullets are blown to one side by a cross-component of wind.

The action of the wind on a bullet as it leaves the mouth of the barrel is comparable to that of gravity upon a body beginning to fall. The pressure on the side of the bullet represents a force resisted only by the inertia of the mass of the bullet. Of course as the bullet moves laterally the wind exerts less and less force upon it, but for a strong wind and for the first second or two the force is not far from constant.

The force of gravity will carry in value a falling body more than sixteen feet in the first second of its fall. Wind pressure in engineering calculations is taken at a maximum of thirty pounds per square foot. As one of the new bullets has a longitudinal area of about one half a square inch, such a wind pressure would act upon it even more energetically at the start than would gravity. Any strong wind would, it is clear, deflect it rapidly from its course. If rifle practice were carried on in the assumed thirty pound side wind pressure, then the lateral deviation at first would exceed the vertical.

Such an extraordinary condition practically would never occur. But the possibilities which the above figures suggest have been shown to be real, and in a recent trial the deviation due to wind has been found to be very great. While striving for a flat trajectory and for lightness, the effect of wind in producing lateral deviation has apparently been overlooked.

The wind pressure, as has been said, is resisted by the inertia of the bullet, which varies with its mass and weight. If the weight is increased, the deviation due to wind will be decreased. But to enable the lead to stand the strain to which it is subjected, it has been found necessary to use a jacket of metal lighter than lead, which makes the bullet still more subject to the action of wind than a pure lead projectile would be.

The high specific gravity of lead, 11·352–11·388, makes it available for small caliber projectiles. Were it possible to use some other metal still heavier, an important advance would be made in the direction of high average velocity as well as of diminished wind action. The very heavy metals are rare. Iridium (hammered) is over twice as heavy as lead. Platinum and gold have nearly as high specific gravity as iridium, and uranium and tungsten come next with specific gravities of 18·33 and 17·00 respectively.

A rather curious suggestion has been made to the effect that tungsten might be used for bullets and shot. This suggestion was based entirely on its high specific gravity without regard to its other qualities. It seems quite possible that were a demand created for it, it could be produced in quantities at reasonable rates. It is difficultly fusible, combustible and brittle. At least this is as far as the properties are known. But if made in commercial quantities by alloying or otherwise treating it, there would be a chance of modifying its disadvantageous properties so as to obtain the advantages due to its high specific gravity. Even now the jacketed bullet is a compound structure whose jacketing interferes with its efficiency. A jacket of tungsten or of uranium would increase its weight, while the present jacket diminishes it. It seems quite probable that a compound bullet of lead and one of these heavy metals could be made which would have considerable value in the present days of small caliber rifles.

Aluminum has attracted most attention from its lightness. Another St. Claire Deville, who would initiate the production of a heavy metal to replace lead where weight is the principal requisite, might exert his powers on the reduction of the ores of tungsten and uranium.

Planet Notes for November.

The following is from Popular Astronomy:

Mercury will be at inferior conjunction November 10, at 12 h. 34 m. P. M. central standard time. The declinations of sun and mercury differ by only 4′ 53″, so that the planet will be seen projected on the face of the sun. The transit will last a little over five hours, beginning at 9 h. 55 m. A. M. and ending at 3 h. 12 m. P. M. central time. [An illustration showing how to project the sun's image on a sheet of paper and watch the transit was given in the SCIENTIFIC AMERICAN of October 27.]

On the 11th, at 10 h. 21 m. A. M., Mercury will pass by Venus, only 8′ south of the latter. On the 27th, at 10 h. 58 m. A. M., Mercury will be at greatest elongation west from the sun, 20° 10′. He will be at greatest brilliancy as morning planet, November 26.

Venus will be at superior conjunction November 30, at 9 h. 17 m. A. M., being then directly behind the sun. She will not be in good position for observation during the month.

Mars has for some time been the most conspicuous object, save the moon, in the evening sky. He far outranks the first magnitude stars in brilliancy, appearing almost to have a disk visible to the naked eye. Having in October passed his point of nearest approach to the earth, he is still comparatively near and in very favorable position for observation by amateurs. He will be in conjunction with the moon, 3° south of the latter, November 9, at 12 h. 56 m. A. M. On the 22d he will reach the end of the westward loop in his apparent path among the stars and will then begin to move eastward.

Jupiter lights up the eastern half of the sky while Mars does the western. The two planets are nearly equal in brilliancy but quite different in color, the silvery hue of Jupiter contrasting strongly with the ruddy light of Mars. Jupiter is in good position for observation after midnight. He will be in conjunction with the moon November 16, at 4 h. 4 m. A. M.

Saturn and Uranus will be behind the sun during November.

Neptune may be observed all night, the best time being about midnight, when the planet is near the meridian. He is in Taurus, not far from the star *l*.

The Absorption of Odors by Milk.

Parville relates some interesting facts upon this subject. If a can of milk is placed near an open vessel containing turpentine, the smell of turpentine is soon communicated to the milk. The same result occurs as regards tobacco, paraffin, asafetida, camphor, and many other strong smelling substances. Milk should also be kept at a distance from every volatile substance, and milk which has stood in sick chambers should never be drunk. The power of milk to disguise the taste of drugs—as potassium iodide, opium, salicylate, etc.—is well known.

IT is said that the frigate bird can fly at the rate of 100 miles an hour and live in the air a week at a time without touching a roost.