SCIENTIFIC AMERICAN

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HERMAN LUDWIG FERDINAND VON HELMHOLTZ.

On September 8, 1894, after seventy-three years of life, which yielded a record almost unsurpassed of work in physiology, anatomy and physics, Von Helmholtz died. The combination which he possessed of mathematical and experimental talents of the highest order, backed by a medical education, placed much of his work in the intermediate regions between physiology and physics, gave his investigations a peculiarly practical value and caused them to influence surgical practice on the one hand, while his work in pure science has enlightened the world of science.

Herman Ludwig Ferdinand von Helmholtz was his full name. He was born in Potsdam, August 31, 1821, in which city his father held a position as a teacher in the "gymnasium" or elementary school. When seventeen years old he entered the University of Berlin in the Frederick William school, taking up the study of medicine. He desired to be a physicist, but circumstances forced him to take the more practical course of medicine. Later in life he was pronounced in his views of the great utility of the study of medicine to himself, as a guide and basis for his later work in physics.

In 1841, sick with typhus fever, he was treated in the Charité hospital gratuitously, a privilege which was his due as a student. On recovering he received the portion of his income which had accumulated during his illness, and this money he at once devoted to the purchase of a microscope, and began to study the nervous processes of the ganglion cells of invertebrates. These studies were used in his graduating thesis, and in 1842 he received his doctor's degree. In 1843 he published a work on putrefaction and fermentation, rejecting Liebig's chemical theory, and laying the foundation for the modern biological treatment of the subject. He was military surgeon in Potsdam during this period, yet prosecuted his work in science, in 1845 preparing an article on heat for a medical dictionary. The sub-

HERMAN LUDWIG FERDINAND VON HELMHOLTZ.

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.

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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