increase in height near Ouvira, to the northwest of the lake; they reach a height which Mr. Fergusson estimated to be 8,000 feet. These mountains form a range parallel to those of the northeastern side, whose height is also quite considerable. From Lake Tanganyika Messrs. More and Fergusson proceeded to Lake Kivou, which was first seen in 1894 by the German Lieutenant Von Goetzen. Mr. Sharpe and the German Doctor Kandt, who have recently explored that region, say that the position of Lake Kivou is very badly laid out on the maps. The present explorers climbed the volcano of Karounga, which is in activity; it lies on the north bank of the lake. They proceeded then to Lake Albert Edward, and arrived about the middle of February at Fort Gerry, having decided to make the ascension of Mount Rouenzori, which has an altitude of 17,600 feet. It is the principal peak of the mountainous region which rises between the Lakes Albert and Albert Edward.

CATHODE RAYS.*

BY P. VILLARD.

The passage of the electric discharge in gases produces luminescent phenomena easily observable at pressures of the order of one millimeter of mercury. In a tube provided with electrodes the discharge gives the following appearance. A violet-red luminous column starts from the positive toward the negative electrode, but stops before reaching the latter, ending at the dark space of Faraday. It is deflected by a magnetic field; as the pressure is reduced, the column increases in volume, but becomes more feeble and disappears. On the contrary, the luminosity at the negative electrode envelops all or part of the electrode, being violet in color (yellow in oxygen, pink in hydrogen). As the rarefaction increases, it enlarges and covers all the surface, increasing in thickness; at the exterior it ends at the dark space and at the interior it is separated from the cathode by an equipotential surface, the interior space being relatively dark. In immediate contact with the cathode is a layer of pinkish light, visible only at high vacua.

ELECTRIC RESISTANCE OF DISCHARGE TUBES.—The gaseous medium is not to be compared with a conductor; the current passing in it is discontinuous and not regulated by Ohm's law. It is not comparable to an electrolyte. The law connecting the current intensity with the difference of potential is not known exactly, but below a certain tension the gas acts as a perfect dielectric, while above that point a discharge is produced and the current increases with the tension; 300 volts is the minimum for the discharge.

BEAM OF CATHODE RAYS.—In a spherical or ovoid bulb provided with a cathode in the form of a concave mirror, the negative light is voluminous and fills the bulb, the dark space extending a few millimeters from the cathode, and a luminous cone is formed, which becomes more distinct as the vacuum increases. The cone is the trace of the beam of cathode rays in the residual gas; scarcely visible in the dark space, it becomes brilliant farther out; its color is violet in air, pale yellow in oxygen. As the vacuum is increased, the cone changes to a cylindrical beam starting from the center of the cathode. The cathode rays are propagated in straight lines, and cross without interference.

PHENOMENA OF PHOSPHORESCENCE, ETC.—M. Villard points out the well-known effects produced upon the different bodies, especially the alkaline earths and phosphorescent screens, and recalls their propagation in straight lines, as demonstrated by the shadows cast by bodies placed in the path. The mechanical effects of the rays are shown in turning radiometer vanes, etc. The calorific effects are strongly marked; according to the action produced upon a fragment of diamond, M. Moissan estimates that the temperature thus reached 3,600° C. An object encountered by the rays becomes a source of Roentgen rays. As to the chemical effects, M. Goldstein has discovered that the haloid alkaline salts become colored and their phosphorescence diminishes; chloride of sodium becomes brown, and bromide of potassium blue; the colors disappear slowly in the dark and rapidly in the light. Messrs. Wiedemann and Schmidt have found that the salt acted upon has an alkaline reaction; Messrs. Elster and Geitel find that they possess the photoelectric property in a great degree, and part with a negative charge under the action of violet light. These reactions indicate a reducing action on the part of the rays. If the shade of an obstacle is projected upon a sheet of copper oxidized at the surface, the copper is here reduced to the metallic state. When the rays encounter the air, ozone is produced, as M. Lenard has shown.

The deviation of the rays by the magnet is well known; the deviation diminishes with the pressure, or as the tension rises. Its direction is determined by the laws of charged bodies. M. Villard shows the calculation of this deviation, which has been made by Mr. J. J. Thomson. If e is the charge, m the mass, and if the speed, v, is small compared with that of light, the calculation shows that $\frac{e}{m}$ is a constant and independent of the nature of the gas.

ELECTROSTATIC DEVIATION OF CATHODE RAYS.—The enlargement of the shadow of a wire united to the cathode or to the ground has been observed from the beginning by Mr. Crookes and others, but the question has only recently been made clear by the experiments of M. Majorana and M. J. Perrin. A beam of parallel rays traverses an anode of wire gauze and casts the shadow of a wire upon the walls. A static machine has one pole joined to the gauze and the other to the wire; when the wire is charged negatively, the two half-rays which it forms are separated, enlarging the shadow; a positive charge brings them together, and they may even cross, showing them to be attracted by a positive and repelled by a negative charge. Two beams of cathode rays have no reciprocal action upon each other, as has been shown by Wiedemann and Ebert, Bernstein and the author. The absence of mutual action does not imply absence of electrification; it suffices to admit that the particles in movement follow each other at distances which are great compared with their radius of action.

The fact that the rays are propagated in straight lines shows that even near the anode the electric field is too weak to have a sensible action upon them. Experiments show that the field is very intense near the cathode, but very weak in the rest of the tube. As to the speed of cathode rays, the attempts at direct measurement made by Mr. J. J. Thomson and M. Majorana have not been conclusive. Mr. Thomson has made a series of calculations by an indirect method. If m is the mass of the particle, e its charge and v its velocity, the result of the calculation shows that the value of $\frac{m}{e}$ varies from $1{\cdot}1 \times 10^{-7}$ to $1{\cdot}5 \times 10^{-7}$; and that it is independent of the nature of the gas. The value of v lies between $2{\cdot}2 \times 10^9$ and $3{\cdot}6 \times 10^9$ centimeters per second. M. Wiechert has determined the velocity by a direct method, and finds the value of v between $5{\cdot}04 \times 10^9$ and $3{\cdot}96 \times 10^9$ centimeters per second. It is thus of the order of one-tenth the speed of light.

ELECTRIC AND MAGNETIC DISPERSION.—M. Birkeland has shown that a cathodic beam may be decomposed by a magnetic field into several distinct beams unequally deviated. This experiment, made with a beam passed through a slit and a magnetic field parallel to the slit, gives upon a fluorescent screen a veritable cathodic spectrum. The number of rays is variable with the conditions of experiment. M. Deslandres has formed a spectrum with an electrostatic field placed perpendicular to the slit. It is found that these beams unequally deviated correspond to different potentials, and they must, therefore, be emitted successively.

The experiments of M. Lenard are of great interest. He has studied the rays outside of the tube; for this he uses a tube whose end is formed of a thin sheet of aluminium. The rays passing outside are soon diffused in air, but in a rarefied gas he obtained a cone of rays three feet long. M. Lenard shows that the rays render the air a conductor of electricity, provoke the condensation of supersaturated vapor and ozonize the air.

SECONDARY EMISSIONS.—M. Goldstein has observed that if a tube has narrow places or elbows, these emit cathode rays at the side of the anode. When a perforated paper screen is placed between the anode and cathode, each hole becomes a center of emission. An isolated metallic sheet, struck by the rays, emits secondary rays, which are always perpendicular to the surface.

PASSAGE OF THE RAYS THROUGH METALLIC SHEETS.—Hertz has shown that very thin metallic sheets allow the rays to pass. According to Lenard, glass 0·2 millimeter thick is also traversed. Mr. J. J. Thomson and the author consider that the transmission is not real, but that secondary rays are emitted. Another series of experiments have been made by M. Goldstein. If a tube is divided into two parts by a cathode having several openings, beams resembling cathodic beams are observed in the part of the tube opposite the side of the anode, these leaving from each of the openings in the cathode. These new rays have been given the name of "Kanalstrahlen" by the experimenter; they are peculiar in not being deviated by an electric or magnetic field.

NON-DEVIABLE RAYS.—Mr. J. J. Thomson has found that only a part of the cathode rays are deflected by the magnet. If the vacuum is such that the rays start only from the center of the cathode and are visible by the illumination of the residual gases, it suffices to approach a magnet to show that a part of the beam is unacted upon and continues in a straight line. These rays illuminate the residual gases, but seem to have no action upon phosphorescent bodies.

NATURE OF THE RADIANT MATTER.—The phenomena of reduction already pointed out with many chemical compounds is obtained either by the cathode rays or the "Kanalstrahlen." If at the same time it is remarked that the cathodic phenomena are independent of the nature of the gas and that the relation $\frac{e}{m}$ is invariable, one is brought to admit the unity of the radiant matter. Hydrogen, however, is the only simple gas known which has a reducing action, and it is precisely this gas whose spectrum is always and often alone visible in the cathode layer. This element has special properties, such as the power to traverse metals heated to redness. While waiting for another simple reducing gas to be discovered, the hypothesis may be considered as acceptable that hydrogen constitutes the radiant matter.

* Lecture delivered before the Congress of Electricity, Paris Exposition. Abstract prepared by special Paris correspondent of the SCIENTIFIC AMERICAN.

PURIFICATION OF GASES.

In the course of a lecture delivered before the English Institution of Civil Engineers, Dr. C. H. Wedding described the purification of noxious gases at the Kotterbach iron mines in Upper Bohemia. The ores obtained in this locality are richly impregnated with carbonates, and they are roasted before their conveyance to the blast furnaces, for the purpose of liberating the carbonic acid. By this means, an economy approaching 33 per cent is effected in the cost of freightage. This district, in addition to being a rich iron mining center, is also a profitable agricultural country. In fact, agriculture is quite as important as the iron mining. It was discovered that the driving off of the sulphurous and mercurial vapors during the roasting was detrimental to the welfare of both the animal and vegetable life in the vicinity. An attempt was thereupon made for the purpose of purifying the noxious fumes before their dissolution in the atmosphere, and a condensing plant was installed. Two timber towers, each three stories in height, have been erected. The floors of the buildings are thickly set with blocks of limestone. At the summit of each tower is placed a large tank of water, from which a steady spray, equal in area to the whole surface of the floor, is constantly running. The gases upon their exodus from the ores in the roasting process are conveyed to the bottom of the first tower, and ascend against the stream of water through the floors to the top of the building. The cool spray deprives the gases of their mercury and compounds, and arsenic and antimony compounds, also a portion of the sulphur oxides. That part of the sulphur oxide which is not freed from the gases by the water displaces the carbon dioxide of the limestone, forming sulphites and sulphates of lime. The gases in their semi-purified condition are conveyed from the top of the first tower to the bottom of the second structure, and the process repeated, after which they escape into the air, and have been found in this purified state to have no effect upon either the cattle or crops. The cost of running this condensing plant is defrayed by the recovery of the mercury, which is collected in settling ponds, purified, and sold.

DEATH OF MAX MÜLLER.

Prof. Friedrich Maximilian Müller, Corpus Professor of Comparative Philology at Oxford University, died October 28. He was born in Dessau, Germany, in 1823, and after attending the universities at Leipzig and Berlin received his degree in 1843. He early showed a great fondness for philology and the languages of the East. He studied Arabic, Persian and Sanskrit, and visited several countries to study manuscripts. In 1848 he settled at Oxford. His rise in the university was rapid, and he was elected a Fellow of All Souls College in 1858. The university intrusted to him the editing of a series of translations of the sacred books of the East and fifty volumes have been issued. He published a large number of the most important works and papers upon Oriental languages, and he received many honors from foreign universities and courts. To some extent he outlived his reputation, and he held a much higher place in the estimation of British scholars a quarter of a century ago than he held in recent years.

The theory with which he is most closely associated in the public mind is that the cradle of the Aryan languages must be looked for in Central Asia; this view no longer commends itself to most students of the subject.

OYSTERS IN EUROPE.

Vice Consul-General Hanauer writes from Frankfort under the date September 22, 1900:

The French naval department has an exhibit in the Paris Exposition giving a graphic view of the development of oyster cultivation in France. During 1879–1887, the yearly average production of French oysters amounted to 11,000,000 francs ($2,123,000), gradually increasing to 20,500,000 francs ($4,825,000) for the year 1898, when 15,500,000 French and 3,000,000 Portuguese oysters were sold along the French coasts. The bivalves are a great luxury in Europe, and so dear that only the wealthier classes can afford to eat them. In the city of Frankfort, small German or Dutch oysters in the shell cost from 60 to 72 cents (2½ to 3 marks) per dozen. Some resident Americans occasionally have a barrel of American oysters sent by their friends at home. The shipment of our oysters in cold storage would be practicable and afford profit.