daily to maintain its present rate of radiation. The process of receiving and sending out corpuscles is competent to supply all its radio-activity. And it can issue many kinds of radiance, so long as the interchange with other suns is maintained. The problem here now is so much larger than any ever presented to man before, that all others appear to be childlike in comparison. It is to discover, rescue from space, and use these obscure radiations from our own and other suns. All other employments that can be engaged in by human hands are as straws beside this chief of all work and research. Arrhenius shows that many particles, balanced by radiance and attraction, "swim in space" in regions adjacent to suns; but vast quantities not in the clutch of critical forces escape and dart into space. These are surely the corpuscles of electricity exploited by Thomson. For three years the floods of mail received here, letters, essays, pamphlets, books, everything, have one inevitable trend and tendency, and that is: The universe rests on an electrical base. In other words, nothing exists but electricity. This doctrine comes here from all directions. This universe is now maintained by "action at a distance"; that is, radio-activity is its sole support. There is not a trace of a new idea in this. It is exceeding familiar. All have heard of it thus: "Action and reaction are equal." This is flux and flow of radiance in a nutshell.

Then the universe is alive, is a living organism. This is familiar also; it was said in India many thousands of years ago, and has teemed on the pages of all Aryan literature since. None gave it attention, thinking it to be a vagary of some poet. The reception and emission of electrical corpuscles by every sun in existence are the causes of every conceivable phase of radiance. These two combined constitute the life of Nature. All work like that of Roentgen, Lenard and a hundred like them must be put into the great Principia.

It is a wonderful thing to be upon a mountain and watch the scientific literature change. And the most astonishing of all is to behold two things: the rapidity and worldwide unanimity of wheeling into the grand procession or march on the "electrical way." There are electrical "pushes and pulls" everywhere, universal and cosmical. They are so delicate that early physicists in many cases could not detect them. But now they are being explored with comparative ease. Thus every form, phase, condition, state, or type of radiation is corpuscular. Circulation throughout the universe is a rigid proof of conservation. Radiance is manufactured on the surfaces of suns. Radium is all right, and does not conflict with conservation. It receives and pays out like suns. So does everything else. The radiations of most phases of matter are too feeble to be detected by present means. For the words action and reaction are equal. They ought to go into the new Principia thus: Activity and return are equal. Great is the demand from all sides for the Principia.

BURKE'S OWN ACCOUNT OF THE SPONTANEOUS ACTION OF RADIUM ON GELATIN MEDIA.

The following is an abstract of the communication which was made to Nature by Mr. J. Butler Burke, of the Cavendish Laboratory, Cambridge, and which has given rise to so much sensational newspaper discussion:

"In the course of some experiments on the formation of unstable molecular aggregates, notably in phosphorescent bodies, I was led to try whether such dynamically unstable groupings could be produced by the action of radium upon certain organic substances. It will scarcely be necessary to enter here into an account of the many speculative experiments which I have at one time or another tried, but it will suffice if I describe, as briefly as possible, the experiment which, among others, has led to a very curious result, and that is the effect of radium chloride and radium bromide upon gelatin media, such as those generally used for bacterial cultures.

"An extract of meat of 1 pound of beef to 1 liter of water, together with 1 per cent of Witter peptone, 1 per cent of sodium chloride, and 10 per cent of gold-labeled gelatin, was slowly heated in the usual way, sterilized, and then cooled. The gelatin culture medium thus prepared, and commonly known as bouillon, is acted upon by radium salts and some other slightly radio-active bodies in a most remarkable manner. In one experiment the salt was placed in a small hermetically-sealed tube, one end of which was drawn out to a fine point, so that it could be easily broken. This was inserted in a test-tube containing the gelatin medium. The latter was stopped up with cotton wool in the usual way with such experiments, and then sterilized at a temperature of about 130 deg. C. under pressure for about 30 minutes. Cultures without radium were also at various times thus similarly sterilized. When the gelatin had stood for some time and become settled, the fine end of the tube containing the radium salt was broken, from outside, without opening the test-tube, by means of a wire hook in a side tube. The salt, which in this particular experiment consisted of 2½ milligrammes of radium bromide, was thus allowed to drop upon the surface of the gelatin.

"After 24 hours or so in the case of the bromide, and about three or four days in that of the chloride, a peculiar culture-like growth appeared on the surface, and gradually made its way downward, until after a fortnight, in some cases, it had grown fully a centimeter beneath the surface. If the medium was sterilized several times before the radium was dropped on it, so that its color was altered, probably by the inversion of the sugar, the growth was greatly retarded, and was confined chiefly to the surface. It was found that plane polarized light, when transmitted through the tube at right angles to its axis, was rotated left-handedly in that part of the gelatin containing the growth, and in that part alone.

"The controls showed no contamination whatever and no rotation. The test tubes were opened and microscopic slides examined under a twelfth power. Objects were observed which at first sight seemed to be microbes, but as they did not give sub-cultures when inoculated in fresh media they could scarcely be bacteria. The progress of any of the sub-cultures after a month was extremely small, and certainly too small for a bacterial growth. It was not at all obvious how bacteria could have remained in one set of tubes and not in the other, unless the radium salt itself acted as a shield, so to speak, for any spores which may originally have become mixed with the salt, perhaps during its manufacture, and when imbedded in it could resist even the severe process of sterilization to which it was submitted. On heating the culture and re-sterilizing the medium, the bacterial-like forms completely disappeared; but only temporarily, for after some days they were again visible when examined in a microscopic slide. Nay, more, they disappeared in the slides when these were exposed to diffused daylight for some hours, but re-appeared again after a few days when kept in the dark. Thus it seems quite conclusive that whatever they may be, their presence is at any rate due to the spontaneous action of the radium salt upon the culture medium, and not alone to the influence of anything which previously existed therein. When washed they are found to be soluble in warm water, and however much they may resemble microbes, they cannot for this reason be identified with them, as also for the fact that they do not give sub-cultures as bacteria should.

"Prof. Sims Woodhead has very kindly opened some of the test-tubes and examined them from the bacteriological point of view. His observations fully confirm my own. He assures me that they are not bacteria, and suggests that they might possibly be crystals. They are, at any rate, not contaminations. I have tried to identify them with many crystalline bodies, and the nearest approximation to this form appears to be that of the crystals of calcium carbonate, but these are many times larger, and, in fact, of a different order of magnitude altogether, being visible under comparatively low powers; and are, moreover, insoluble in water. A careful and prolonged examination of their structure, behavior, and development leaves little doubt in my mind that they are highly organized bodies, although not bacteria. Unfortunately, the quantity is so very minute that a chemical analysis of their composition is extremely difficult. The amount of salt in the first instance is so small, and the number of aggregates, or whatever they may be, thus produced perhaps still smaller.

"Photographs, together with the numerous results of eye observations, indicate that a continuous growth and development take place, followed by segregation. The stoppage of growth at a particular stage of development is a clear indication of a continuous adjustment of internal to external relations, and thus suggests vitality. They are clearly something more than mere aggregates in so far as they are not merely capable of growth, but also of sub-division, possibly of reproduction, and certainly of decay.

"I have ventured, for convenience, in order to distinguish them from either crystals or microbes, to give them a new name, *radiobes*, which might, on the whole, be more appropriate as indicating their resemblance to microbes, as well as their distinct nature and origin. Some slightly radio-active bodies appear also to produce these effects after many weeks. A more detailed account of these experiments will be published shortly. This note merely contains some of the principal points so far observed."

THE CURRENT SUPPLEMENT.

The current SUPPLEMENT, No. 1541, opens with a well-illustrated and well-written article by Herbert I. Bennett on the building of the Santa Fé Railroad into San Francisco. Carl Lautenschlaeger, who has become well known to Americans by his connection with the New York Metropolitan Opera House, writes on "Theatrical Engineering, Past and Present." It is a well known fact that steamers will perform vibrations of a magnitude that depends upon the design and location of the engine. The well-known German marine engineer, Otto Schlick, has formulated some valuable rules for the construction and arrangement of the marine engine, calculated to minimize these vibrations. It is mainly due to his investigations that modern transatlantic liners may sail at speeds of twenty-four knots. Schlick's investigations have been carried out by means of an instrument of his invention called the Pallograph, described in the current SUPPLEMENT by Dr. Alfred Gradenwitz. The "Dey" Time Register is described by Emile Guarini. Sir William White continues his discussion of submarines. In an entertaining article by T. C. Hepworth, the incongruities and anachronisms of artists are treated. Charpentier finds that odorous substances are definitely acted upon by the N-rays. The results of his researches are summarized in a brief note. Prof. August Smithells writes on the Temperature of Flames. Recent progress in photography is reviewed by Dr. Ludwig Guenther. A history of the telephone is presented by W. H. Sharp, in which the claims of Reis are revived.

OPENING OF EXTENSIONS OF THE NEW YORK CITY SUBWAY.

On Monday, July 10, the Broadway section of the Rapid Transit Subway, comprising two tracks, extending from Wall Street to Battery Place, through which it passes in the form of a loop, as at City Hall Park, and the Lenox Avenue East Side extension from 135th Street under the Harlem River to the elevated section at 149th Street, and thence *via* Westchester Avenue and Boston Road to West Farms, was opened to the public for the first time, trains being run on five minutes headway. This marks approximately the completion of the Manhattan system, except the Washington Heights extension, which is to be in operation before the expiration of the summer.

The tunnel under the Harlem River is composed of two separate tubes, having a space below the roadbed of five feet, to collect seepage that may accidentally leak through. Pumps are provided in the center and at each end to draw this water out in emergencies.

The tunnel is dry at all times, and resembles in appearance the stretch between 33d Street and 42d Street on Fourth Avenue. The bottom of the tunnel is thirty feet below the river surface. The successful termination of this great work is a triumph of American engineering skill, and the facilities afforded will be of lasting benefit to the city and its population.

OFFICIAL METEOROLOGICAL SUMMARY, NEW YORK, N. Y., JUNE, 1905.

Atmospheric pressure: Highest, 30.15; lowest, 29.61; mean, 29.96. Temperature: Highest, 90, date, 18th; lowest, 51, date 8th; mean of max., 77.6; mean of min., 60.1; absolute mean, 68.8; normal, 68.9; deficiency under the mean of 35 years, —0.1. Warmest mean temperature for June, 72, in 1888, 1892, 1899. Coldest mean, 64, 1903. Absolute maximum and minimum for this month for 35 years, 97 and 47. Average daily deficiency since January 1, —0.7. Wind: Prevailing direction, west; total movement, 7.275 miles; average hourly velocity, 10.1 miles; max. velocity, 46 miles per hour. Precipitation, 4.18; greatest, 1.19, date 12th; average for 35 years, 3.29. Excess, +0.89; deficiency since January 1, —3.21. Greatest precipitation, 7.70, 1887; least, 0.86, 1894. Thunderstorms, 2d, 6th, 7th, 19th, 22d, 23d, 26th. Clear days, 7; partly cloudy, 12; cloudy, 11.

Near the end of the 60's, when most of the early bridge companies had been formed, there were, besides the engineers interested in bridge-building firms, only a few experienced bridge engineers in this country. The engineers who were at that time connected with bridge companies were mostly men who had gained their experience in the employ of some railroad company, had worked out their own type of construction, and had experience, not only in designing, but also in superintending the construction and erection of bridge work. Their theoretical knowledge, measured with the present standard, was limited to elementary methods, but their thorough practical training enabled them to combine theory and practice to the best advantage. They understood how to make their designs conform to the methods of the workshop, as well as to facilitate erection. This was really the beginning of the development of American bridge building and of the distinctly American types of construction which at that time differed so materially from those of other countries. The most distinguishing feature of the methods then prevailing in this country, as compared with those of other countries, the influence of which is felt to the present day, is that at that time in America the bridges were designed by experienced specialists, and the work was constructed in shops built and equipped for that special purpose by experienced mechanics trained in that class of work. At first these companies controlled the work in certain territories, or the contracts were awarded to them on account of the reputation of their engineer. However, as competition became keener, railroads desired to purchase their bridges for the lowest price, and invited several firms or companies to submit tenders on the bidders' own designs, which started the competitive system of designing and bidding on bridge work.