and jurists, amongst whom were Renan, Taine, Berthelot, and others.

This led to the creation of seven complete universities, to which the nearest separate faculties attached themselves. M. Waddington, after having looked over the scheme, did not ask for a discussion. He thought that universities could not be established before university life had been founded, before the material, scientific, and moral situation of the faculties had been ameliorated. It is in this direction that the reforms were directed.

In 1885, the localities of the faculties having been changed, their scientific instruments being complete, their courses extended, at the cost of great pecuniary sacrifices, the question of universities was again renewed. The Minister of Public Instruction, at this time M. R. Goblet, signed two important resolutions. For each group of faculties there was instituted a general Council composed of two delegates of each faculty, with extended functions for academic, scientific, administrative, financial and disciplinary matters. The Rector of the Academy received the presidency. The ordinary life of the faculties of the same town was thus created. Each one of the faculties received, besides, confirmation of the right that they possessed since their creation, but which was repealed in deed to receive endowments, legacies and relief.

The faculties became therefore civil persons, but their grouping remained extra-legal, and had no judicial unity. It is in a scheme of law presented to the Senate in 1890 by M. Bourgeois, then Minister of Public Instruction, that the proposition is first made to confer the civil personality and the name of University on the groups, comprising at least the four faculties of law, literature, science and medicine, and to give to the universities the autonomy of their budget, by abandoning to them all the receipts which they effected (right of inscription, of study, revenues) for covering their expenses, with the help of a State subsidy. This project, rather badly received by the Senate, was sent back to a Commission, which very soon gave up its examination. It met with the strong opposition of the senators who represented the towns of the little groups of two or three faculties, which could not, by the terms of the project, pretend to the rank of University.

In spite of this repulse, the Minister of Public Instruction, and especially M. Liard, the eminent Director of Higher Instruction, were not discouraged. They succeeded in having inserted in the Finance Law of April 28, 1893, an article (No. 72) which conferred civil personality on the faculties in the same academic resort. The Senate, averse to the project of 1890, accepted the provision of 1893 by 212 votes against 56. Thus new progress was made.

Nevertheless, as it became more evident that the Senate would never consent to sacrifice the little groups of faculties, the partisans of the universities had to content themselves, in order to obtain anything, with demanding less.

In 1895, M. R. Poincaré presented the proposition which has just been voted for by the Chamber, and which he defended as Reporter, at the side of his successor in Public Instruction, M. Combes.

Briefly, in the terms of the project, the bodies of faculties, instituted in 1893, take the name of University; the general councils of the faculties, created in 1885, become councils of the university. In 1898 each faculty will have a budget of its own.

This arrangement has its importance, for it confers on certain groups of the university considerable receipts—646,000 francs at Paris, 105,000 at Bordeaux, 128,000 at Lyons, 83,000 at Lille.

By the vote of the Chamber, and that of the Senate, the universities, suppressed by the Revolution, will be reconstituted in France and endowed with civil personification. The new law is, on the other hand, but the result of the long evolution commenced twenty years ago. It perpetuates results already attained, and so little contested, that in 1889 M. Gréard, in his inaugural discourse at the Sorbonne, talked of the University of Paris, and the new buildings of the Faculties of Lille bear the inscription "University of Lille."

It is certainly to be regretted that the proposal of 1890 was not adoped. Real universities must include four faculties. And, as the Rector of the Catholic Institute of Paris, M. d'Hulst, has said at the Chamber, it is a delusion to call the union of only two or three faculties a university. It may be presumed that the incomplete groups, in order to maintain their new name and the concurrence of the complete groups, will try to give themselves the faculties which are wanting. If they do not succeed, they will remain, of necessity, in the shade; and it is better, in short, to see the faculties of Paris become a university, even if those of Clermont-Fenaud receive the same title, than to see the ambiguous situation, created in 1885, continued.

There are fifteen groups of faculties in France; there would, therefore, be fifteen universities, of which seven are complete: Paris, Lyons, Bordeaux, Toulouse, Montpellier, Lille, and Nancy. It is to be remarked that the southern half of the country will possess four of the seven universities. The incomplete universities are Aix-Marseilles, Rennes, Caen, Poitiers, Grenoble, Dijon (law, science, and literature), Clermont, and Besançon (science and literature).

The above-mentioned towns, Clermont and Besançon excepted, contain a preparatory school of medicine. Many of these schools will probably be turned into faculties.

NATIONAL ACADEMY OF SCIENCES.—WASHINGTON MEETING.

THE recent annual meeting of the National Academy of Sciences in Washington brought together an unusual number of members; and the papers read during the first three days of the meeting included several of special interest and value.

Naturally the Röntgen rays have been the prominent topic, and it is fortunate that most of the successful investigators have attended and read papers, or participated in the discussions. Some errors which have gained credence and wide publication have been corrected, and perhaps the most satisfactory feature of the discussion has been the elimination of these errors, and the correction of too hasty generalisation from experiments conducted without sufficient care.

What the rays are Prof. Rowland frankly admits we do not know, nor are we perceptibly nearer a solution of the problem than when Röntgen first launched his epoch-making essay.

Prof. Rowland presented to the Academy some notes on the rays, in which he said in part that investigators of the source of these rays generally overlook the fact that electrical currents are almost invariably accompanied by oscillations, so that each pole is alternately anode and kathode, thus vitiating any generalisations as to the anode or the kathode being the source of the rays. He mentioned that the rays are developed to the greatest extent when the kathode rays fall on the anode, and hence a kathode ground to a reflecting surface focused on the anode gives the best results. This fact is utilised in the construction of the "focus-tubes" now largly used in Röntgen photography.

Prof. Rowland has obtained good results by using perfect vacuum tubes in which the electrodes are brought within one millimetre of each other. The source of rays here is less than 1/1000 of an inch in diameter. This throws a shadow with remarkably sharp outline, being less than 1/1000 inch. The width of the image gives the limit of wave-length—if it is indeed an undulation, and not the projection of material particles—not greater than 1/8 the length of waves of yellow light.

A paper on the source of the Röntgen rays was read by Prof. A. A. Michelson and S. W. Stratton. Prof. Michelson maintains that these rays are not essentially different from those of Lenard. The latter produce their effect mostly within the tube, the former without; but Lenard also found an actinic effect outside the tube. He also brought forward evidence to show that Röntgen rays radiate in all directions from the surface first encountered by the kathode rays, and do not start from the anode.

Prof. A. M. Mayer read several papers. He showed that investigations of polarisation of these rays must be made with some very thin substance of low density, herapathite being the best; but this substance, which is an iodo-sulphate of quinine, is difficult to obtain. He described the process, already communicated by him to NATURE (April 2). On using plates of herapathite with three different exposures of half-hour, one hour, and three and a half hours, no polarising effect was produced. He remarked that calc-spar was utterly unavailable as a test of polarisation of these rays, because it could not be procured of sufficient thinness for the rays to penetrate, Hence the researches of some experimenters, though widely published, were of no value whatever. He has determined the density of herapathite with great accuracy and by repeated

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experiments, and finds it much smaller than Herapath did, namely, 1·557.

Prof. Mayer also gave formulæ of transmission of Röntgen rays through glass, tourmaline and herapathite. To determine whether rays just go through or nearly go through, he uses a wire grating which will appear in the picture if rays go through. Transmission depends on the thickness of the glass plus the time of exposure. Glass of various thickness is used, one plate being superposed upon another in successive gradations. The eye cannot distinguish a difference less than about 1/100, and this is what passes through glass of five millimetres thickness. If we begin with glass 1/10 millimetre thick, it absorbs 1/10 of the rays, and each superposed 1/10 millimetre absorbs 1/10 of the residue, so that the formula in general is $I' = Ia^t$. It is evident, therefore, that there is no constant ratio of comparison of absorption by different materials, because the successive powers of "a" have not the same ratio to each other that the first powers have. In the case of herapathite the absorption (a) is found to be ·9382, so the formula becomes $I' = I\ {\cdot}9382^t$. The formula for tourmaline is the same as for glass, so tourmaline is a very imperfect substance to use.

Prof. Ogden N. Rood read a paper detailing his experiments in reflecting the X-rays, which have enabled him to reflect 1/260th part of the rays incident on platinum at an angle of 45° (see NATURE, April 30, p. 614).

Prof. Arthur W. Wright read a paper on the relative permeability of magnesium and aluminium by Röntgen rays. He reported experiments showing that magnesium is much more permeable than aluminium. Magnesium is also more readily wrought than aluminium, thus making it much more desirable to use in the investigation of these rays.

Prof. T. J. J. See, of Chicago University, read a paper on double stars, giving results of three years' observations. He concludes that at the end of 115 years we know accurately only forty; that there is only evidence of disturbing bodies in a few cases, which are indecisive; that great eccentricity of orbit prevails, the average being twelve times as much as that of planetary orbits, and that the law of gravity is rendered probable and may be hereafter confirmed by spectroscopic investigation.

Among other papers read are:—The geological efficacy of alkali carbonate solutions, by E. W. Hilgard, read by G. Brown Goode; on the colour relations of atoms, ions, and molecules, by M. Carey Lea, read by Ira Remsen; on the characters of the Otocœlidæ, by E. D. Cope; on the determination of the coefficient of expansion of Jessop's steel, between the limits of 0° C. and 64° C., by the interferential method, by E. W. Morley and Wm. A. Rogers; on a remarkable new family of deep-sea Cephalopods (*Opistotenthis*), and its bearing on molluscan morphology, and on the question of the molluscan archetype, by A. E. Verrill; on *Pithecanthropus erectus* from the Tertiary of Java, which was discovered by Dubois in 1895, by Prof. Marsh; on the separate measurement, by the interferential method, of the heating effect of pure radiations and of an envelope of heated air, by Wm. A. Rogers; judgment in sensation and perception, by J. W. Powell; exhibition of a linkage whose motion shows the laws of refraction of light, by A. M. Mayer; location in Paris of the dwelling of Malus, in which he made the discovery of the polarisation of light by reflection, by A. M. Mayer. Ira Remsen read a paper on some studies in chemical equilibrium, and several papers were read by title.

The Academy adjourned to meet at New York, November 17, 1896.

WM. H. HALE.

THE MANUFACTURE OF ARTIFICIAL SILK.

LANCASHIRE is on the eve of some important expansions of the textile trades, for, from an interesting article in the *Times*, it appears that the manufacture of artificial silk from wood pulp will shortly be added to her industries. At present the wood-silk comes from France, large works having been established at Besançon under patents granted to Count Hilaire de Chardonnet, who discovered the process, and first established in 1893 the fact that it might be made into a commercial success. The demand for the new commodity increased so considerably that the idea of introducing its manufacture into England was mooted, with the result that a number of silk and cotton manufacturers met to discuss the question, and finally sent out to Besancon a deputation, consisting of some of their own number, an engineer, a chemist, and a lawyer, to investigate the subject thoroughly. This was done, and the outlook was found to be so promising that certain concessions have been secured and a company is now in process of formation, and, to begin with, a factory, which will cost £30,000, is to be built near to Manchester for the manufacture of artificial silk yarn from wood pulp, for sale to weavers, who will work it up by means of their existing machinery. The way in which wood pulp can be converted into silk yarn is explained in the *Times*. The pulp, thoroughly cleansed, and looking very much like thick gum, is put in cylinders, from which it is forced by pneumatic pressure into pipes passing into the spinning department. Here the machinery looks like that employed in Lancashire spinning sheds, except that one of the pipes referred to runs along each set of machines. These pipes are supplied with small taps, fixed close together, and each tap has a glass tube, about the size of a gas-burner, at the extreme point of which is a minute aperture through which the filaments pass. These glass tubes are known as "glass silkworms," and some 12,000 of them are in use in the factory at Besancon. The effect of the pneumatic pressure in the cylinders referred to above is to force the liquid matter not only along the iron tubes, but also, when the small taps are turned on, through each of the glass silkworms. It appears there is a scarcely perceptible globule. This a girl touches with her thumb, to which it adheres, and she draws out an almost invisible filament, which she passes through the guides and on to the bobbin. Then, one by one, she takes eight, ten, or twelve other such filaments, according to the thickness of the thread to be made, and passes them through the same guides and on to the same bobbin. This done, she presses them together with her thumb and forefinger, at a certain point between the glass silkworms and the guides. Not only do they adhere, but thenceforward the filaments will continue to meet and adhere at that point, however long the machinery may be kept running. In this way the whole frame will soon be set at work, the threads not breaking until the bobbin is full, when they break automatically, while they are all of a uniform thickness. The new product is said to take dye much more readily than the natural silk. The chief difference in appearance between the natural and the artificial silk is in the greater lustre of the latter. The success already secured by the new process in France is such that the introduction of the industry into Lancashire is expected to produce something like revolution in the conditions of trade there, not only by bringing into existence a new occupation, but also by finding more work for a good deal of the weaving machinery that is now only partially employed.

A THEORY OF THE X-RAYS.[1]

THE principal facts, which any satisfactory theory of the X-rays is called upon to explain, may be summarised as follows:

(1) The production of the rays by electric impulse, at the kathode,[2] in a highly exhausted enclosure.

(2) Propagation in straight lines and absence of interference, reflection, refraction and polarisation.

(3) The importance of density of the medium as the determining factor in the transmission of the rays.

(4) The production of fluorescence and actinic effects, and the action on electrified conductors.

Two theories have been proposed to account for these remarkable phenomena: (1) the theory of longitudinal waves; (2) the theory of projected particles.

In reference to the first theory it may be said that unless it is proved that an oscillatory discharge is essential to the production of the X-rays, there can be no reason for supposing that these rays are of a periodic nature—that they are wave-motion as commonly understood. The absence of interference, reflection and refraction is also a very formidable difficulty. Attempts have been made to account for the absence of these invariable accompaniments of every known form of wave-motion, but, as I think, with very indifferent success.

The most serious difficulty in the second theory is the attempt to explain the passage of the electrified particles of the residual gas (or of the electrode) through the walls of the

[1] From the *American Journal of Science*, April.

[2] Even should further experiment prove that the X-rays proper originate at the first obstruction encountered by the discharge, the fact remains that this discharge originates at the kathode.

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