be worthy of attention; but it is not accurately so. The electrical theory of matter, and the consequent variation of inertia at high speeds, necessitates further analysis. The speed in a circular orbit is constant; but is not so in an elliptic orbit. Hence the mass in an elliptic orbit is not constant either. The result can be shown, astronomically, to be a cumulative progression of the apses: that is to say, a revolution of the orbit in its own plane,—like that which has long been familiar in the planets, especially in the planet Mercury²—the particle describing a kind of rosette instead of a really closed curve. This progressive elliptic motion can be compounded of two opposite circular motions of nearly but not quite the same period, and nearly but not quite the same energy; accordingly it has the effect of doubling the line which would otherwise be emitted. That is its main effect.

² See, for example, *Phil. Mag.* for August 1917, *et seq.* If $m = \beta m_0$ a revolution through $2\pi\beta$ is needed for a journey from one perihelion to the next.

Other perturbations are possible too, which will give multiple lines—what is called the fine structure of the spectrum—all which has been worked out in detail by Sommerfeld, and found to agree with observation; though the observations in the visible part of the spectrum are very difficult and delicate, and some of them quite recent.

With X-ray frequencies, these effects are more marked; and it is in the X-ray spectrum that they were first discovered. The fact that they can be accounted for in accordance with astronomical laws, supplemented by the electrical theory of matter, is surely a remarkable testimony to the general validity of what may be called the astronomical theory of the atom.

They strengthen the position of the kinetic atom of the physicist, as against the static atom of the chemist, beyond any reasonable doubt: though for chemical purposes and molecule-building, the static atom is certainly attractive, and, I expect, useful.

The Scientific Renaissance in China.

By Prof. J. W. GREGORY, F.R.S.

THE political changes in China during the last decade have had two opposite effects on the intellectual sides of Chinese life. The Revolution of 1911 gave a powerful stimulus which enabled the intellectual aristocracy to revolt successfully against the domination of tradition, and to advance a scheme of education free from the chains of classicism; but the concurrent political disorder has led to a reactionist triumph in administration. The reform in education which was regarded in 1911 as of primary importance was the replacement of the old written language by one based on an alphabet. The debt China owes to its written characters is incalculable. They have formed the real bond between the many provinces and races of the Empire, and long training in their use has given the Chinese their precision in observation, tenacious memories, and fine artistic perception. These great benefits have been attended by serious drawbacks. Learning the characters practically monopolises all school time. Each character has to be learnt by a distinct effort of memory. A child learns in the four years in the lower primary classes 700 or 1000 characters and a little arithmetic; and if it leaves school with a knowledge of only that number, it in time falls into the ranks of the illiterate. Knowledge of 4000 characters is required for general purposes, and a well-educated man is expected to know 8000 or 10,000. Hence the seven years spent at the lower and higher primary schools, and most of the subsequent four years at a secondary school, are occupied in learning to read and write.

There have accordingly been repeated attempts during the past 2200 years to replace the ideographic by an alphabetic system; but they have failed owing to the inherent advantages of the old system. The primary difficulty is that while the written characters are the same throughout China, the meaning of the words alters with the tone of expression, and the pronunciation varies from province to province. A phonetic rendering of a given character would mean different things in different localities. A uniform alphabetic system is possible only if the same pronunciation be adopted in all parts of China. The first step is therefore the establishment of a standard pro-

nunciation for the whole country. Such a system having been prepared and enacted, the second step is the invention of a set of phonetic alphabetic characters. A Commission for the Unification of the National Language adopted an alphabet of 39 letters, and the teaching of its system was begun experimentally in 1915. In 1918 the scheme was regarded as satisfactory, and it was introduced into the schools. The 39 letters having proved insufficient, another was added in 1920, and in addition to the established 40, others will be required for some dialects, such as Cantonese, which are exceptionally rich in sounds.

This system would give China a unified colloquial language which people could learn to read in a few months instead of requiring a decade of daily toil; it would enable the schools and colleges to give a liberal and scientific education, and would render possible the development of a living literature. The reformers hope that this system will be established throughout China in twenty years.

Concomitant with this reform, a new system of Chinese popular and higher education was promulgated in 1912 by a National Education Conference. This system consists of a universal compulsory course for four years; a higher primary course of three years; a secondary school course of four years; a preparatory course for the colleges of three years; and, finally, three years in colleges or professional institutions for pupils of the ages of 21-24. The scheme included four national universities—Peking for the north-east, Nanking for the middle east, Wuchang for the north-west, and Canton for the south and south-west. Each of these universities was intended to have faculties in literature, science, medicine, law, commerce, agriculture, and industry.

These noble schemes have been to a large extent frustrated by the political disorders that followed the Revolution. After the collapse of the Manchu Government, the local military leaders seized the reins of power and the revenues. The old officials, who had been selected by severe competitive examination, were replaced by nominees of the military. A riot of corruption and inefficiency has ruined the provincial govern-

ments. In many provinces the educational funds have been seized by the soldiers, and the schools were compelled to close. Education has had a severe set-back instead of being greatly extended.

Nevertheless, the virtues of the individual Chinaman are once again enabling the country to conquer apparently insuperable difficulties. The provinces of Kiangsu and Chekiang have maintained their schools by securing the old grants; in some districts richly endowed temples have been converted into high schools, the lack of which long rendered impossible advanced educational institutions and universities.

The university problem in China is complicated by the existence of numerous foreign Christian universities established by the missionary societies. They are not universities according to British standards. There are two Christian universities in Shanghai—the Aurora University, Roman Catholic, and the St. John's University, Church of England. Others are at Pekin, Wuchang, Nanking, Shantung, Suchow, and Chengtu. The Pekin University was founded in 1888 by the American Methodist Episcopal Mission; and the National University at Pekin has been compelled to adopt the name of the Government University of Pekin.

There are two foreign institutions which promise to reach a high rank and do much for Chinese scientific education. The Union Medical College in Pekin has been richly endowed by the Rockefeller Foundation, and was opened in 1921. Its object is to train not medical practitioners, but medical teachers and investigators; it has at present to undertake some pre-medical classes, but this elementary work will be discontinued as soon as there is an adequate supply of students sufficiently well grounded to profit by the advanced teaching of the College. The College is on a great scale; its teaching staff numbers 67, and one branch of it has a service staff of more than 600. It has already achieved valuable medical research.

What the Rockefeller Institute may do for medical work in northern China, the Hongkong University may do for general education throughout China. It was established by Sir Frederick Lugard when Governor of Hongkong, and opened through the generosity of Mr. H. Mody in 1912.

This institution is planned on novel lines, which seem admirably adapted to the development of an Oriental university. Its original faculties were those of medicine and engineering. These technical departments require chairs in academic subjects; and the number of these chairs is being gradually increased until a wide range of teaching is provided in pure science. A faculty of pure science will thus be founded on those of applied science. A faculty of arts has been already instituted, with commerce as its strongest branch. The university hopes that its external examiners will maintain its degrees on the same standard as those of the University of London, like which it has an external as well as an internal side. Its external side should prove of high service to China as the standardising and co-ordinating agency for the scattered sectarian universities. Their students may enter for its degrees by examination, and Hongkong University may thus raise their standards of teaching and afford a public test of their educational efficiency.

Meanwhile, the Chinese have themselves established universities which promise well. The National University of Pekin has been re-established by its Chancellor, Tsai Yuan-Pei, and is managed by a Senate elected by the professors. The teaching staff numbers 250 in faculties of science, literature, philosophy, history, and economics. At Nanking the High School has been developed into a university for the south-east of China, with its faculty of commerce at Shanghai. A university has been established at Amoy owing to the munificence of Tien Kak Kee, who has endowed it with a million dollars and an annual grant for maintenance of 120 thousand dollars, which is guaranteed for 25 years.

Tsing Hua is a college in the suburbs of Pekin which is extending American influence in China. The United States in 1908 remitted about half the indemnity due to it after the Boxer Rebellion on the understanding that the money was spent in sending Chinese students to American universities and on a college for their preliminary training. The college was founded in the suburbs of Pekin. Its non-Chinese teachers are American, 18 in number.

Shansi University was also due indirectly to the Boxer Rebellion. The two missions in Shansi nobly refused to accept compensation for the murder of their members, and suggested that the provincial government should spend the money in educational work and thus lessen the chance of similar massacres. The provincial government acted on this suggestion and founded the Shansi University at Tai-yan, placing it under European direction for the first ten years. Attached to it is the Nystrom Institute for geological and biological research, from which Dr. Norin has made valuable additions to the geology of north-central China.

Advanced scientific research in China is being promoted by new institutions and societies. The institution which is regarded as most successful is the Geological Survey and Museum, which have been organised by the first director, Mr. V. K. Ting. He has now the help of Dr. Gunnar Andersson, the Mining Adviser to the Chinese Government and head of the Geological Survey Museum, and of Dr. Grabau, the well-known American palæontologist. This Museum is being arranged on lines which combine due attention to scientific research and an educational exhibition. The Geological Survey has been described as the best thing in science which China has done for itself. The Survey has published a series of four Bulletins, five Memoirs, and five volumes of its "*Palæontologia Sinica*," containing monographs on Chinese fossils. Mr. Ting has given the Geological Survey of China an excellent start, but his recent resignation of the directorship, in order to undertake the general managership of a great Chinese coal company, is a serious loss to Chinese geology. He has an able successor in Mr. W. H. Chang.

An Archæological Society has been founded under the presidency of Dr. Black, director of the Anatomical Department of the Pekin Union Medical College, and has begun publication of contributions to Chinese ethnology; also a Chinese Engineering Society. A Chemical Society has been established at Shanghai, and has adopted the *China Journal of Science and Arts* as

its official organ. That journal is published by the China Society of Science and Arts, which was planned as a Biological Society, but, as it was found that there was more need for a general society, its scope was extended to include the pure sciences and arts. The journal of this society has issued four numbers containing many valuable and interesting contributions. The articles are partly popular and partly technical. The combination of original memoirs with popular articles has obvious drawbacks which may lead to its subdivision into a general magazine and a technical journal.

The Geological Society of China has begun on more normal lines. Its regular meetings are held at Peking. It has issued the two first volumes of its Bulletin, which contain many important additions to Chinese geology. The Journal of the Chinese branch of the Royal Asiatic Society is available for the publication of technical articles both on science and arts; the volume for 1922 contained seven biological and two geological memoirs, showing the increasing attention paid by that society to natural science.

Much of the new scientific work of China is naturally centred at Peking, but Shanghai, in addition to being the headquarters of the Chemical Society and the Faculty of Commerce of the University of Nanking, is projecting a first-class science museum, which is being organised by the Shanghai Museum Association.

It may be felt that the outlook for these schemes is not promising and that the existing political chaos in China may bring them all to naught. But Chinese history encourages confidence as to their future. Its general story has been of the gradual decadence of a ruling dynasty until it has become incompetent and corrupt and has been swept away. Then follows a confused interregnum which may be passed through in a decade or may last for a couple of centuries; it ends when some strong-man establishes a new dynasty. Though the present disorders may last for years, peace will assuredly be restored. In the meantime, the new Chinese Renaissance promises to make good progress in spite of political turmoil and military misgovernment.

The Serum Diagnosis of Syphilis.

THE Wassermann test for syphilis was discovered by the logical pursuit of a coherent series of observations. From the first it has proved of the highest value for the diagnosis of an infection which is often obscure. But it soon turned out that it was simply an empirical trick and not an application of the general principle which it was originally supposed to illustrate. If the typhoid bacillus, typhoid antibody, and fresh blood serum are mixed together, the three will combine in such a way that the substance in (or property of) fresh serum known as "complement" will disappear. If typhoid antibody is not present, the complement remains and its presence or absence can be determined by a test mixture of red blood corpuscles and red blood corpuscle antibody, in which the red cells will be dissolved if complement is also present. Supposedly the same would apply to a mixture of the spirochæte of syphilis, syphilitic antibody, and complement; and just as typhoid antibody, and therefore typhoid infection, can be detected by this Bordet-Gengou reaction, so was it thought that syphilitic antibody could be found in a patient's serum and syphilitic infection thereby inferred. In practice the idea seemed to work excellently, until it was found that an alcoholic extract of, *e.g.*, normal heart muscle would do as well as spirochætes. The reaction is therefore not specific, and as a matter of fact it is given by the blood in a proportion of cases of many protozoal infections. But it is specially constant in syphilis, and, as other protozoal infections are rare in Great Britain, it comes to be a splendid empirical method of diagnosing that disease.

The widespread use of the method in practical medicine has led the curious to come across a further series of phenomena in which the serum of syphilitics is quantitatively different from that of normal people. Thus it more easily becomes opaque on dilution with water or by admixture with the suspension of lipoids made by adding an alcoholic extract of heart muscle to salt solution—facts which have formed the basis of a number of simplified methods of diagnosis, all of which indicate that the proteids in syphilitic serum aggregate

into masses more easily than do those of normal serum. It is doubtless in this formation of aggregates or precipitates—visible or invisible to the bare eye—that the serum loses its property of acting as complement. A number of observations on the opacity of these mixtures of serum and lipoids in the presence of various concentrations of electrolytes have recently been described by Holker,¹ and illustrate the complexity of phenomena which have at present no rational explanation. The whole theoretical basis of the original Wassermann test and its almost innumerable progeny badly needs investigation. The problem is beyond the interests of the practical empiricism which has raised it.

Of the practical modifications of the original procedure, that introduced by Sachs and Georgi has proved one of the best. In this a solution of the alcohol-soluble acetone-insoluble lipoids of heart muscle, to which a small amount of cholesterol has been added, is diluted with salt solution. This opaque suspension is then added to the serum under examination: syphilitic sera give a flocculent precipitate more easily (*i.e.* with less serum) than normal. Experience showed that this simplified procedure was almost or quite as useful in diagnosis as the original more elaborate method.

In 1921 Dreyer and Ward made an ingenious attempt to standardise what at first sight seems rather an uncontrollable reaction, and so reduce it to comparable quantitative terms. The Medical Research Council has lately published² an exhaustive account of the method, with an elaborate analysis of the results obtained in a long series of cases in comparison with the more classical procedure. The value of the new "sigma" method is fully confirmed. But the account of the procedure should be studied by others who are concerned with colloids rather than medicine; it evidently raises larger problems than the diagnosis of syphilis.

¹ *Journ. Path. Bact.* vol. xxv. pp. 291, 522; *Proc. Roy. Soc., A*, vol. cii. p. 710.

² *The Serum Diagnosis of Syphilis: the Wassermann and Sigma Reactions Compared.* Medical Research Council: Special Report Series, No. 78. (London: H.M. Stationery Office, 1923.) 5s. 6d.