Obituary.

PROF. A. A. MICHELSON, FOR.MEM.R.S.

WE much regret to announce the death, which occurred on May 9, of Prof. A. A. Michelson, the distinguished physicist of the University of Chicago. Prof. Michelson was probably best known for his wonderful experimental work to detect any effect of the earth's rotation on the velocity of light. At the end of 1929, he resigned his position at the University of Chicago and went to Pasadena, where he proposed to carry out further work on this subject, and it is reported that preliminary measurements have already been made. Prof. Michelson had worked previously at Mount Wilson Observatory, Pasadena, and a brief account of repetitions of the famous Michelson-Morley experiment, as it is generally called, with a diagram of the apparatus, was contributed to NATURE of Jan. 19, 1929, by him and his collaborators. The results then obtained showed no displacement of the interferometer fringes so great as one-fifteenth of that to be expected on the supposition of an effect due to a motion of the solar system of three hundred kilometres per second through the ether. Since then, Prof. Michelson has been awarded the Duddell Medal for 1929 of the Physical Society of London for his work on interferometry.

In NATURE of Jan. 2, 1926, we were fortunate in being able to publish, as one of our series of "Scientific Worthies", an appreciation of Prof. Michelson and his work by Sir Oliver Lodge. We print below extracts from that article.

"Albert Abraham Michelson was born in Strelno, Poland, on Dec. 19, 1852. In 1854 his parents migrated to the United States. After emerging from High School in San Francisco, young Michelson was appointed to the Naval Academy, from which he graduated in 1873, and two years later became instructor in physics and chemistry under Admiral Sampson, continuing this work until 1879. After a year in the Nautical Almanac Office at Washington, Michelson, now an ensign, went abroad for further study at the Universities of Berlin and Heidelberg, and at the Collège de France and the École Polytechnique in Paris. Upon his return to the United States in 1883 he became professor of physics in the Case School of Applied Science, Cleveland, Ohio; whence, after six years, he was called to Clark University, where he remained as professor until 1892, when the University of Chicago opened its doors. Prof. Michelson went to this new institution as professor of physics and head of the department. In June 1925 he was honoured by being appointed to the first of the Distinguished Service Professorships made possible by the new development programme of the University.

"It was while he was at Cleveland that Prof. Michelson collaborated with Prof. Morley in their joint experiment; and it may have been for the purpose of that experiment that he invented his particular form of interferometer, with the to-and-fro beams at right angles. Later, he applied it in Paris to the determination of the metre, with an estimated accuracy of about one part in two million.

"During the War, Prof. Michelson re-entered the Naval Service with the rank of Lieutenant-Commander, giving his entire time to seeking new devices for naval use, especially a range-finder, which became part of the U.S. Navy Equipment.

"A Nobel Prize was awarded to Prof. Michelson in 1907, the first American to get one for science; and the Copley Medal, the most distinguished honour of the Royal Society of London, was awarded him in the same year.

"The gold medal of the Royal Astronomical Society was presented to Prof. Michelson on Feb. 9, 1923; and the compact exposition of the reasons for that award, by the president, Prof. Eddington, on that occasion will be found in NATURE, vol. 111, p. 240.

"Michelson touched on many departments of physics, but in optics, the highest optics, he excelled. In this subject he can be regarded as the most fertile and brilliant disciple of the late Lord Rayleigh, for his inventions are based on a thorough assimilation of the principles of diffraction, interference, and resolving power; and his great practical achievements are the outcome of this knowledge. Michelson seemed to have a special instinct for all phenomena connected with the interference of light, with a taste for exact measurement surpassed by none in this particular region. The interferometer with which he began became in his hands much more than an interferometer. He applied it to the determination of the standard metre in terms of the wave-length of light, with exact results which will enable remote posterity millions of years hence to reconstruct, if they want to, the standard measures in vogue at this day. He applied it also to analyse the complex structure of spectrum lines, and with remarkable completeness to determine the shape and size of invisible objects, such as to ordinary vision, however much aided by telescopic power, will probably remain mere points of light.

"In a magnificent paper in the *Phil. Mag.* of July 1890, Michelson suggested the application of interference methods to astronomy. He knew well that the resolving power of a telescope depended on the diameter of its aperture, and that the formation of an image was essentially an interference phenomenon; the minuteness of a point image, and therefore the clearness of definition, depending on the size of the object-glass. But he pointed out that if the aperture was limited to slits at opposite edges—so that no actual image anything like the object would be formed, but only the interference bands which the beams from the two slits could produce—a study of those bands would enable us to infer about the source of light very much more than we could get by looking at its image. For example, suppose it was a close double star, and suppose the slits over the object-glass were movable, so that they could be approached nearer together, or separated the whole distance of the aperture apart. A gradual separation of the slits would now cause the fringes to go through periods of visibility and invisibility; and the first disappearance of the fringes would tell us that the distance apart of the two components of the star (multiplied by the distance between the slits and divided by the distance of the star) would equal half a wave-length of light. The two components might be far too near together ever to be seen separately, and yet we could infer that the star was a double one; and by further attention to the visibility curve we could infer the relative brightness of the two components and their position relative to our line of sight.

"Furthermore, if, instead of looking at a star, we turned the slit-provided telescope on a planet with a disc too small for ordinary measurement, the size of that disc could be estimated from the behaviour of the interference fringes produced by its light in a suitable interferometer, or by the telescope converted into one.

"In view of the great interest aroused by the application of this method by Michelson himself, with the aid of collaborators at Mount Wilson Observatory, Pasadena, California, and with the hundred-inch telescope established there, it may be interesting to quote here part of the conclusion of his paper of date 1890:

"'(1) Interference phenomena produced under appropriate conditions from light emanating from a source of finite magnitude become indistinct as the size increases, finally vanishing when the angle subtended by the source is equal to the smallest angle which an equivalent telescope can resolve, multiplied by a constant factor depending on the shape and distribution of light in the source and on the order of the disappearance.

"'(2) The vanishing of the fringes can ordinarily be determined with such accuracy that single readings give results from fifty to one hundred times as accurate as can be obtained with a telescope of equal aperture.'

"'If among the nearer fixed stars there is any as large as our sun, it would subtend an angle of about one hundredth of a second of arc; and the corresponding distance required to observe this small angle is ten metres, a distance which, while utterly out of question as regards the diameter of a telescope-objective, is still perfectly feasible with a refractometer. There is, however, no inherent improbability of stars presenting a much larger angle than this; and the possibility of gaining some positive knowledge of the real size of these distant luminaries would more than repay the time, care, and patience which it would be necessary to bestow on such a work.'

"There seemed little hope at that time, and certainly no reasoned expectation, that any stars, except perhaps some of the very nearest, could have discs big enough for perception and measurement even by this virtual telescope of thirty feet aperture. The possibility of giant stars came, however, above our mental horizon; and Eddington made the notable prediction that a star like Betelgeuse must be in a highly rarefied state at a tremendously high temperature, and that it would be swollen out by the pressure of light to a size almost comparable with the dimensions of a solar system, although it could not contain very much more matter than, say, two or five times our sun. His argument, in brief, is that the spectrum of a young red star like Betelgeuse shows that it cannot be radiating furiously. Why then is it so conspicuous an object to our vision? It can only be because it is of enormous size, its density perhaps a thousand times less than atmospheric air. By utilisation of the data available in the light of his theory of stellar constitution, Eddington made an estimate of the diameter of the star.

"So with great skill Michelson and his collaborators got the interferometer to work. After many preliminary adjustments, on Dec. 13, 1920, Dr. F. G. Pease at Mount Wilson, with Michelson's apparatus, measured the diameter of a star for the first time, using Betelgeuse for the purpose. The interference-fringes formed by the star were observed, the object mirrors were gradually separated, and it must have been a joyful moment when, as they grew farther and farther and farther apart, the fringes at the eye end became less distinct and ultimately disappeared. The distance apart of the mirrors now, multiplied by the proper fraction, gave the angular dimensions of the star—a thing which had never before been observed in the history of the world. An estimate of the star's distance gave its actual diameter, and confirmed Eddington's prediction!

"Other stars have since been measured, and the giant stars well deserve their name. Moreover, an instrument has been put in the hands of posterity to the power of which we can scarcely set a limit in investigating utterly invisible details, both about the heavenly bodies and about atoms, by the new and powerful method of analysing the radiation which they emit.

"The form of instrument adapted to the heavens is, however, not applicable to the atoms. The spectrum of atomic radiation is formed by a grating; and Rayleigh showed that the power of a prism spectroscope is expressed approximately by the number of centimetres of available thickness of glass, which is one form of saying that, to get high definition or separating power, we must use interference depending on a great number of wave-lengths retardation. Michelson perceived that the retardation principle might be employed so as to make a grating which combined with its own effect the resolving power of a prism. A slab of glass, a centimetre or more thick, might be used to give the necessary lag in phase of many thousand wave-lengths, and thereby secure a definition and resolving power unthought of before. So Michelson designed the Echelon spectroscope, consisting of thick slabs of glass, each protruding a millimetre or so beyond the other—a staircase spectroscope—which is now a regular instrument in the examination of the minute structure of spectrum lines.

"What, however, is popularly the best-known work of Michelson is the application of his interferometer to determine if possible the motion of the earth through the ether. The speed expected was of the order one-ten-thousandth of the velocity of light; but since the journey of the light in the instrument is a to-and-fro journey—one half-beam going as nearly as possible with and against the hypothetical stream of ether, while the other half-beam goes at right angles to that direction—the amount to be measured was not one-ten-thousandth but the square of that quantity; that is to say, the observer had to measure one part in a hundred million—no easy matter. The interferometer was mounted on a stone slab floating in mercury, and the whole observation conducted with great care. The result was zero; and that zero was used afterwards as the corner-stone of the great and beautiful edifice of relativity."

WE regret to announce the following deaths:

Mr. St. George Littledale, who was awarded the Patron's Medal of the Royal Geographical Society in 1896 for three important journeys in the Pamirs and central Asia, on April 16, aged seventy-nine years.

Sir Charles Lucas, lately chairman of the Royal Empire Society (formerly the Royal Colonial Institute), distinguished as a historian of British colonial development, on May 7, aged seventy-seven years.

Mr. Emil Torday, a distinguished authority on the anthropology of Africa, on May 9, aged fifty-six years.

News and Views.

THE question of the introduction of twenty-four hour reckoning for railway time-tables has recently been discussed in Parliament. The subject is a well-worn one. It is nearly half a century since the late Sir William Christie made efforts in this direction. He suggested that, if it were done, astronomers might meet the public by reckoning astronomical time from midnight, a change that was actually made in 1925. A few years ago a committee appointed by the Council of the Royal Astronomical Society interviewed the railway authorities, endeavouring to persuade them to adopt the 24-hour system in time-tables, pointing out that the method was already in use in many countries. The companies, however, refused to make the change unless clear evidence was submitted to them that the public desired it. It is, however, fairly obvious that the public is inarticulate in matters of this kind. There was little enthusiasm for the summer-time scheme until it came about as a war-time economy; but once it was tried, it was welcomed with enthusiasm by all except a small minority. If the 24-hour scheme were adopted there would be no need to have new clock dials; the addition of 12 hours is an easy mental operation: moreover, the use of the new time for time-tables and public announcements would entail no obligation to use it in private life.

FOR some little time the attention of the public has been specially directed to eastern affairs in such a way as to emphasise the need for appreciation of the distinctive features in Oriental culture as a basis of understanding. More recently, however, the success of the exhibition of Persian art has given undue stress to the æsthetic side, which scarcely comes within the scope of NATURE. It is for this reason that we have refrained from comment on the various suggestions for the foundation of a museum for Oriental or Asiatic art which have appeared in the correspondence columns of the daily press. A proposal of a more comprehensive and scientific character is now put forward by the Royal Anthropological Institute. At a recent meeting of the Institute's Joint Committee on Teaching and Research, which includes representatives from all the universities and institutions interested in anthropological and archæological studies, it was strongly urged that a central institute is needed to serve and guide the study of Indian and Oriental cultures as an expression of the thought and life of the people; and that such an institute should include, as recommended by the Royal Commission on the National Collections, provision for the study and exhibition of the national collections from the scientific and technological as well as from the æsthetic point of view. It was added that provision should be made in the Institute for the endowment of advanced teaching and research, and that its constitution should be on a federal basis, to permit the closest co-operation with existing institutions devoted to such studies.

THE bearing of the last suggestion is elaborated in a memorandum by Prof. J. L. Myres which was circulated to the Committee and is published in *Man* for April. It is there pointed out that the provision of a chair of Indian cultural studies, which has been suggested, is scarcely practicable, in view of the wide range of studies to be covered; while a series of chairs "in some British University" would not necessarily stand in the desired relation to the national collections. On the other hand, there are in other university cities, as well as in London, long-established and well-supported centres of Oriental study, such as the Indian Institute at Oxford. This institute, as founded by Monier-Williams, did indeed, on a small scale, anticipate the combination of library, museum, and provision for teaching and research such as is now contemplated and could alone cover adequately the study of art and technology, illustrate the thought and social structure of the people, and in the literature provide the interpretation of their culture. A national institution of the type suggested might then be linked federally to all existing establishments by the structure of its directorate and the composition of its staff.

THE Patent Office has recently made changes in the method of publishing its abridgments of specifications which should be noted by all who have to search through British patent literature. Hitherto, the weekly official journal has always contained, in numerical sequence, the week's series of abridgments, the whole from year to year forming a complete numerical set for immediate reference purposes. In addition, the abridgments allotted to each of the 271 classes into which the subject matter of inventions