gravette type with the *dos rabattu* back was the most common. The number of flint cores and chips point to the implements having been made on the spot. The raw flint would have to be carried a distance of some 25 miles from the nearest point at which chalk flint would be available. Mr. J. A. Davies, who has reported on the flint implements, ascribes them to the Aurignacian culture developed along native lines and contemporary with the Magdalenian of France.

Perhaps the most interesting find was made in layer 19 (9 ft. 6 in. deep); this was a *bâton de commandement* of reindeer antler. Part of another was found in the same cave in 1903 close to the 'Cheddar Man.' These are the only specimens found in England, though they are not uncommon in some of the French caves. The use of these artefacts is not very clear; some of the French archæologists consider them to be a kind of sceptre carried by the chiefs, but Sir William Boyd Dawkins and Prof. Sollas and others maintain that they were used to straighten arrow shafts.[3] The latter seems to be the more likely theory. The specimen now found has a hole bored through the expanded portion of the antler where a tine branches. This tine has been cut off. The hole is bevelled on either side in a line with the shaft, and the perforation has five lines cut rather deeply on the inside, presumably to give a better grip to the arrow shaft. The instrument is ornamented on either side of the shaft by bands of lines cut lightly and rather roughly into the surface. The lines are not continued right round the shaft, each side having a separate design.

[3] W. J. Sollas, "Ancient Hunters," p. 530.

A rod of ivory and numerous bone piercers and points of a rather distinctive type were found between layers 8-15, and layers 9 and 14 gave us two canine teeth of fox beautifully bored at the root ends for suspension as a necklace ornament. There was also from layer 11 a shell of *Neritoides obtusatus* bored for suspension.

Parts of two human skulls were found in layers 10-13. They have been submitted by Dr. N. C. Cooper to Sir Arthur Keith, who assigns them to the same age as the 'Cheddar Man,' that is, some 12,000 years ago.

The animal remains include wolf, bear and reindeer, Irish elk, arctic fox, and English varying hare.

A full account of the excavations will be published in the next volume of the *Proceedings of the Somerset Archæological and Natural History Society*, where the reports of Mr. J. A. Davies on the flint implements, Mr. H. St. George Gray on the bone and antler implements and pottery, Sir Arthur Keith and Dr. N. C. Cooper on the human remains, and Miss D. M. A. Bate on the animal remains, will appear.

Obituary.

PROF. WILHELM WIEN.

PROF. WILHELM WIEN, of Munich, whose death on Aug. 30 last, at the comparatively early age of sixty-four years, is deeply regretted, was in the front rank of the physical investigators of his time. He was born at Gaffken, near Fischhausen, in East Prussia, where his father was a farmer, and received the earlier part of his education at gymnasia in Rastenburg and Königsberg. He then studied at the universities of Göttingen, Berlin, Heidelberg, and finally at Berlin again, where he was a pupil of Hermann von Helmholtz.

Wien's career, in its outward aspects, was very like that of most successful German men of science. He took his doctorate in 1886 with a thesis on absorption phenomena associated with diffraction. After two or three years as assistant to Helmholtz, he became a 'Dozent' in Berlin in 1892. In 1896 he became professor extraordinary at the Technical High School in Aachen. In 1899 he was appointed professor of experimental physics at Giessen; in 1900 at Würzburg, where he remained twenty years; and finally at Munich

The immense importance of Wien's contributions to physics was recognised by the award in 1911 of the Nobel Prize. His published papers cover a great variety of subjects, including hydrodynamical researches (no doubt inspired by Helmholtz), electric discharge in rarified gases, cathode rays, positive rays (*Kanalstrahlen*), X-rays, and, most important of all, the theory of black body radiation.

To appreciate properly Wien's work we have to remember that at the time he began as an investigator the Newtonian basis of physics was still held to be something established for all time, and Clerk Maxwell's electromagnetic theory was a new and daring speculation, regarded by many English and most continental physicists with suspicion and distrust. In fact, so far as physical principles and the underlying basis of the science are concerned, physics was thought by many to have reached a state of completion and finality. Among those who prepared the way for the splendid new era in physical science, Wilhelm Wien was one of the most prominent. His greatest achievements are embodied in the two laws of black body radiation which are named after him.

We owe the first serious attempt at a theory of black body radiation to Gustav Kirchhoff, who showed that the character of the radiation in an enclosure, every part of the walls of which has the same temperature, is independent of the nature of the materials forming the walls and is a function of the temperature only. In 1884, Boltzmann deduced from thermodynamic considerations the Stefan-Boltzmann law expressing the total energy density of the radiation in such an enclosure as a function of the temperature. The problem of the distribution of energy among different wave-lengths was still untouched, and Wien's two laws constitute an important advance in the direction of its final solution. His first paper on the subject was communicated to the Berlin Academy by Helmholtz in 1893 and entitled, "Eine neue Beziehung der Strahlung schwarzer Körper zum zweiten Hauptsatz der Wärmetheorie." In it he showed that the density of the energy associated with the wave-length λ at the temperature T is proportional to the product of the fifth power of the absolute temperature and some function of the product λT. What is usually called Wien's displacement law is an inference from this; namely, that $\lambda_m T$ is a constant, where λ_m is the wave-length where the energy density is a maximum. Experimental proof of it was soon furnished by Paschen and by Lummer and Pringsheim, who found the value of the constant to be approximately 0·29 cm. degree centigrade

Wien's second great contribution to the theory of black body radiation is contained in his energy distribution formula, published in 1896, according to which the energy density in the neighbourhood of the wave-length λ is proportional to $\lambda^{-5}\exp.(-c/\lambda T)$, where c is a constant. This law agrees with the observations only when the product λT is sufficiently small, and it has not the same sound theoretical basis as the displacement law. It was, nevertheless, of the greatest importance, since it provided Planck with one of the clues he needed for the complete solution of the problem of full radiation. Although it is unlikely that Wien, or anybody else but Planck, dreamt at that time of such a revolutionary innovation as the quantum theory, he certainly contributed to it indirectly.

Scarcely less important than his investigations of the character of black body radiation is Wien's work on the positive rays or *Kanalstrahlen* discovered by Goldstein. In this important line of research he was a pioneer. So far back as the year 1898 he read a paper to the German Physical Society on the electrostatic and magnetic deflection of canal rays. This was the first of a long series of papers on a subject which occupied his attention almost to the time of his death.

Wien was the editor of the *Annalen der Physik*, the greatest and the oldest of the scientific journals devoted to physics in Germany. A fine lecturer and teacher, he was held in high esteem and affection by his students, and they and all who knew him will mourn the loss of Wien the man as much as that of Wien the savant. This brief appreciation and tribute to his memory may fittingly conclude with words which he himself used on the death of the great master Kelvin:

"Now closes a life that was infinitely rich with an inner wealth, a life that it was worth while to have lived."

PROF. P. P. SUSHKIN.

PETER PETROVITCH SUSHKIN was born on Feb. 8, 1868, in Tula, Central Russia. From his early days he was deeply interested in wild Nature, and already as a young student of the University of Moscow made a thorough study of the bird fauna of the Tula, Moscow, and Voronezh provinces and published his first paper, a forerunner of a long series of faunistic studies on birds of various parts of Russia, from the Urals and the Kirghiz steppes to Altai and Mongolia. Explorations of this kind were made possible for him because, as a brilliant student, he received a special research scholarship at the University of Moscow, and in 1901 he was made a lecturer in zoology. In 1910 he was appointed to the chair of vertebrate zoology and comparative anatomy in the University of Kharkov. During the revolution he had to move from Kharkov to the Crimea, where he lectured in the local university for some time, until in 1921 he was elected Keeper of the Ornithological Department of the Zoological Museum of the Russian Academy of Sciences in Leningrad. Two years later he was elected a member of the Academy. His activities in the Academy were numerous, since, besides being in charge of the bird collections of the Zoological Museum, he presided over several permanent commissions, took charge of the newly formed North Dvina gallery of palæozoic vertebrates of the Academy's Geological Museum, and acted as secretary of its physico-mathematical section.

Ornithological science is indebted to Sushkin for his extensive and thorough studies in the faunistics and distribution of birds of the Altai, Kirghiz steppes, Siberia, and Mongolia. In these studies Sushkin always used his unusually wide knowledge of related sciences and tried to apply the distributional data to the solution of general problems of the origin and history of the bird fauna of palæarctic Asia, and his works are of immense value in this respect to every biologist studying any group of animals in Asia. Faunistic work on birds led Sushkin to his attempts to find confirmation of his conclusions with regard to other animals, and he did a considerable amount of work on the distribution of butterflies, since he believed that their distribution follows more or less the same laws as that of birds. Lately, he expanded his views on the history of the fauna of Central Asia so as to include even the problem of the origin of man, and he believed that man originated in the barren mountainous regions of Central Asia.

Apart from faunistic work, Sushkin is well known for his masterly systematic studies of several difficult groups of birds; these papers of his are particularly valuable because of his deep knowledge of the comparative anatomy of birds. Recently, Sushkin undertook a study of palæozoic reptiles and amphibians, and published several important papers on them, but this work has been cut short by his untimely death, which occurred on Sept. 17 last, from pneumonia. He left numerous pupils in Russia and many friends there and abroad, since he travelled in Europe in 1900 and again in 1924 (when he visited also America). A tragic detail, typical of the conditions under which he had to work in recent years, may be added: his flat in Leningrad was broken into during his funeral and everything of value stolen, including some unfinished manuscripts on which he was actually working up to the day of his death.