being at low pressure, and his results led him to devise his mercury vapour pump.

The principle is to let the gas diffuse into a rapid stream of mercury vapour which carries it away to a place where it can be removed by a rough pump. The vapour stream is produced by strongly heating liquid mercury; vapour which diffuses into the receiver space is condensed. Although the fore-vacuum is necessarily at a higher pressure than the receiver, gas cannot get back against the stream of mercury vapour. The pump will only work well at low pressure, for unless the mean free path is long the diffusion process does not become really operative. To render the diffusion effective Gaede used a slit, which diminishes the counter-current of mercury vapour. This case can be worked out mathematically, and it can be shown that diffusion is most effective when the width of the slit is equal to the mean free path of the gas. If the slit is too wide the density of the mercury vapour is too great, and the 'brush' action of the slit loses its sharpness; if it is too narrow not enough gas molecules diffuse through. Similarly, if the vapour pressure is too high the counter-current is too vigorous; if it is too low the stream is not fast enough.

A better arrangement of the vapour stream was devised by Langmuir. In his type of pump the vapour issues through a tube, which is surrounded by a wider tube, the walls of which are water-cooled. The tube to the receiver enters the outer tube at a point in the rear of the vapour jet. If the pressure is so low that the mean free path of the vapour is greater than the distance between the tubes, the molecules cannot diffuse back against the gas stream, but strike the wall and condense. It is true that a much lower temperature than the boiling point of mercury is needed for condensation at such low pressures, but with tap-water cooling the condensation is fairly effective. The importance of condensation is clear, and Langmuir called his pump a condensation pump, but the gas enters the vapour stream by diffusion just as in Gaede's pump. Both the original Gaede pump and Langmuir's pump are really diffusion-condensation pumps.

The different types of diffusion pump all need a good preliminary vacuum, as they cannot hold up against more than a slight difference of pressure without gas coming back against the vapour stream. A fore-pump producing something between a tenth and a hundredth of a millimetre of mercury should be employed. However, at higher pressures, where the diffusion effect is small, we can use the steam-injector principle, for in a jet of fast-moving comparatively dense vapour there will be a diminution of pressure corresponding to the kinetic energy of the accelerated vapour. The surrounding gas will flow in as a whole under the difference of total pressure, not partial pressure. This principle has been used for the creation of a fore vacuum by a vapour stream. In Gaede's three-stage steel mercury-vapour pump, for example, which has great speed of pumping, there is an injection stage working at comparatively high pressure, and a diffusion stage for the lowest pressure, while in between there is a stage of mixed action.

Mercury is not the only liquid which is suitable for use in a vapour pump. Quite recently Mr. Burch, by a process of distillation *in vacuo*, has obtained an oil the vapour pressure of which at ordinary room temperatures is extraordinarily low. This oil can be used effectively as the working fluid in pumps. Another liquid which can be used is normal butyl phthallate.

In addition to the types of vacuum pumps to which reference has been made, it must be remembered that other processes are widely used, especially in industrial laboratories, for producing high vacua. Solid surfaces in general exercise a marked condensing action on gases, and absorb on themselves thin layers of gases at temperatures and pressures under which the substance is gaseous in bulk. Consideration of these surface actions lie outside the scope of this discourse, as do the methods of combining the residual gases chemically with a substance which deposits on the walls of the glass, by the use of the so-called 'getters'. We may, however, with reference to the part which the walls of the vessel play in these processes, refer to these methods as *mural* methods. If we are allowed to do this we may alliteratively divide the methods of producing high vacua into *mechanical*, as exemplified not only by the Geryk pumps, and box-pumps, but by all pumps, such as the Gaede rotary pump, in which a portion of the gas is cut off and bodily expelled; *molecular*, including in this term both what is ordinarily called the molecular pump and also the vapour stream pumps, since they are based upon molecular theory; and *mural*. The action of the first is perfectly understood; the action of the second is largely understood, but more difficult; the third method, though widely applied, is theoretically still very obscure in many cases.

Finally, it may be mentioned that while pressures as low as a ten-thousand-millionth of atmospheric pressure can be certainly produced in the laboratory, even at this pressure more than a thousand million molecules are present in every cubic centimetre. We are still very far from being able to produce the kind of vacuum that exists in outer space.

Obituary.

DR. C. EASTON.

ON June 3, 1929, Dr. Cornelis Easton died at the Hague at sixty-four years of age. Though he was not professionally engaged in science, his work attracted the attention both of astronomers and of meteorologists, and a short account of his life and work, abstracted from a contribution by Dr. J. Stein, S.J., to *Hemel en Dampkring*, July-September 1929, may interest readers of NATURE.

Born at Dordrecht on June 10, 1864, Dr. Easton attended schools there and passed the entrance examination to the Polytechnicum at Delft in 1881. From early youth the stars had interested him, and one of his teachers encouraged observational

work, so that even during his student's time at Delft he began observing the Milky Way with the view of producing an exact picture of Galactic details and nuances. Though he left his technical studies in 1884 for a literary career and eventually became editor of a leading newspaper, he continued his astronomical work, and after many difficulties, succeeded in 1893 in publishing his first and important work: "La Voie lactée dans l'hémisphère boréal", containing four maps in lithography, prepared with the author's assistance and under his supervision.

This work, which was very favourably received by professional astronomers, was followed by a series of papers dealing with the distribution of the stars near the Galactic system. The principal view put forward is that the Milky Way must be considered as a spiral with two principal curves, a centre in Cygnus, secondary streams going in the direction of Perseus and Ophiuchus, the sun in a rather open space between the windings. The theory was further developed in "A Photographic Chart of the Milky Way and the Spiral Theory of the Galactic System" (*Astrophys. Journal*, **27**, Mar. 2, 1913). The original maps on which this photographical chart was based, were partly published this year (*Monthly Notices R.A.S.*).

In the meantime another research had been undertaken, and in 1903 the result appeared in the memoirs of the Kon. Akademie van Wetenschappen at Amsterdam, "La distribution de la lumière galactique comparée à la distribution des étoiles cataloguées dans la Voie lactée boréale," followed by other treatises on the distribution of nebulæ (1904) and the distance of galactic star-clouds (1921). Soon after the first of these publications, June 13, 1903, he obtained from Kapteyn's hands the honorary degree of doctor of the University of Groningen.

Easton's important studies on periodicity in climate ultimately led to the publication of his book: "Les hivers dans l'Europe occidentale", recently reviewed in NATURE. This work, like that on the Milky Way, involved careful and patient collection and criticism of a vast amount of material, and apart from the value of the results regarding periodicity, it will form a basis for other theoretical investigations. The principal conclusion in favour of an 89-year cycle in the frequency of severe winters certainly was confirmed by the severe winter 1928–29.

Of course, a journalist so well acquainted with astronomy and meteorology, which appeal most to the general public, had an excellent opportunity of popularising these sciences in the papers, and he did so with great success. This was one of the reasons why Easton was chosen as a member of the board of visitors of the Royal Dutch Meteorological Institute of the Netherlands. Since 1921 he was president of the Society for Meteorology and Astronomy, and since 1922 chief editor of its periodical, *Hemel en Dampkring*, which was much extended under his leadership. In every respect Easton will be very difficult to replace, but his work remains and will long continue to be appreciated. E. VAN E.

PROF. LOUIS CAPITAN.

THE death is announced from Paris of Prof. Louis Capitan, one of the foremost French archæologists of the day. M. Capitan was a doctor of medicine, a member of the Academy of Medicine, and had for many years been a professor at the École d'Anthropologie. He was the author of numerous communications dealing with archæological subjects which appeared in French scientific periodicals, and especially in *L'Anthropologie*.

With various collaborators Prof. Capitan was responsible for several of the magnificent publications dealing with the exploration of the French palæolithic caves, which appeared under the patronage and with the subvention of the Prince of Monaco and under the auspices of the Institut de Paléontologie humaine. "La Caverne de Font de Gaume", written with MM. Breuil and Peyrony, was published at Monaco in 1910. "Les Combarelles aux Eyziès", written with the same collaborators, appeared in Paris in 1924. Other volumes were "Limeuil, son gisement à gravures de l'âge du Renne", Paris, 1924, in collaboration with M. Bouyssonière, and "La Madeleine", Paris, 1928, of which M. Peyrony was joint author.

M. Capitan was a strong supporter of the view which claims a very high antiquity for the art of flint working, and argued forcibly that the flints of earliest date from East Anglia for which an artificial origin was claimed were rightly attributed to man or a pre-human precursor of man. The ground for this conclusion which appealed most strongly to him was a classification of the specimens into 'artificial' and 'natural' based upon his long experience in handling flint implements in large numbers. In fact he had practically reached the position that the final test of the eolith was a judgment which had become almost intuitive as the result of experience—a subjective test which was likely to appeal more to its author than to his audience.

M. Capitan was also keenly interested in Americanist studies. He was one of the French delegates who attended the International Congress of Americanists held in London in 1912, and in 1914 he published, with the assistance of M. Lorin, a book entitled "Le travail en Amérique avant et après Colombe". He was actively concerned in the record and preservation of ancient monuments, and took a prominent part in relation to a projected series of archæological maps, recording the existence and distribution of prehistoric monuments, for which he hoped to obtain international co-operation.

MR. E. H. MAN, C.I.E.

WE regret to record the death of Mr. Edward Horace Man, which took place on Sept. 29 at Preston Park, Brighton. Mr. Man, who was formerly in the Indian Civil Service, retiring in 1901, was born in 1846. As a young man he was appointed to the Andaman Commission, and not only entered into close and friendly relations with the