laws by a simpler accumulation of evidence. This distinction is false. Laws must be guessed by induction; they must be fitted together into an axiomatic model; and the model can only be tested by such critical devices.

The point is crucial; and it leads us to ask: How, in fact, does the scientist invent the nexus of primitive entities and their relations which make his model? The axioms of Euclid do not raise this question, because plainly they are simple experiences in geometry, and this is why they were long thought to be self-evident. But the entities which underlie an axiomatic description of Nature are not at all immediate to the senses. How does science come to isolate them?

Experiments as Messages

Leibniz gives the clue to this when he says that the scientist must read the cryptogram in Nature. His hint has been neglected; but then, so has the whole fundamental problem.

Take some commonplace from the chemistry book, the simpler the better: say, the action of sulphuric acid on common salt. This reaction was known to Dr. Glauber in the seventeenth century. From that time, apothecaries knew what substances are involved, and more and more other reactions in which they take part. All these reactions were in a sense messages, that is, they had a systematic content; but chemists failed to read them, and chemistry remained incoherent, until their code was broken down. In effect, modern chemistry begins when Glauber's reaction could be written as

$$2\,NaCl + H_2SO_4 \rightarrow Na_2SO_4 + 2\,HCl.$$

This and the formulæ like it trace an order in the chemical actions by showing that they are all assembled from one set of code letters or elements.

The code does not stop there. It prompts the chemist to ask why S is so often coupled with O_4, and why the letter H moves about in so many of these messages. This is the familiar step in decoding which counts the frequencies of letters and of groups, and here it at once leads to the theory of valencies. From it we pass to physical theories, which seek a still more compact structure within the alphabet of ninety or so elements. The messages of physics can, in fact, be broken down, by these steps, first to electrons and unidentified nuclei, and then to a three-symbol Morse code of electrons, neutrons and protons.

Code and Meaning

In this procedure, Nature is conceived as an assembly of processes (and not of objects or events). The sentences which describe these processes are thought to be a set of code messages. To trace the laws within the processes is then systematically to break down the code into its constituent symbols and their laws of arrangement. This is the most powerful form of the axiomatic method, for it recognizes that we do not analyse experiments but the sentences which record them.

This procedure, however, as yet has no criterion for preferring one axiomatic model to another. The choice between two ways of decoding the sentences, and the wish to pass from a code of ninety-odd symbols to one of three symbols, must be governed by a rational demand. This requirement is that the code shall make the content of information in the record as large as possible. In this context, information and meaning are identical; so that this is the demand that *the code shall make Nature as meaningful as possible.*

By way of example, consider two models each of which can account for the same set of experiments. The experiments are read as messages on the symbols and axioms of the two models; they therefore have in each case a content of information made up of sums

$$-\sum_i p_i \log p_i,$$

where the p's are the probabilities that the symbols occur in their places by chance. The demand for the larger content of information therefore prefers the model in which the symbols have more free choices for their occurrence or behaviour. Succinctly, we are to prefer the less restrictive model; or, as Ockham put it, we are not to multiply hypotheses.

Even the messages of Nature, of course, do not reach us without noise. This background noise is provided by the experimental errors and ultimately by the coarseness of all observation. To this, Nature might have added a random process of her own, with no known law of distribution. But if so, we have not detected it. We set about the task of decoding on the assumption that nothing in the processes of Nature is meaningless.

Direction of the Message

A message has only one dimension, and most scientific constructs have several. But since the message transcribes a process or experiment, plainly it singles out the dimension of time. Objects, events and structures are to be pictured within the code groups, where they can have their own function spaces. The direction of the message is the direction of time.

But, of course, a code message carries no mark of direction, and it might read forward or backward. Even a book of messages, or the whole record of the past, might be decoded in either direction; and its meaning would not be essentially different, with one exception. The exception is that we should not know which way time is running. This is an odd and final use of experiment: that we have to add one experiment of our own to the record, in order to fix the direction of time as we experience it.

OBITUARIES

Sir William Dampier, F.R.S.

Sir William Dampier was born in 1867 and named William Cecil Dampier Whetham. His early work was published under that name; but later he changed his surname to that of his mother's family. His father and grandfather were prominent citizens of London, the latter being its Lord Mayor in 1878; but his own most vital interest lay in the country rather than the town. After taking his degree in Cambridge in 1889, he went to work in the Cavendish Laboratory under the inspiration of J. J. Thomson. The best-known result of his early work is his experimental proof that when liquids flow through tubes there is no slipping at the liquid–solid interface. Later he studied the motion of ions in liquids and developed methods for measuring ionic velocity which have since been used by others. With E. H. Griffiths he made accurate measurements of the conductivity and depression of freezing points of dilute solutions and showed that their results were in agreement with the ionic theory which Arrhenius had recently put forward. As a result of these studies he published in 1902 his book "The Theory of Solution", which was for a time the standard text-book on the subject.

In 1891 Dampier was elected to the fellowship at Trinity College, Cambridge, which he retained until the end of his life. After serving for some years as a College lecturer, he accepted the heavy duties of a College tutorship. In this office he showed a capacity for human sympathy which his many pupils gratefully remember; but his duties took up so much of his time that he had to drop his laboratory work. His mind, however, was very active. During this period he published books on eugenics and was collecting material for his "History of Science" (1929).

Meanwhile, with his love of the country and country pursuits, Dampier could not be satisfied with life spent entirely in Cambridge. He and his wife bought an estate in Devonshire, and problems connected with agricultural economics soon forced themselves on his attention. In 1917 he inherited a small family estate. At that time he was working part-time with Sir Thomas Middleton at the Food Production Department of the Ministry of Agriculture. He characteristically decided to put his agricultural ideas to the test by taking two farms near his estate and operating them through a manager. The scarcity of cheese during the First World War directed his attention to this product, and he set up a small cheese factory in connexion with his farms. Here the problem of using the surplus whey led him to experiments in the production of lactose, which eventually developed into a process used on a commercial scale.

The falling prices from 1920 onwards focused Dampier's attention on the relationship between money, prices and agricultural profits. He published his opinions on these subjects in the *Economic Journal* (1925) and in a book, "Politics and the Land" (1927).

The interest aroused by these publications and the reputation for sound judgment which Dampier had acquired in several forms of public service led to his being consulted by the Government on many problems of agricultural policy. Of these none was more important than those which led to the formation of the Agricultural Research Council. After the First World War, when it became clear that the Government would have to spend large sums in supporting scientific and medical research, the Department of Scientific and Industrial Research and the Medical Research Council were set up to encourage and regulate government expenditure and activity in these fields. No such body existed for agricultural science; but a number of laboratories devoted to agricultural research were being largely supported through public funds. Since these independent bodies were in some cases absorbing increasingly large grants, it became clear to the authorities that a body analogous to the Department of Scientific and Industrial Research or the Medical Research Council would have to be set up for agriculture. Dampier's tact and experience were of great value during the delicate negotiations which were necessary to bring the existing independent bodies into a state of mind favourable for setting up an Agricultural Research Council which would regulate their grants. Dampier became the secretary to the Council, and guided it in the difficult early stages until it became firmly established. He also took great interest in rural community councils.

Dampier was elected to the Royal Society in 1901, was knighted in 1931 and awarded the Gold Medal of the Royal Agricultural Society in 1936. He married Catherine Holt in 1897 and had five daughters. His loss will be deeply felt in Trinity College, to which he was so devoted and gave such good service.

G. I. TAYLOR

Prof. L. B. Smyth

LOUIS BOUVIER SMYTH was born in Dublin in 1883 and died there on July 11, 1952. His father was Mr. Isaac Smyth of Dublin; his mother was French. He received his school education at Wesley College, Dublin, and entered Trinity College in 1902. He graduated in 1906, obtaining senior moderatorship in natural science with a large gold medal, awarded for first place on exceptionally high marks. In those days candidates took botany, geology and zoology, equal weight being assigned to each course during the four years; but for the degree a special course also had to be taken in one subject. Smyth took botany and was appointed as assistant to Prof. H. H. Dixon during the period when the present School of Botany was being built and the department organized. This happy collaboration continued for three years. He then accepted a post as naturalist in the Fisheries Branch of the Department of Agriculture and took part in several cruises to study, in particular, the phytoplankton. After a year there he was invited by Prof. John Joly to join his staff, and from 1911 until his death he continued in the Iveagh Geological Laboratory at Trinity College, Dublin. In 1911 also he married, very happily. He is survived by his widow.

Joly sent Smyth to work in Oxford under the late Dr. Arthur Vaughan, the leading English palæontologist of that period, and, on his return to Dublin, Smyth was appointed lecturer in palæontology. Then for more than twenty years he did all the exclusively honours teaching in the Geological Department in mineralogy, petrology, palæontology and geological map-reading. Sometimes also he had to lecture as Joly's deputy, and in six consecutive years he had the Senior Engineering Class on ore deposits. From 1931 until 1934 he occupied also the newly made post of lecturer in geography.

But Smyth's influence in Trinity College, Dublin, extended far beyond the geological laboratories. He joined the O.T.C. when it was first started, and was commissioned. He was in the Territorial Forces (Unattached List) in January 1915 and was promoted lieutenant 1916; but a disabling affliction denied him his wish of going on active service. The value of his military work may be realized on looking at the T.C.D. War List (1922); the total trained by the Corps was 1,490, with some 3,000 members of the University serving, and more than 460 names on the walls of the Hall of Honour. On committees too his quiet business-like manner and precision were of much value; most notable was his service as secretary of the University Council, and on the Board of Trinity College in his last years.

His first published work (1911) was with Joly, on the radium emanation in the soil. The rest were almost all in his sole name and appeared mainly in the *Scientific Proceedings of the Royal Dublin Society*, the *Proceedings of the Royal Irish Academy*, the *Geological Magazine* and the *Quarterly Journal of the*