pressure, and a short description of how this has been done may not be uninteresting.

In order to determine the boiling-points, about 15 cubic centimetres of the liquid were obtained as above, gently freed from pressure, and communication with the air established by opening the valve *h*. Marsh gas, nitric oxide, and oxygen behaved under these circumstances perfectly quietly, evaporating only from the surface, necessitating shaking of the apparatus to prevent super-heating; while in the case of carbon monoxide and nitrogen the evaporation proceeded with gentle ebullition. It required 5 to 15 minutes for the liquid to escape completely out of the apparatus, affording ample time to take the boiling-point with a hydrogen thermometer. A list of the boiling-points obtained is given in the table. It is satisfactory that Wroblewski has completely confirmed the accuracy of Olszewski's temperatures by thermo-electric measurements, and he asserts that a hydrogen thermometer affords correct indications as far as −193°, but the latter gentleman proves that the error must be very small, as all the boiling-points are above −220°, the critical temperature of hydrogen, and he shows that oxygen and nitrogen thermometers are not influenced by an error exceeding 2° even at several degrees below their critical points. From an inspection of the critical points given in the table we can at once see why the earliest attempts to liquefy these gases so utterly failed, for no amount of pressure would liquefy nitrogen for instance, unless its temperature could be at the same time reduced to −146°, a temperature not procurable by the means known to the earlier experimenters.

For the purpose of the density-determinations the inner tube within the liquefaction tube was calibrated, the thermometer removed, and the hole in the stopper closed with glass rod and sealing-wax. About 15 c.c. of the liquefied gas were obtained as before, freed gradually from pressure, and, as soon as all the liquid in the interspace had evaporated, the height of the liquid column left under atmospheric pressure was read off. At the moment of reading off the valve *h* was connected by a caoutchouc tube with the aspirator *r*, and when the gas was completely volatilized, water was run out until the levels in the tube and respirator were again equalized. The volume of water received in the measuring-flask was of course equal to that of the gas formed by evaporation of the known volume of liquid, and, after applying certain corrections dependent upon the nature of the apparatus, was reduced to 0° and 760 mm. As the pressures under which the densities of marsh gas, oxygen, and nitrogen were determined were nearly identical, the numbers obtained are strictly comparable.

	Boiling-point. °C.	Melting-point. °	Critical point. °	Density. (° , mm.)
Marsh gas	−164			0·415 at −164° and 736
Oxygen	−181·4		−118·8	1·124 at −181·4 and 743
Nitrogen	−194·4	−214	−146	0·885 at −194·4 and 741
Carbon monoxide	−190	−207	−139·5	
Nitric oxide	−153·6		−93·5	

It is a subject for sincere congratulation that these dangerous experiments should have been so far free from accident, but this immunity was not to last *ad infinitum*, for, just as the last experiment with nitrogen was in progress, the liquefaction tube suddenly flew to pieces and so deranged the apparatus that the densities of carbon monoxide and nitric oxide could not be determined.

These researches, taken in conjunction with those of Victor Meyer on the dissociation of the molecule of iodine, and of Lockyer, Liveing and Dewar, and other workers on the effect of high temperature generally in simplifying the structure of molecules, have assisted, and will in the future assist us still more, in arriving at much more accurate views respecting the ultimate structure of matter itself. On the assumption that the molecule of iodine consists of two atoms, which, according to the view now becoming more and more accepted by thinkers on this subject, may themselves consist of aggregations of a still simpler substance—aggregations which, at temperatures obtainable in the laboratory, we have not been able to break up—the classical experiments of Victor Meyer have shown that at a temperature of about 1500° C. the molecules are dissociated into single atoms, that is to say, the intensity of the heat-vibrations is so great that the attraction between the two atoms in the molecule is overcome, and they are torn asunder. At still higher temperatures there is a possibility that the atom itself could be resolved into something simpler still.

Reasoning on the same lines, there is great probability that even hydrogen, oxygen, and other more permanent gases could, by a sufficiently high temperature, be resolved first into single atoms and then into something simpler still. Now, taking the opposite extreme, on reducing the temperature sufficiently to liquefy and even to solidify these gases, we ought to find that as the atoms in the molecule are allowed to approach more closely, and consequently to attract each other more strongly (according to the law of inverse squares), the difficulty of breaking up the molecule into its constituent atoms is more and more increased. This, in the case of liquefied oxygen, has been directly proved to be the case by a series of very beautiful experiments performed by Prof. Dewar, who has shown that liquefied oxygen at −160° C. has not the slightest chemical action upon, among other substances, the alkali metals and phosphorus, which in ordinary air or oxygen are rapidly converted to oxides. Chemical action, if such there had been, would have shown that the force of the attraction of atoms of phosphorus or potassium for those of oxygen exceeded that of the atoms of oxygen for each other; but the result proved that at this low temperature the force (whatever force may mean) exerted between the atoms of the molecule of oxygen was greater than that between the atoms of potassium and oxygen. What the possibilities are as we approach absolute zero form an interesting subject for the "scientific use of the imagination," but, reasoning from analogous phenomena of polymerization, of which organic chemistry furnishes so many examples, and from the antilogous effect of high temperature, we have some reason to suppose that the condensation will continue until molecules more complex than those consisting of the ordinary two atoms are built up. However this may be, the main result of these important experiments has certainly been to show in the clearest possible light how completely the state of matter depends upon the temperature under which it exists.

A. E. TUTTON.

A RECENT JAPANESE EARTHQUAKE.

PROFESSOR SEKIYA, of the Imperial University, Tokio, has lately sent to this country a remarkably interesting and complete record of earthquake motion obtained by him during a severe shock which occurred at 6.52 p.m. on January 15 of this year. The most important portion of the record is shown in Fig. 1, reduced to a little more than one-third of the original size. The motion is recorded (by means of the writer's horizontal pendulum and vertical motion seismographs) in three rectangular components—two horizontal and one vertical—on a plate of smoked glass which is caused to revolve uniformly by clockwork. The plate is started by an electric seismoscope at the beginning of the disturbance, and for one or two seconds its motion is consequently slower than the uniform rate it afterwards attains. On this occasion the plate made one revolution in 126 seconds, and the horizontal motion continued during several revolutions. To avoid confusion only the first of these is reproduced in the figure: the motions which occurred subsequently were smaller, and, as usual, the disturbance subsided very gradually. The circles in which the three components are recorded have been arranged so that simultaneous motions are on the same radius. Radial straight lines, where they are drawn, mark seconds of time. The disturbance begins at *a*, *b*, and *c* in Fig. 1. In its early portion it is marked very conspicuously by a feature which has been noticed (also at the beginning) in previous records—the presence of short-period oscillations superposed on larger and slower motions. These are particularly well defined in the horizontal motion, where they

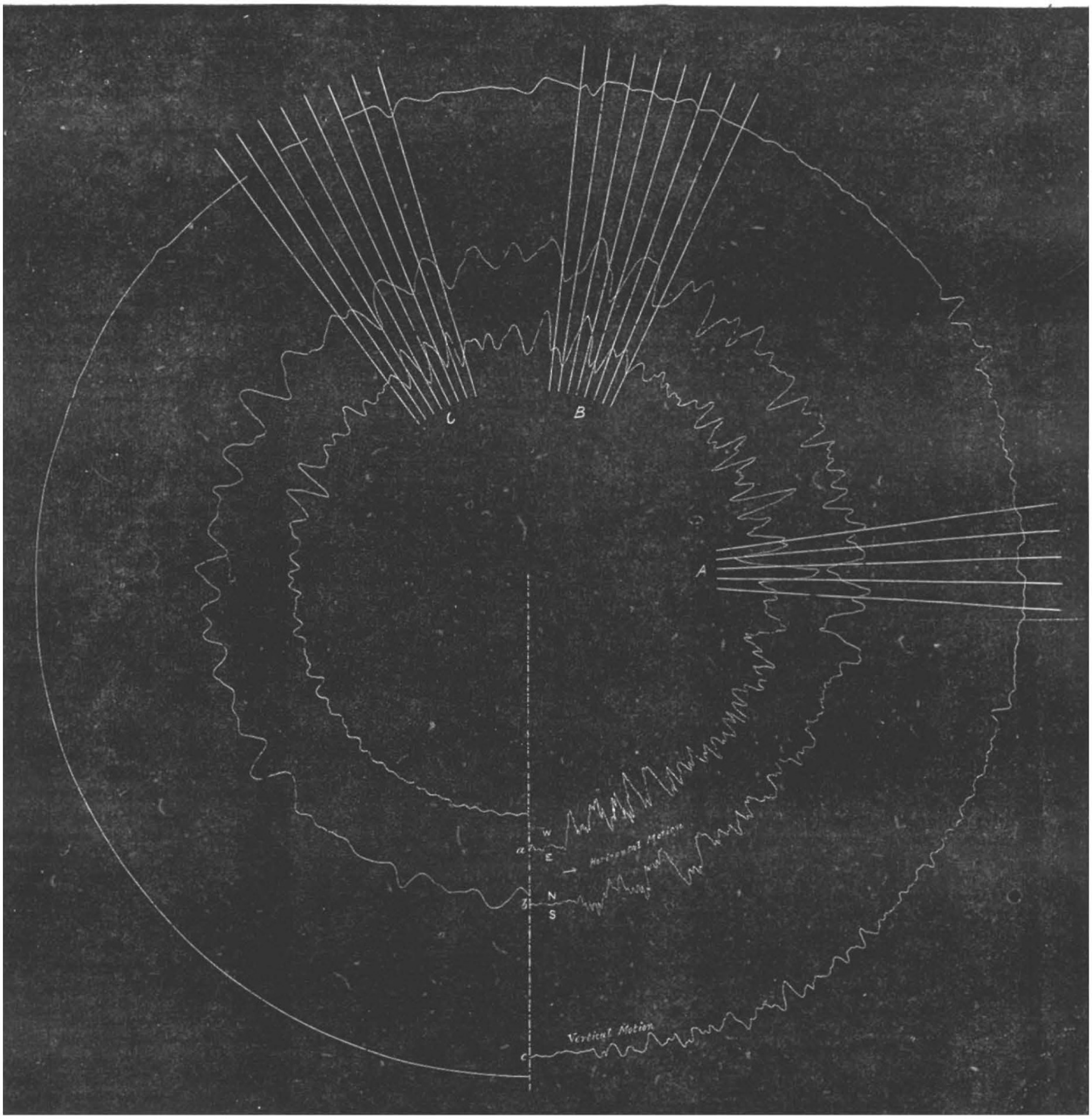

FIG. 1.—Earthquake recorded at the University, Hongo, Tokio, Japan, January 15, 1887, 6.52 p.m., by Prof. Sekiya. The horizontal motion is magnified 1·8 times; the vertical motion is magnified 2·9 times; the radial lines mark seconds of time.

occur, during the first part of the disturbance, with a period of about one-sixth of a second, or with about twelve times the frequency of the principal motions. The greatest amplitude of horizontal motion is found when these small oscillations have nearly died out, at the place marked A. By that time the vertical motion has become comparatively small. A few seconds later two considerable vertical oscillations appear on the record; but the vertical component is, by a long way, the first to vanish. In the original record the horizontal components are each magnified five times, and the vertical component eight times: the same ratio between horizontal and vertical multiplication is of course maintained in the figure given here. At three places, A, B, and C, the

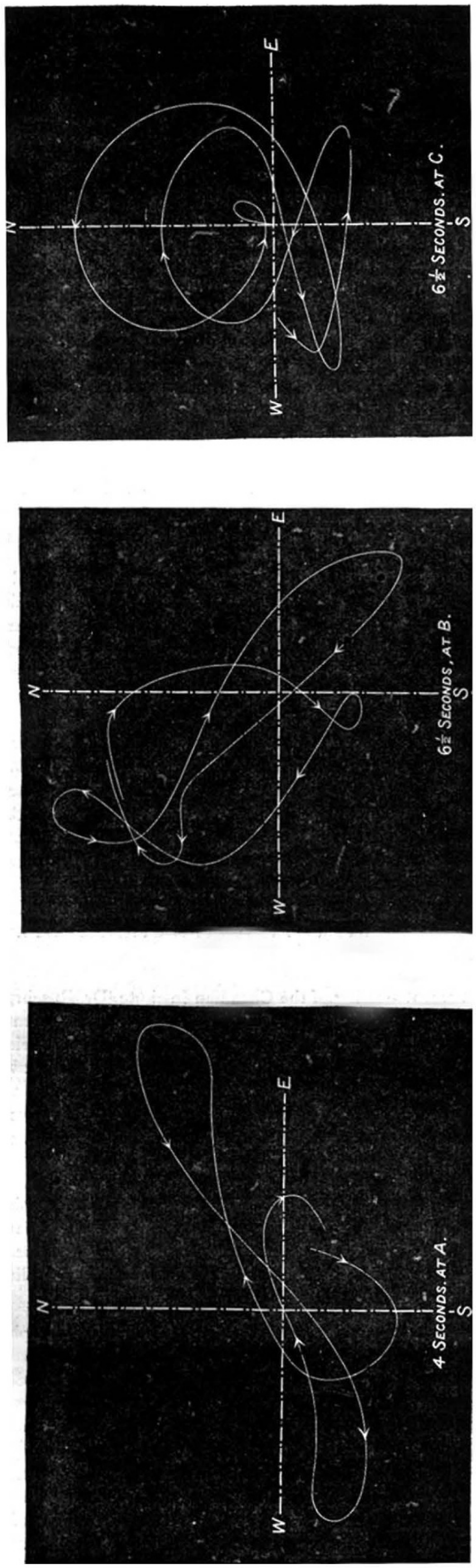

FIG. 2.—Compounded Horizontal Motion.

horizontal motion has been compounded during intervals of 4, 6½, and 6½ seconds respectively: the results are shown to a magnified scale in Fig. 2, and illustrate well the complex character of earthquake motion. The greatest extent of horizontal motion is from one to the other extremity of the figure-of-eight in the first of these diagrams: its actual amount (on the ground) was 7·5 millimetres. The greatest vertical motion was 1·5 millimetres. Other records obtained by Prof. Sekiya lead him to conclude that the greatest vertical motion in Tokio earthquakes is about one-sixth of the greatest horizontal motion. In former examples published by the writer the record was in all cases taken on the soft alluvial soil on which the greater part of the city of Tokio is built. In this instance the record was taken (at the site of the new University buildings, Kaga Yashiki, Hongo) on the much harder ground which here and there rises above the alluvial plain. From a comparison of records taken at the old and the new sites of the Seismological Observatory, Prof. Sekiya concludes that the motion of the alluvial plain is generally greater than that of the higher and stiffer soil in the ratio of two or three to one.

J. A. EWING.

NOTES.

ON Tuesday, Congregation at Oxford declined, by a majority of 106 votes to 60, to sanction the lending of books or manuscripts from the Bodleian Library. This decision is, no doubt, greatly regretted by a number of resident graduates, but it has the cordial approval of most other persons. Had the proposed change been made, it is certain that sooner or later many valuable books and manuscripts would have been lost or injured, and scholars would constantly have found that the works they wanted were "out." It would have been a serious mistake to transform one of the most magnificent collections of books in the world into a lending-library for the benefit of a small class of students.

IN celebration of the fiftieth anniversary of Her Majesty's reign, the general meeting of the Zoological Society of London on June 16 will be held, at 4 p.m., in the Society's Gardens on the lawn, which will be reserved for this occasion. After the usual formal business, the silver medal awarded to the Maharajah of Kuch-Behar will be delivered to His Highness. The President will then give a short address on the progress of the Society during the past fifty years. After the conclusion of the general meeting, the President and Council will hold a reception of the Fellows of the Society and other invited guests.

THE new University of Upsala was opened with great ceremony on May 17. There were present the King and Crown Prince of Sweden, a number of delegates from foreign Universities, the leading Swedish men of science, and some 1500 students. The building is very handsome, and has cost nearly £250,000.

IN the Report of the Royal University of Ireland for 1886, just issued as a Parliamentary Paper, it is stated that last year 2933 persons presented themselves at the various examinations, an increase of 43 on the previous year. The degree of Bachelor of Arts was conferred on 9 women, of whom 4 took honours. One lady was admitted to the degree of Master of Arts, and another, Miss Mary Story, obtained the first place in the first-class honours in modern literature, and won a first-class exhibition. Of the 78 women who presented themselves for matriculation, 71 passed, 27 of them with honours. Speaking of the exhibitions founded by the Drapers' Company and the Irish Society for the promotion of education among women in Londonderry, the Vice-Chancellor says:—"It would be most useful that the example thus set should be followed by others. There are other Companies of the Corporation of London who also hold