LIQUID CRYSTALS.[1]

DURING the seven years that have elapsed since the publication, in 1904, of his previous book, entitled "Flüssige Kristalle," Prof. Lehmann has in no way abated his energy, and has poured out a constant stream of papers giving the results of, and the deductions from, further observations, so that another or at least a supplementary work is already called for. Prof. Lehmann decided to write an entirely new book, which, being complete in itself, would readily enable any reader interested in the subject to learn what has been done in it and what is the present situation. The subject is not easily understood, and most of the experiments upon which it is founded cannot be performed without special apparatus. It has so far received scanty attention in this country, and its extreme importance is perhaps not fully realised. Outside Germany Prof. Lehmann has given demonstrations before the Mineralogisch-Petrographische Gesellschaft in Vienna, and the Société Française de Physique in Paris; may we not hope that some society in this country will be sufficiently enterprising to induce Prof. Lehmann to give a similar demonstration in London? No one who has witnessed these beautiful phenomena can fail to agree in the main with Prof. Lehmann's conclusions; to see is to believe, and, as Prof. Lehmann says (p. 5), "jeder, welcher Gelegenheit hatte die Versuche zu sehen, sich davon überzeugte, die Erscheinungen könnten unmöglich anders gedeutet werden."

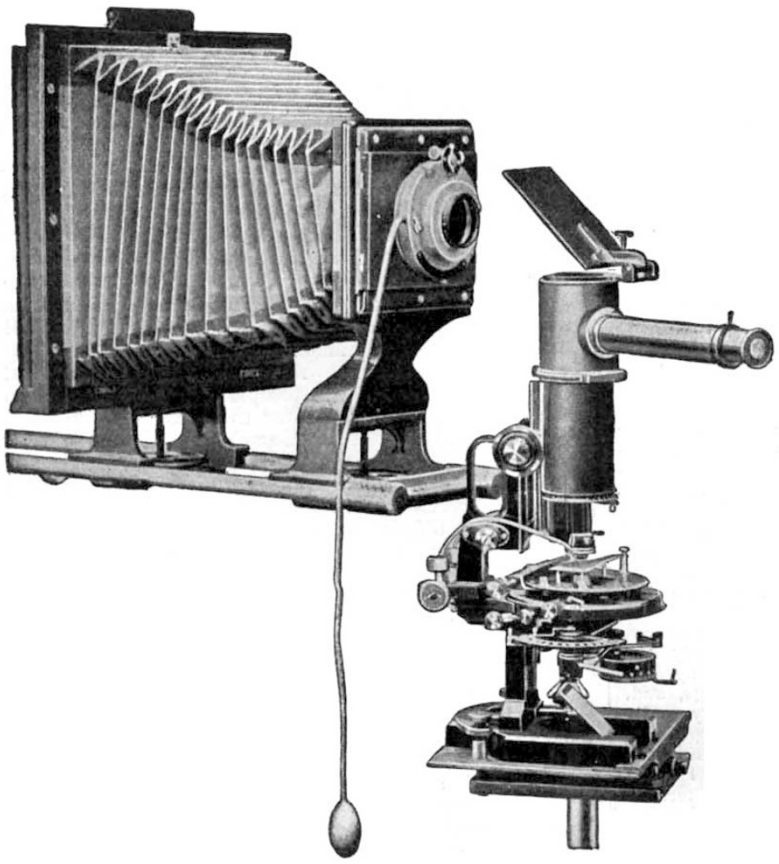

FIG. 1.—Crystallisation-microscope with camera attachment.

The tendency during the past forty or fifty years was for active workers in science to become specialists, *i.e.* to confine their attention wholly to one or two small compartments, and to pay little or no heed to what is being done by others in contiguous compartments; the most striking feature, on the other hand, of recent development of science is the revelation it has afforded of the true interdependence subsisting between the so-called branches of it. This is eminently true of crystallography; for long regarded only in its general aspect as an adjunct of physics and in its specific aspect of mineralogy, it is already recognised as of considerable importance to the chemist and petrologist, and now Prof. Lehmann tells us that crystals are potent factors in the processes of life, and therefore that they form a subject with which biologists should be cognisant.

The field of research into which Prof. Lehmann struck out nearly forty years ago was then so utterly unknown and yielded such amazing results that it is no matter for surprise if his early reports were received with the scepticism usually accorded to travellers' tales. His observations were set down as optical illusions, and his conclusions vigorously combated, but the passage of time has gradually brought about a change, and at the present day most of those who have given any serious study to the subject are in general agreement with him; for instance, Prof. Wallerant, the eminent French crystallographer, has remarked, "La découverte de M. Lehmann est certainement une des plus importantes du siècle dernier; ses conséquences sont nombreuses et de premier ordre

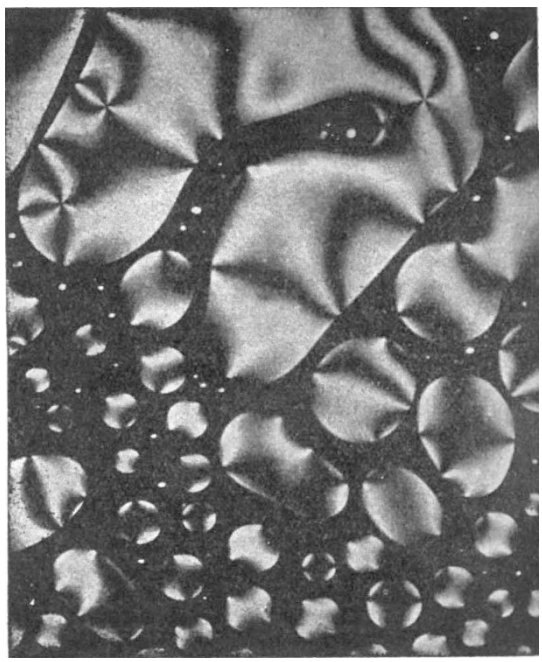

FIG. 2.—Liquid crystals between crossed nicols.

[1] "Die neue Welt der flüssigen Kristalle und deren Bedeutung für Physik, Chemie, Technik und Biologie." By Dr. O. Lehmann. Pp. vii+368. (Leipzig: Akademische Verlagsgesellschaft m.b.H., 1911.) Price 12 marks.

et elles permettent en particulier de préciser nos connaisances sur la structure des corps cristallisés." The change is not without its drawbacks; Prof. Lehmann finds complacent acceptance more irritating than ignorant scepticism, and complains (p. 5), "In neuester Zeit machen sich sogar Stimmen geltend, die glauben machen wollen, es handle sich um eine längst bekannte Sache, die ganz selbstverständlich sei."

We discussed the scope of Prof. Lehmann's researches two years ago (1909, vol. lxxix., p. 286), and need not traverse the same ground again. The present volume is naturally more coherent and easier to read and digest than a series of isolated papers published in various journals, and it may be commended to all who would fain learn of a remarkable subject. In chapter x. the author gives, with illustrations,

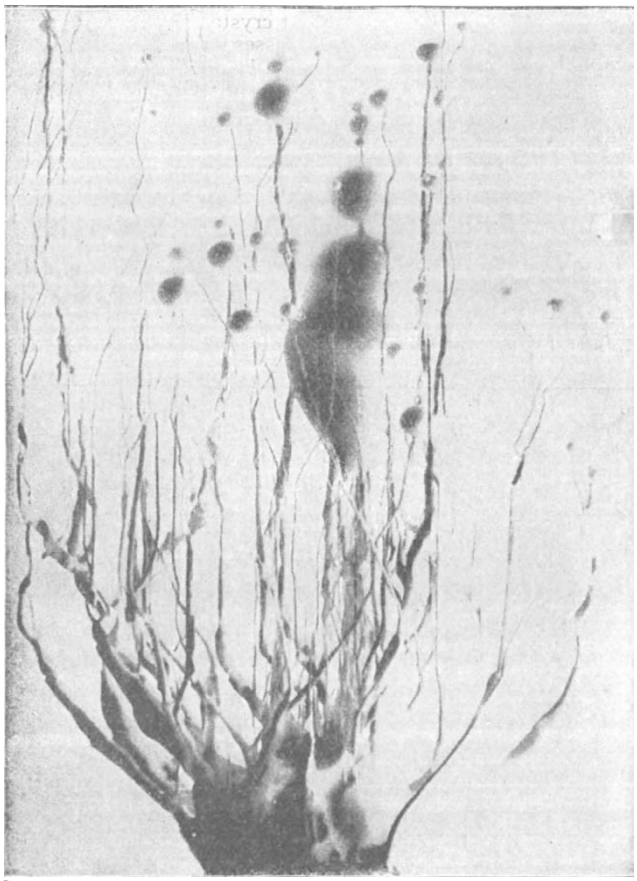

FIG. 3.—Silicate-vegetation.

descriptions of the various forms of the crystallisation-microscope, the invention of which rendered his researches possible. The principal conclusions arrived at may be summed up briefly. The old idea of a crystal as necessarily a rigid body bounded by plane faces must be definitely abandoned, as the author says (p. 149), "Demnach gehört auch die Bildung in ebenflächiger Form nicht unbedingt zu dem Kristallbegriff." Crystals may, indeed, be solid and rigid, and liquid and mobile, and there is no break in the transition from one sort to the other. The ultimate particles are invariably anisotropic. Isotropic crystals result from the neutralisation of the action of the particles by their mutual arrangement, which is regular; amorphous substances, on the other hand, are isotropic because their arrangement is irregular. Prof. Lehmann points out (p. 194), "Dass regulär Kristalle durch Zug und Druck doppelbrechende werden, ist veilleicht teilweise darauf zurückzuführen, dass sie anisotropen Molekülen bestehen, welche verdreht gegeneinander angeordnet sind, so dass keine Richtung bevorzugt wird." We are left therefore with, as the fundamental character of a crystal, its power under suitable conditions to grow; it is thereby sharply differentiated from an amorphous mass, which cannot in any circumstances grow. It is this important character which has led Prof. Lehmann to believe that crystals are the agents in the growth of living organisms. The curious and beautiful silicate-vegetation affords an instance of growth of purely unorganised matter. The close similarity in behaviour and appearance between certain kinds of crystals and bacteria has often been remarked, and cannot be dismissed as accidental.

Prof. Lehmann gives us a lucid exposition of the subject which has constituted his life's work and has been developed almost solely by himself, and the reasoning is rendered easier to follow by the aid of numerous excellent illustrations, three of which we are permitted to reproduce here. An index, which might perhaps have been fuller, is provided. The printing and the paper used are both good.

THE TIDAL SURVEY OF JAPAN.

IN the Journal of the College of Science of Tokyo for April, 1911 (vol. xxviii., article 7), Prof. Hirayama publishes results derived from tidal observations made during the last sixteen years at fourteen places distributed round the coasts of Japan and Formosa. The tide-stations were administered by the Land Survey, but the reductions are in the department of the geodetic committee, of which Prof. Terao is president.

The sites of the observatories have been carefully chosen so as to give good representations of the tides in the neighbouring seas, and twelve of the stations are permanent establishments, while two are temporary. Samples are given of the tide-curves recorded at nearly all the stations, and it is clear that perturbation due to seiches has been slight. Many of the observatories are at somewhat inaccessible places, and therefore the clocks of the gauges were regulated by the aid of a simple form of sundial. The gauges themselves were for the most part of Lord Kelvin's pattern, and have been found very satisfactory. The paper shows that the work has been carried on with Japanese thoroughness.

In the office of the United States Coast Survey a number of stencil plates pierced by holes are laid successively on the tabulated hourly values of the heights of the water, and the numbers which are visible through the holes are those which are to be added together to form the sums required to furnish the data for harmonic analysis. The late Dr. Börgen attained the same end by means of sheets of tracing paper laid on the tabulated values which indicate by zigzag lines the columns for addition. Prof. Hirayama tried both these plans, but he finally concluded that the use of my tidal abacus[1] was the most convenient method, and it alone was used. The work involved in treating the observations at the fourteen stations must have been enormously laborious, as no fewer than sixty-six years of observation have been reduced.

I have not tried to make a minute examination of

[1] Proc. Roy. Soc., vol. liii. (1892), p. 345, or "Scientific Papers," vol. i. p. 216.