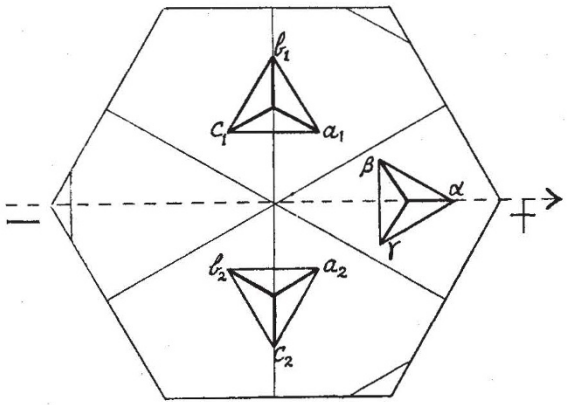
Orientation of the Etching Figures of Quartz

THE etching figures produced on quartz crystal by hydrofluoric acid are different on surfaces cut in different orientations. The case in which the surface is normal to the optic axis is particularly interesting, since with such a surface, the etching pattern obtained consists of a great number of projecting triangular pyramids. This fact, first observed by Leydolt[1], was afterwards studied by Molengraf[2] and more recently by H. Arsandaux[3], Pan Tcheng-Kao[4] and A. de Gramont[5]. It is generally accepted that the three heights of the equilateral triangular base of each pyramid are respectively parallel to the three electric axes of the quartz, and that the three vertices of the base point towards the positive extremities of these axes when the crystal is under compression. A. de Gramont[6] asserted that the parallelism between the orientation of the elementary pyramids and the bisectors of the angles formed by the hexagonal prism of quartz is not always true and that a deviation of a few degrees may sometimes be found. According to this author, the directions of the pyramids and not those of the bisectors represent the true directions of the electric axes of quartz.

In the course of investigating the effect of ultra-violet radiations on the etching figures of quartz, I have carefully compared, by means of a high-precision micrometer, the orientation of these pyramids with the edges of the cross-section of the hexagonal prism. Measurements were performed on a number of plates cut from different crystals of Brazilian quartz. In contradiction to the observations of previous workers, the three basal heights of the pyramids are by no means parallel to the three directions of the bisectors of the angles of the hexagonal cross-section. As a matter of fact, the angle formed by them is 30°, with some possible variations of only a few degrees; in other words, the pyramids are directed to the mechanical axes rather than to the electric axes of quartz. For left-handed quartz, the directions of the three basal heights of a pyramid are orientated clockwise by 30° with reference to the positive extremities of the three compression electric axes, while for the right-handed quartz the orientation is anti-clockwise, as shown diagrammatically in the illustration.



THE REGULAR HEXAGON REPRESENTS A CROSS-SECTION OF THE HEXAGONAL PRISM OF QUARTZ. FOR A LEFT-HANDED CRYSTAL, THE PYRAMIDS OF CORROSION ARE ORIENTED AS a_1, b_1, c_1, AND FOR A RIGHT-HANDED CRYSTAL AS a_2, b_2, c_2. THE PYRAMIDS ARE BY NO MEANS ORIENTED AS $\alpha\beta\gamma$ AS GENERALLY BELIEVED.

A. Langevin[7] has investigated, by the method of etching, the quality of a number of old piezo-electric quartz plates used in the Laboratoire Curie and the École de Physique et Chimie of Paris. He concluded that the plates which gave low values of the piezo-electric constant were due to the existence of electric twinning, which could not be detected by the plate-makers of the past, who used only optical methods for the selection of plates, and that for plates free from this twinning the values of the constant were found to be very consistent, having as a mean $7{\cdot}05 \times 10^{-8}$ C.G.S. unit. In this connexion, it is interesting to mention the result of A. de Gramont[6]. This author, using the same method of selection as Langevin, found $6{\cdot}38 \times 10^{-8}$ C.G.S. unit instead of $7{\cdot}05 \times 10^{-8}$ as the piezo-electric constant of plates of the best quality. This discrepancy is too great to be accounted for by the ordinary experimental error. It may very probably be caused by the difference in the choice of direction of electric axis of the plates used; since for the determination of this axis A. de Gramont relied on the orientation of the elementary pyramids rather than on the geometrical form of quartz.

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[1] Leydolt, *Sitz. K. Akad. W. Math. Naturw.*, 59 (1855).
[2] Molengraf, *Z. Kryst. u. Min.*, **14**, 173 (1888).
[3] Arsandaux, H., *Bull. Soc. Franc. Min.*, **51**, 166 (1928).
[4] Pan Tcheng-Kao, *Rev. d'Optique*, **10**, 153 (1931).
[5] de Gramont, A., *Rev. d'Optique*, **10**, 213 (1931).
[6] de Gramont, A., "Recherches sur le Quartz Piezoelectrique", 22, 52 (1935).
[7] Langevin, A., *C.R. Acad. Sci.*, **209**, 627 (1939).

Collapse of Determinism

MANY readers of *Nature* will have noted with interest Prof. H. T. H. Piaggio's clear and dispassionate article on the "Collapse of Determinism"[1]. Of particular interest is the statement, "But a third interpretation goes so far as to claim that the existence of causality is disproved". This, of course, was the theme of Prof. E. T. Whittaker's Guthrie Lecture[2]. His arguments, however, are open to serious criticism, and there has been a tendency to throw the onus on Von Neumann's mathematical demonstration[3]. This, however, is also under criticism[4] and there are many who, knowing how easily assumptions can lurk in analytical work, refuse to be mathematically bludgeoned. Harm can be done to the reputation of science by any who proclaim as a definite doctrine what is but a tentative effort.

In Prof. Piaggio's last paragraph he remarks, "Some philosopher-physicists welcome these conclusions as giving us a hope of escape from the tyranny of an iron law of causation and assuring freewill to mankind as well as to electrons!" That, of course, is quite true: one all too often hears the view expressed. Nevertheless, to jump to talk of the "freewill of mankind" after having just talked only of electrons, and without noticing that there has been thrown into the equations an entirely unknown function called 'mind', is 'philosophy' of a type which surely even Thomas Aquinas would not have thought worthy of consideration.