Kana (*ku*) or (*ke*) presents three characteristic portions. The beginning corresponds to the consonant *k*, the end corresponds to the vowel *u*; and there is an intermediate portion between the two where the amplitude of the oscillations is reduced to an insignificant amount. This middle portion does not play any important part in the formation of sound quality, or the Japanese Phoneme. Cutting away this part or lengthening it artificially does not change the reproduced quality of the sound or sound value. The same holds when the consonant is followed by any other vowel.'

It must be also remarked here that a change-point is ordinarily conceived to be any point at which any organ changes from one type of function to another and an α-sound is also similarly conceived to be a segment between two successive change-points.[10] But an α-sound is quite different from the α-phoneme (the *Āytam*). The latter is a speech-sound of a group while the former is merely a sound. Failure to recognise this distinction will lead to much needless confusion. But it is clear that there are no ascertainable change-points. All the laboratory investigations lead to the conclusion that it is certain that there are no definite change-points. It is also clear that we are dealng with *macrophonic* speech here.[11]

If we know the defining characters V and C, then we could give a rigorous definition of the *Āytam* by means of Dedekind sections, namely, we have a Dedekind section in which the lower segment consists of V (*i.e.*, vowel sound-profiles) and the upper segment of not—V; we have also a second Dedekind section in which the lower segment is composed of not—C (non-consonantal sound-profiles) and the upper segment of C. The interval between the two section-points is the *Āytam* (the α-phoneme).

The *distances* bween the vowel, the α-phoneme and the consonant in each of our ordered classes have to be measured, and on the basis of the three *physical assumptions* stated already (in my paper on the sub-class of α-phoneme[12]) which are:—

(1) In the *transitional*, the vowel and the consonant are always together; there is superimposition.

(2) During the *transitional* as a consequence of superimposition the *masking effect* will be of importance.

(3) If the *duration* of the consonant extends beyond the refractory period there is a chance for the *audibility* of the consonant, in case the preceding vowel has an *influence* on the following consonant; the properties of the α-phoneme have yet to be experimentally studied. It needs no over-emphasis here that as some kind of accent distribution is involved in the occurrence of our α-phoneme, the relation between quantity and stress,[13] should not be lost sight of in our investigations.

The foremost advantage got by defining the α-phoneme can be easily seen to be the *conception* of a new 'bound' class (rather, a sub-class) of 'phoneme'.[14]

Althouh the definition of the α-phoneme has so far been restricted by me only to certain speech-forms in Tamil, still as we meet with phonetic features in another Dravidian dialect Gōṇḍī similar to those that characterise the production of the *Āytam* in Tamil, I need hardly say that the formulation of the 'cut' conception may open up an altogether new vista. In Icelandic, too, we meet with a phoneme under conditions similar to those under which the *Āytam* seems to have appeared in old Tamil. In Kashmiri dialects, too, there appears to be a similar phenomenon.

The phenomenon of the *Āytam* (the α-phoneme) is, therefore, a strong pointer to the possibility of defining vowel and consonant phonemes by certain (so far undiscovered) positive characters V and C.[15]

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1 *Nature*, 1935, **136**, 261 and 644. 2. Scripture, Prof. E. W., *Researches in Experimtntal Phonetics*, pp. 43–45. **3**. Sankaran, C. R., *Bulletin of the Deccan College Postgraduate and Research Institute (BDCRI.)*, **2**, 348–49. 4. Scripture, Prof. E. W., *Nature*, 1932, **130**, 275. 5. Wood, Alexander, *Acoustics* **360.** See also Sankaran, C. R., *BDCRI.*, **4**, 124. 6. Scripture, Prof. E. W., *Nature*, 1935, **136**, 759. 7. —, *Ibid.*, 1935, **136**, 456. **8**. —, *Researches in Experimental Phonetics*, pp. 42–43, 58–59; Andrade, M. J., *Language*, 1936, **12**, 2. 9. "A Study of Japanese Phonemes by means of Tone Films," *Proceedings of the Second International Congress of Phonetic Sciences*, 1936, **118.** 10. Hockett, C. F., *Language*, **18**, 5. 11. Scripture, Prof. E. W., *Nature*, 1933, **132**, 138. 12. Sankaran, C. R., *BDCRI.*, **4**, 55–56. 13. Heffner, R. M. S., *American Speech*, 1941, **16**, 204–7; Haugen, E., and Twaddell, W. F., *Language*, 1942, **18**, 230. 14. Sankaran, C. R., *BDCRI.*, **3**, 393. 15. I am indebted to Dr. R. Vaidyanathaswamy, Department of Mathematics, University of Madras, for the clarification of many ideas in the matter of application of Dedekind section idea in defining the α-phoneme.

RAMAN FREQUENCIES OF CALCITE

FOLLOWING the earlier work of Bhagavantam and Venkatarayudu,[1] one of us has recently given a satisfactory explanation for most of the prominent features of the Raman spectrum of sodium nitrate.[2] In this note, the case of calcite is dealt with on similar lines.

1065, 860, 680 and 1,407 cm.$^{-1}$ are assumed to be the normal frequencies of the CO_3-ion in solution and using the well-known equations for the frequencies of vibration in such a case, the following force-constants are evaluated:

$$K=5\cdot45\times10^5,\ K_1=1\cdot75\times10^5,\ K_2=0\cdot45\times10^5,\ K_3=3\cdot33\times10^5.$$

In the crystal, besides altering the value of K_1 to $1\cdot86\times10^5$ so as to take account of the surrounding structure, three additional constants representing effectively all the inter-ionic and other forces of the crystal are postulated and their values are given below:

$$K_4=0\cdot22\times10^5,\ K_5=0\cdot38\times10^5 \text{ and } K_6=0\cdot16\times10^5,$$

Taking the above values of the force-constants, the frequencies that are to be attributed to the $CaCO_3$ crystal can be evaluated as follows:

A_1 (Raman active, infra-red inactive)—1084.
A_2 (Inactive in both)—877, 213, 0.
B_1 (Infra-red active, Raman inactive)—890, 331, 106.
B_2 (Inactive in both)—1082, 297.
E_1 (Infra-red active, Raman inactive)—1487, 676, 403, 225, 139.
E_2 (Raman active, infra-red inactive)—1438, 703, 277, 141.

The significance of the various force constants and that of A_1, A_2, etc., is fully described in the paper already referred to and is not repeated here for want of space.

The results thus obtained are summarised and compared with the experimental observations in Table I:

TABLE I

Raman effect	Calc.: 141, 277, 703 1084, 1438. Obs.: 155, 282, 709, 1084, 1434.
Infra-red absorption	Calc.: 106, 139, 225, 331, 403, 676, 890, 1487. Obs.: 106, 106, 182, 357, 380, 706, 879, 1429–1492.

The agreement is good. The appearance of lattice lines in the Raman spectrum and of low frequencies in the infra-red absorption, the lack of exact coincidence between the Raman and infra-red frequencies in respect of the degenerate modes, a shift in the value of the total symmetric frequency from the ion to the crystal are amongst the features that are satisfactorily accounted for.

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1. *Proc. Ind. Acad. Sci.*, 1939, **9**, 224. 2. *Ibid.*, 1944 **19**, No. 1.

REFRACTION OF ULTRASONICS AND VELOCITIES IN COLOURED LIQUIDS AND IN SOLIDS

IN the Debye-Sears method of diffraction of light by ultrasonic waves, the intensity of lines on both sides of the central line is symmetrical only when the sound waves are exactly at right angles to the light beam. This phenomenon was used to measure the refraction of sound waves. The vibrating quartz was placed in a metal vessel having a plane mica window and containing a liquid, say xylol. The vessel containing the quartz was placed in a bigger plate-glass vessel containing a second liquid, say water. Through this vessel a monochromatic light-beam was sent for diffraction effect. Now by simple arrangements the quartz plate could be rotated through an angle without disturbing any of the vessels and[2] the assembly of the two vessels could be rotated as a whole through an angle without disturbing the quartz with respect to the vessels. This was done by fixing the whole arrangement for rotating the quartz on to one of the vessels.

To begin with, the plane of the quartz was set parallel to that of the mica window. In this position, the ultrasonics being incident normally upon the mica window would suffer no bending. The outer plate glass vessel was rotated till symmetry of intensity in the spectrum was obtained. The quartz was then rotated through an angle "*i*". "*i*" was then the angle of incidence. The outer vessel was again rotated till symmetry of intensity was obtained. Clearly the angle between the rotations of the other glass vessel was the angle of refraction. Two applications follow immediately, *viz.*, finding velocities in coloured liquids and in solids, transparent or opaque. The coloured liquid is of course to be put in the inner vessel. In case of the quartz cannot be set accurately parallel to the mica window, then more than two settings of the quartz can be used and corresponding refractions found. The method then becomes somewhat mathematically cumbersome. If the coloured liquid is electrically conducting, so that the quartz cannot be directly put in it then an innermost vessel can be put inside the inner vessel containing the coloured liquid. This innermost vessel has to be made of plate-glass and quartz put in it along with some non-conducting liquid, so that the plane of the quartz is always parallel to the side of the innermost vessel. This can be permanently set by cementing the quartz on to the inside of the vessel. The whole innermost vessel has now to be used in place of the quartz alone.

Solids.—A prism or wedge of the solid can be made having a small angle "*i*". The quartz can be cemented plane on one face of the prism containing the angle "*i*". In one way of using it, a permanent line can be drawn at the base of the plate glass-vessel (no inner vessel) and for convenience parallel to its breadth, and along the direction of the beam of the light. The prism is made to stand in the vessel, so that the quartz directly faces the side of the liquid exposed for diffraction, the side of the prism being directly on the line. The vessel is now rotated till symmetry of intensity is obtained. The prism is then turned over, the other face of the prism containing "*i*" being on the ruled line. The waves have now to pass the prism in order to come to the part of the liquid used for diffraction. "*i*" then becomes the angle of incidence. The vessel is again rotated to get symmetry of intensity. The angle between the two rotations is the angle of refraction.

Accuracy.—The accuracy by this new method depends upon the accurate measurement or setting of the following:—

(1) Position of the crystal when intensity is symmetrical.
(2) Plane of the crystal parallel to the plane of the mica window. Of course any other suitable substance can also be used in place of mica, say glass.
(3) Angles of incidence and refraction.

As regards (1), Parthasarathy (1936) found