THE MUSIC OF CRYSTALS, PLANTS AND HUMAN BEINGS

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Introduction

Just as the driver of a car recognises through the noises produced by the engine whether it is running correctly or not, so also any medical doctor knows very well how great a part sound plays in his medical diagnosis. Whether he percusses with his finger the body of his patient, or uses the stethoscope, it is always the sound in its various forms which will give him the required information. As a matter of fact, already Robert Hooke, an English physicist, wrote in the late 17th century that " . . . it may be possible to discover the motions of the internal parts of bodies, whether *animal*, *vegetable*, *or mineral* (italics mine), by the sound they make ; that one may discover the works performed in the several offices and shops of a man's body, and thereby discover what instrument or engine is out of order, what works are going on at several times, and lie still at others, and the like ; that in plants and vegetables one might discover by the noise of the pumps for raising the juice, the valves for stopping it, and the rushing of it out of one passage into another, and the like ? . . ." (1). This text can hardly be enough emphasised. Unfortunately its implications have been left almost untouched up to the present time.

It is quite evident that the flow of the blood, the beat of the heart, the functioning of any organ, &c., must produce a noise, as friction is constantly acting there. This noise, as Hooke noted, can be compared to the hum of a factory, and by its quality one will be able to find out what is actually going on inside. It is believed that there is no need to say more about this fundamental truth.

Is the stethoscope which is in constant use by medical doctors, or the percussing by the finger of the chest or abdomen, &c., sensitive enough an instrument for modern requirements ? It is not intended here to argue about the simplicity of these instruments which can be carried in any doctor's pocket. Neither shall we deny that the human ear is extremely sensitive to a narrow wave-band of sound in the range of about 2,500 c/sec. But to higher or lower frequencies the human ear is either very inefficient,

or even completely deaf. And it is very possible that just these particular noises are the most important. The pulse of the heart is extremely low, and it is still the most fundamental. Actually all the life pulses, as experience teaches us, are very slow. These pulses are entirely below the threshold of audibility. Others, which are above the audible range, on the contrary, produce often deadly effects, or are at least very dangerous. We mean here the ultrasonics. From this very short inspection of the problem it is immediately seen how very important it is to get exact information of these particular noises in the organism. The present technical developments of our age should easily provide good enough means not only to amplify the quality of these noises, but also to show us their actual picture on the screen of a cathode ray tube. In other words to show the quality of the sound in a pictorial way.

Theoretically speaking this could be displayed in a two-fold manner. One could show the actual wave-form on the screen, with its very complicated peaks and sharp turnings. Or else one could demonstrate the interference pattern resulting from these thousands of waves superimposed on one another. Let us explain this. It is enough to set two sources of waves on a surface of a still water, to see such pattern of wave interference. (Slide shown) (2). There are crests and troughs, rows in between, and they are perfectly symmetrical. Now imagine this in *three dimensions*. Let us pass through this pattern a strong beam of light, so that it would light up, say, all condensed nodes as small stars. You will then get a picture of a beautiful network looking actually exactly as an X-Ray pattern of a crystalline lattice produced by Laue method. (Slides shown) (3). If we imagine further that all these flickering star-points—according to their intensity and frequency interferences, beats or pulses producing periodic scintillations—will assume different colours and shades, then you will have an exact picture of a sound interference pattern, but instead of seeing lights and their colours, you will hear a beautiful harmonically related music. Such music, apart from its melody and orchestration, will have in addition a morphological shape. It will have a structural and architectural appearance. The modern technique should provide us with means to project such patterns on a Braunian tube (cathode ray tube). An investigation of these patterns or wave-forms should provide a perfect means of information of what is going on in the organism and organs of the human body. It should enable the doctors to give an exact diagnosis. As a skilled physiologist looking at a microscope slide of a tissue will immediately recognise what tissue he is dealing with, so exactly the same should result from the wave interference pattern or wave-form, watched on a cathode ray tube. Any distortion in such pattern will inform the modern doctor that there is something wrong.

The Music of Crystals

Before we enter on a discussion of crystals themselves, let us first define what is meant by music. One single note, e.g., middle C, is not itself music. This is only periodical vibration in time, and we call it a tone. On the contrary, when we hear a collection of tones, which follow one another in time, we may call it a tune or melody, and when tones appear together then it can be a chord.

If these collections of tones are not properly and proportionately related, then they produce a noise, but when the proportionality is preserved, then our ear appreciates it, and it appeals to us as music. We can see immediately that the meaning of the word "music" is essentially related to a certain proportionality between a collection of notes. This proportionality could be described also as a *correct relation* or *proper relativity* between two or more motions; periodic motions. The word *proper* represents the meaning of *evaluation* of these proportions, which evaulation is a purely mental process. Nevertheless, instead of using the expression "proper relation or relativity," it is preferred to stick to the word proportionality, which is believed to render the meaning better.

These proportions or proportionalities can be represented by numbers. Thus the relation of the middle C (on the piano keyboard) which has 256 c/sec. to itself, can be written as 256/256. If we accept this as the point of reference, then it can be written as 1/1. The ratio of its first harmonic, the octave to C, numerically is written 512/256, and can be represented as 2/1; the next harmonic, the "g," will be given by 3/1, and so forth. We have thus a divergent series, 1/1, 2/1, 3/1, 4/1 . . . n/1. Such representation—a quite simple one—can be used for any number, so long as their ratios are harmonically related. Thus 512,000 c/sec. to 256,000 c/sec. can also be given by the ratio 2/1, &c. We see then that the relation between colossal or minute numbers can be reduced to a very simple numerical form. As has been said, this ratio is evaluated by a purely mental process, and the mind does not bother as to whether its perception is of billions or only a few cycles per second, whether the ratio is astronomical or atomic in size; what is essential is the harmonic ratio and its value (4).

In music this sequence of tones harmonically related is named by letters, as c, d, e, f . . . and so forth. We must remember that these tones bear a numerical relation of periodic motions in time to the fundamental tone from which we start. In any C major scale it will be the c. Hence, the name of a tone, for instance g, does not mean the quantity of periodic motions in a unit of time, as there are several g's in the keyboard, and each of them has a different frequency. The name "g" represents a

relationship to another tone, and this relationship is evaluated mentally. It is not only a quantity nor a pure physical fact; it represents also a mental process. This statement is most important for the understanding of the Psycho-Physical Law of Fechner-Weber. In any what we call MUSIC the perception of a physical fact is closely related to a mental process of evaluation (5).

If we take the numerical proportionalities only, then these proportions are called in music "intervals," as for instance an octave, a fifth, fourth, a third, &c. The mental process of evaluation relates them immediately to the fundamental tone, the very moment a sequence of such intervals harmonically related is played. It is these proportionalities and their possible sequences which are evaluated and perceived by the ear and involve the mental process. When such sequence fits with our own standard of proportions, we label it as correct, nice or beautiful, but when such a collection of tones does not harmonise with our own standard *inborn in our minds*, then we call it a noise or a discord Why we have an inborn standard, and of what this mechanism of pleasing and displeasing consists, is a different problem and will not be dealt with here.

This fundamental fact of perception of proportions was thoroughly analysed a long time ago by the two scientists Fechner and Weber, and it led them finally to the formulation of the well-known *Fechner-Weber Psychophysical Law* (5). This law can be applied not only to hearing, but also to vision, and *mutatis mutandis* to other senses, as in all of them, the mental process of evaluation of proportions is involved. When we realise that proportions and contrasts are the essential features of every art, then it becomes evident that the psycho-physical law of Fechner-Weber introduces us to the realm of art and beauty. The physical facts and their mental evaluation are here brought into unity, and open to us a new world for scientific psycho-physical investigation. It happens that we prefer to call it psychosomatic research.

About a hundred years ago a Berlin crystallographer called Weiss (6) showed that the angles in crystals, the proportions between their sides and planes could be represented by musical relationship. This idea was taken up later on by a German scientist, Victor Goldschmidt. In his book, *Über Harmonie und Komplikation* (On Harmony and Complication) (7) he showed by all sorts of matrices and exact measurements, that the harmonical musical principle plays an essential part in the world of crystals and their growth. The different crystals follow different musical scales and tonations as E sharp major, E flat minor, &c.; they have separate collections of tones, and show along their co-ordinate axes different motives for polyphony and contrapoints The axes of the crystals are the points of reference in

these measurements of proportions. H. Kayser aptly calls them the "crystal tuning forks." (Slides shown) (8).

The essential reason for such musical representation of crystals lies in the nature of molecules and atoms ; in the basic construction of matter. *Atoms are known to be harmonic oscillators*, where the oscillators themselves are the nuclei, and the electrons and their orbits are, may we call them, the reverberation and echoes of the periodic harmonic motions of the nucleus. Actually the electrons represent the peaks or condensed nodes in the wave interference pattern, and the orbits, and we must not forget this, are the nodal points of the standing waves surrounding any atom. It is music on the atomic scale, and the musical proportionalities are perfectly preserved there. The quanta and their integral numbers with their boundary conditions and energy states leave no doubt about it. The electrons and their shells are the function of the nuclear oscillations *and vice versa.* They are all a sort of double chorus playing alternately their musical proportions. From the very foundations of the atoms, up to stars and galaxies the harmonic law of proportions is the fundamental one. Kepler introduced it into astronomy in his work *Harmonice Mundi*, whilst nuclear physics discusses it in terms of atoms.

This fundamental law of harmony is perceived by human beings as proportions and their musical relationship. Whether the distances are astronomical in size, or minute as atoms and sub-atomic particles, the proportions are always the same, and can be represented by simple figures, as already stated : 1/2, 5/4 . . called in music intervals. They can also be labelled with musical names, c, g, f, d . . . There is no need to be a great expert in physics and philosophy in order to see that these proportionalities can be applied not only to the material world, but also to the immaterial one, as this perception of proportion is essentially a mental process. It has been shown before and we repeat it here again—the psycho-physical law lies at the basis. It links together soul and body, mind and matter, God and creation. It is the law of Beauty and therefore related to Goodness and Truth. *Pulchrum, Bonum, Verum.* The Supreme Being as Beauty, Goodness and Truth must be reflected throughout creation.

In Psychosomatics this law—the Psycho-Physical one—must be the starting point of all real and orthodox scientific research.

Let us return to our crystals. It is well known that they are a splendid network—in physics usually called a lattice—of atoms and molecules which co-ordinate themselves according to their specific axes, and produce thus the resulting shape, the morphological appearance of the crystal. Here are some X-Ray patterns of the crystalline lattice (slides are shown) (9).

A question arises now whether such crystals are surrounded with any actual real musical field ? Will a mechanical vibration

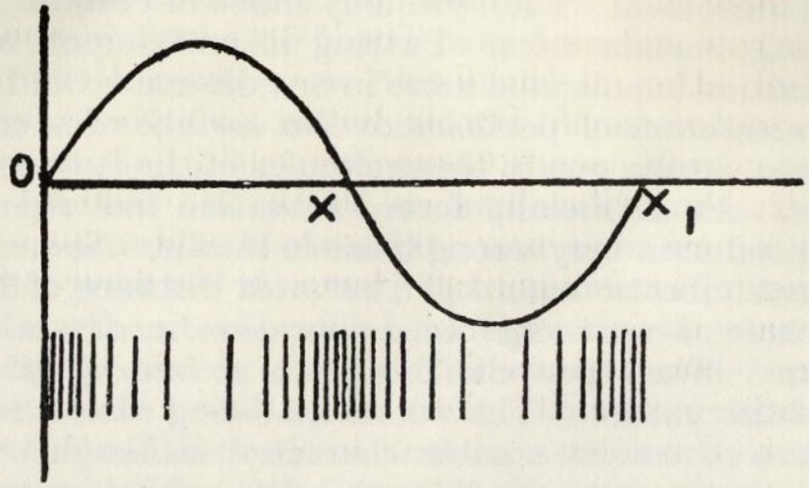
of a sonic nature surround it? We must consider this more closely.

It is known that the molecules of the crystal have only certain freedoms of vibration. They can only move in certain directions, or, say, along certain axes. Putting it a different way, their thermal agitation is polarised more in one direction than in others. Such general motion of particles over a surface of a crystal will produce also a similar one in the molecules of the surrounding gas, e.g., the air. An artificially forced vibration induced in such a crystal can produce a very strong beam in the air. Some ultrasonic beams of such vibration can kill a rat at a distance of 100 yards. Normally there is no such forced vibration in crystals in their natural state. Their periodic motion is a free vibration of an extremely faint nature. This vibration being also a mechanical one will have of course a sonic character, although it may not be audible, simply because it may be too faint or not in the audible range. To a certain extent a vibration of a crystal can be amplified by simply knocking it. This can be done with any object, and it will give out a noise according to its shape, size, chemical nature, state of tension and so forth. We must remember though that in such a case we hear the resultant of two noises, that from the knocking object and that from the object knocked. As every object has different modes of vibration, as we call it in physics, we shall usually hear only one component of its proper vibration. A better example of amplification of the free vibration of, e.g., glass, is when a singer sings into the glass its own note and shatters it to fragments. This due to the principle of resonance. If the singer could produce by his voice all the vibrations of the components of the glass, a complete disintegration would follow. The released energy would be colossal.

Are there any electrical components of such vibration? J. C. Bose showed a long time ago that *a mechanical impulse* involves electrical currents. We know from piezoelectricity of crystals, that any mechanical change of pressure on the Y axis is accompanied by a proportional change of electrical voltage along the X axis. Latest reports seem to attribute piezoelectric phenomena —though very weak ones—to any objects. This is in an exact agreement with what J. C. Bose showed in his numerous experiments (10).

The exact opposite, namely, that alternating currents produce mechanical phenomena, was shown by a French scientist named Ludin. He proved that when a metal wire is heated by an alternating current a sound may be heard, having a frequency double that of the alternating periodicity of the applied current. (11). This is immediately understood in the light of the following curve, where the sine wave represents the electrical frequency (transverse component) and the vertical lines denote the mechanical longitudinal component. We see that one is double

the other. As a matter of fact, here is the actual physical reason why harmonics do actually appear in any wave motion. (It shows the mechanism of it*).



We know that any frequency creates its harmonics, but as far as my knowledge goes, the exact physical mechanism of it has never been shown. It is due to the close relation and connecting link between the transverse and longitudinal component of *ANY wave motion.* From the experiment quoted above we see that electromagnetic and mechanical phenomena are strictly interrelated. Mathematically I have shown this generally in the paper called " The Gravitational Wave." It is applicable to light as well, this being accepted as an electromagnetic wave. The experiments of Prof. Ehrenhaft confirm this.

* It may be objected—as Ludin does—that longitudinal vibrations in wires are entirely excluded. This is only partly correct. The molecules of the heated wire try to vibrate along the direction of the electric field. As this is actually to a great extent hindered, their vibration will result in the direction permissible by the conditions. The following experiment which demonstrates this is due to Young. " He allowed a sheet of sunlight to cross a pianoforte wire, and obtained thus a brilliant dot. Striking the wire he caused it to vibrate, the dot described a luminous line like that produced by the whirling of a burning coal in the air, and the form of this line revealed the character of the vibration. It was rendered manifest by these experiments that the oscillations of the wire were not confined to a single plane, but that it described in its vibrations curves of greater or less complexity. Superimposed upon the vibration of the whole string were partial vibrations, which revealed themselves as loops and sinuosities . . . (Figures of these lines are shown). Every one of these figures corresponds to a distinct impression made by the wire upon the surrounding air " (from J. Tyndall, *op. cit.*, p. 121). Actually it can be shown, that any transversely vibrating wire fixed at its ends, will produce at these ends a stress-strain reaction, which in its turn will tend to produce a longitudinally vibrating component along the wire, resulting in a standing wave. Young's experiment partly reproduces this effect. Thus, it is believed, the meaning of the above diagram is explained. The full mathematical treatment and his arguments against Young and Fresnel can be found in the works of Poisson. See also Prof. T.J.J.: " The New Theory of the Aether," *Astron. Nachr.* No. 5085, vol. 212, Feb., 1921, where the Poisson discussion is treated at length. *Mutatis mutandis* it can be applied to our case.

Returning to crystals, it may be stated that their field is electromagnetic as well as mechanical. Its actual basic foundation can be found in the so-called fine structures of the fields of atoms and molecules. These fields are known to be of electromagnetic nature. It is then quite evident that if we change periodically the mutual position of molecules and atoms, a similar periodic change will occur between their electromagnetic fields, so emitting an electromagnetic wave. A mechanical periodic molecular vibration must radiate an elctromagnetic periodic wave. As a matter of fact the infra red band emitted by any kind of matter is partly of such a nature. Does not heat arise from the mechanical motion of thermal agitation ? Now, if such thermal agitation be polarised in a certain direction, thanks to its mechanical motion, it will produce a sonic wave. This is just what is to be expected in crystals, where the freedom of vibration of molecules is polarised.

It is also well known that in a great many crystals we find the three axes X, Y and Z : the electrical, the mechanical and the optical. This is due to the fact that all the molecules of crystals are axially arranged together with their harmonic proportionalities. Hence the field surrounding the crystal will not be an isotropic one, but definitely anisotropic. Along the Y axis we shall expect mainly the mechanical phenomena to appear, along the X axis the electrostatic, and along the Z axis perpendicular one to the other two, light will operate as an electromagnetic phenomenon. We may find here reason for Reichenbach's claims that light emitted from the top and bottom of crystals was visible to sensitive persons. He succeeded even in photographing this light. But as in those days there was no theoretical explanation of such a possibility, the whole thing was entirely dropped. Now, in the light of modern knowledge, this phenomenon seems to find a reasonable foundation.

To end this short discussion about crystals and their proportionalities it would perhaps be worth while to show some pictures of snow crystals taken from the microphotos in H. Kayser's book, *Grundriss eines Systems der Harmonikalen Werdformen* (Occidentverlag, Zurich, 1946), and compare them with matrices of musical proportionalities made for the possible interference between two or more tones and their harmonics (slides shown). From this comparison we may easily form a more exact picture of how musical harmonic proportions can be represented by the morphological appearance of crystals.

Plants

We pass now to the next subject of to-day's lecture, " Plants." It is known from everyday experience that plants grow according to the proportions which are proper and particular to any one

of their species. These proportions can be easily measured and represented by numbers. Kayser in his most interesting book *Harmonia Plantarum* (12) has shown how these proportions can be perfectly represented by musical intervals and tones, as well as how they follow the harmonic law in their growth.

According to this law, if we strike the middle C on the piano keyboard and release the damper from the strings, its first subharmonic below will be c, one octave lower, the second subharmonic f, then c again. If we go further, we find and perceive by the ear a minor sequence of notes following the minor scale proportionalities. The mental evaluation shows a minor scale. Numerically this sequence is represented by 1/1, 1/2, 1/3, 1/4 . . 1/*n*. If instead of going down from the middle c we go up, the harmonic sequence is represented numerically as 1/1, 2/1, 3/1 4/1 . . . *n*/1 and our ear perceives them as major scale proportions. One is the mirror of the other. Generally speaking, on striking any tone on the keyboard the harmonic sequences will always follow the same sequences of, say, major or minor scales. The dividing point is the tone which has been struck, from which the harmonics towards both ends are counted. For more details we refer the reader to the excellent works of Kayser from which the above was learned. It is necessary to mention that every tone assumes a certain angle relative to the fundamental tone.

If we would try to represent the numerical values of the above sequences by respective sections in length and their angles, then, taking all the above factors into account, the resultant picture represents schematically the exact shape of a plant. Excellent drawings are given by Kayser in his *Harmonia Plantarum* on pages 27, 32, 41. The dividing point is the one at the surface of the earth, the point of germination. The proportions above the ground follow the major scale, and below, the minor one. Of course they can be represented by musical notes, as actually Kayser did, drawing them beneath the schematical design mentioned. Such representations of sectors gives us a good picture of the growth of the stem and the roots (slides shown). If we now imagine this in three dimensions we have the perfect shape of a plant.

One of the most important observations is that the proportions which the growth of plants follows, do not correspond to the numerical value of frequencies. On the contrary it follows the logarithmic law, the same law which stands behind the evaluation of the ear. This evaluation, as it was said, is purely a mental process, and lies at the base of the psycho-physical law of Fechner-Weber. Strangely enough the growth of the plant is governed by the same law. It follows, as Kayser demonstrated, not the material impulse, as he calls it, of pure quantity, but the mental impulse of value (13). In other words it grows according to

the law which governs the world of art and not that of pure quantities.

A further interesting detail is, that from the way the offshoots from the stem grow in any particular plant, one can find the differences of the phases between particular tones and frequencies, of which the very shape of the plant is the result. A great deal could be written about these phase differences, but this would lead us too far. We have to refer the reader again to the works of Kayser (14).

It is easily seen that any seed is not a random accumulation of matter, but a well organised one. Hence only certain freedoms of vibration are permissible and, in the whole seed, the directions are axially polarised, just as they are in any crystal. This freedom of vibration along some specific axis, will depend on the chemical combinations existing in the seed and their chemical bond. The resultant pattern of these vibrations and molecular arrangement, if amplified, will influence the growth of the plant. Now, let us suppose that, for instance in a seed of a particular species of a plant, we have a combination of three fundamental proportionalities, or simply tones, thanks to their chemical constitution. They may be the c, g, and e, which form a major fifth, the c-g, a major third and a minor one, c-e and e-g. These tones will have different frequencies and different harmonics according to their pitch. They may also have different amplitudes, that is intensities. A combination of these tones, thanks to their interference, will produce a definite pattern in three dimensions. It would be enough to amplify these mechanical vibrations which lie hidden in the seed—where this vibration is extremely minute and faint—in order to produce an outburst of the seed. This amplification can be compared to the example given above, of a singer singing its resonance tone into a glass. The glass breaks into pieces when the amplitudes of the molecules become too large, for it cannot grow. On the contrary, the plant being a living thing, begins to grow, but it will begin to grow according to the particular interference pattern of its component tones, the amplitudes of which have been increased. The cause of the amplification, which increases the momentum of the molecules (which is dependent on their freedom of vibration) is Light. To its different wavelength the molecule will react differently. We know that the infra-red band of the light spectrum increases the momentum of molecules by thermal agitation. We see why heat in indispensable for the plant's growth. Other frequencies of the light spectrum will produce analogical effects in their wavelength range. Ehrenhaft's photophoresis, and his latest experiments with graphite dust, leave no doubt about this effect of light (slides of Prof. Ehrenhaft's experiments shown) (15). This aspect of the problem explains in one stroke a great many facts. Unfortunately we have again to drop this point owing to shortage

of space and time. All that can be said is that the increase of the momentum is due to the pressure of light along the so-called Poynting's vector. It is due to the lognitudinal component of light, about which more details have been given in the writer's paper, " The Gravitational Wave " (16).

From the combinations of the possible freedoms of the vibration (due to the chemical bond, &c.) of the seeds, different patterns will result, and the growing plants will assume a different shape, and achieve a different morphological form. We see that the shape of the plant, the peculiar shape of the species, results from the interference pattern of the combinations of the mechanical waves, which we usually call " sounds." From different collections of tones, intervals and their amplitudes, specific shapes will emerge. Such shapes are literally music petrified in form and matter.

Of course the environment of the growing plant will have something to say here as well. In different positions and environments, a slight change in the accidentals of the shape will appear. But the fundamentals will not easily change. Actually the very root and basis of genetics are tangible here.

Considering all these quite logical factors, and accepting them as a working hypothesis for a possible solution of these most interesting problems, it was concluded that the sap of the plant must essentially have in itself the same vibratory combinations as the plant. By crystallising the sap one would expect that the shape of the crystal will correspond in some way to the morphological appearance of the plant from which the sap was taken. Therefore specimens were taken and examined under the microscope. In several cases of very typical shapes of the plants the results were definitely positive. The best examples were obtained with the sap taken from the leaf of Yarrow, or otherwise called Milfoil (*Achillea Millefolium*), Nasturtium or Indian Cress (*Tropaeolum Maius*) and Dandelion *Taraxacum Officinale*) (slides shown). The sap was simply dropped on the microscopic slide and permitted to dry and crystallise. This proves that the principle is not without foundation, anyway in some cases. We leave the more exact determination to specialists. One curious phenomenon was observed. In order to obtain these crystalline patterns, the sap had to be put on the slide shortly after the plant has been picked up. Also better results were obtained when the plants were picked after rain than during a dry spell.

From these results and the logical trend of thought, we may presume that the future shape of any plant is concealed in the vibratory motions of the seed. It is also believed that the general lines given above can be accepted at least as a working hypothesis.

The Human Organism

Before approaching the subject the reader is asked to remember that the problem is purposely simplified in order not to blur the general picture with details.

We may pass now to the human body. It has been shown in the introductory part that the human organism must be surrounded with a " noise," which is the function of the molecular agitation going on in the organs. We can easily see that each organ will have its own sonic field—its own noise—which, if properly detected, should provide us with information of the processes going on in them. We should also keep in mind that the human body, as well as the particular organs, is not a heap of matter accumulated at random, but a well-organised entity and hence bears a sort of analogy to crystals. In scientific literature this analogy has long been suggested.

The first question which presents itself to an investigator is : Can it actually be demonstrated that our reasoning as to the presumed sonic field of the human body is valid ? Can any experiment be given as a proof ?

First of all let us state clearly that these sounds must be of an extreme faintness, as otherwise our ear would detect them. Therefore a very sensitive detector must be used. In the history of physical science all sorts of devices have been found for detecting such sounds. One of them is a sensitive flame, and another a sensitive jet. These sensitive jets have been investigated, mostly by Felix Savart and John Tyndall. They are also sometimes called sensitive veins. We shall here use such jets as a detector.

Under a steady pressure you allow a water jet to flow UPWARDS at a certain angle. When the jet is illuminated you can see that it is surrounded by a whole crowd of small droplets flying in nearly all directions. It is known from Savart's and Tyndall's experiments that such jets under the influence of a sound wave in resonance with them (not all frequencies therefore will produce the effect ; the selection of the frequency depends on all sorts of details) will immediately collect all these droplets into one bunch, and a definite wave pattern will appear on the jet vein itself. Please note that this wavelength of the jet does NOT correspond to the wavelength of sound which produces the effect. Actually such jets are the finest sound detectors known. Remember that in using the word " sound " we mean, throughout this paper, all mechanical vibrations, that is the audible range, as well as the ultra and infra sounds.

What does Tyndall himself write about such jets ? He uses a steatite orifice to produce them, as he claims that if is far more sensitive than any other one. Here is his description : " By means of an india-rubber tube the burner (orifice) is connected

with the water pipes . . . and, by pointing it obliquely upwards, we obtain a fine parabolic jet. At a certain distance from the orifice, the vein resolves itself into beautiful spherules, whose motions are not rapid enough to make the vein appear continuous. At the vertex of the parabola the spray of the pearls is more than an inch across, and, further on, the drops are still more widely scattered. On sweeping a fiddle-bow across a tuning fork which executes 512 vibrations in a second, the scattered drops, as if drawn together by their mutual attractions, instantly close up, and form an apparently continuous liquid arch several feet in height and span. As long as the proper note is maintained the vein looks like a frozen band, so motionless does it appear. On stopping the fork the arch is shaken asunder, and we have the same play of liquid pearls as before. Every sweep of the bow, however, causes the drops to fall into a common line of march." Tyndall shows further that beats between two frequencies can be actually seen on such jets (17).

It has been found by the writer that if such a jet is flowing under a very low pressure, it becomes still more sensitive. Instead of using the steatite burner or orifice, we use a simple one of metal, and the jet is produced by using an ordinary German-type primus. By pumping the air into the container and by a special screw which can regulate the opening of the tube leading to the orifice, we can thus adjust the jet itself and its pressure. The best results are obtained when the jet is not higher than about three inches.

If the human body is surrounded by a sonic field, as theoretical considerations predict, then we should expect that a similar effect would appear on a water jet as described by Tyndall. This is what actually happens. The very moment we approach our hand, for instance, to such a jet, all the small droplets collect themselves together and the jet assumes a definite wave pattern. So long as the hand is held by the jet this wave pattern is visible. We withdraw the hand, and the spray of droplets again becomes visible.

Experiment shows, so far as one can notice with the unaided eye, that this wave pattern in the jet is not a simple sine wave, but betrays rather a more complicated wave-form such as would result from hundreds of waves superimposed on one another. Such a wave-form is just what would be expected, as the human sonic field is by no means a simple one. If, as Tyndall maintains, beats between two frequencies can be observed on such a jet, then in a more sensitive one a whole wave-pattern would be observable as well. Hence it is suggested that such jets should be observed by a conveniently arranged telescopic tube, set at a distance from the jet, as otherwise the sonic field of the telescope itself will affect the jet predominantly. It must be recalled that in any object the molecules have their thermal agitation,

and thanks to the limited freedom of vibration and its directional resultant, by summation a sonic field should surround the object. Such a field will affect the jet. This can be actually observed by approaching any object to it. Remember, it is not the effect of temperature, as a source of heat from a distance will not affect the jet. It is also suggested that interesting results should be obtained in low temperatures with jets of liquid gases.

This fact, it is believed, gives an experimental proof of our theoretical considerations. As to the possibilities of a wave-form appearance on the jet, we abstain from definite statements until a telescopic observation shall actually prove it. It may happen that for every individual a different pattern will appear on the jet. Other liquids than water should be used as well. Chemical affinities and resonance principles should be observable by such methods ; anyway wide possibilities are open to research. We may note here that the effect on the jet of the magnetic and electric fields is powerful. Lord Rayleigh noticed this with electric fields years ago (18), but no special attention was then drawn to it. As for the magnetic field it is believed that this was not observed and was unknown until now. The explanation is simple. In the electric as in the magnetic fields the air molecules and their thermal motions are polarised in the direction of the field, and will thus produce a resultant sonic field. When the dielectric rod is rubbed its molecules are put in vigorous motion, though inaudible to the ear. For more theoretical details we refer the reader to the notes of the writer's paper read to the Congress of Radionics (19). As to sensitive flames it is believed that they are not as sensitive as the jets are.

The general statement can now be made that, as well as the human beings, all objects are radiating sound waves, and therefore their fields are sonic fields as well. Of course every individual will have his own different pattern, a different collection of tones, as the shape, the geophysical position, the state of health, &c., is different in each of us.

It must be noted that this sonic radiation will impinge upon the surrounding objects, and be partly reflected by them. Therefore, according to the environment, a standing wave pattern should surround us, with its nodes and antinodes. As we move about in life, the field of the standing wave arranges itself accordingly, and will change in some accidental details, but the fundamental pattern of interference will remain permanent. The general law could be defined thus : *This radiation and its pattern is due to the distribution of the matter and its mutual correlation* in any individual case. The actual chemical nature of the matter, its temperature, shape, position and so forth, is implicated by this definition. We entirely omit here the electric components of the field. Now how can we explain in the above light the therapeutic

results of drugs, plants, the curative effects of music, especially in some nervous diseases, &c.

Here in our opinion we have to turn to gravity. Suppose that from the planetary system we withdraw suddenly the planet Jupiter. What will happen to the motions of other planets? In accordance with the third Keplerian Law, their motions and distances from the sun will rearrange themselves immediately, as one of the potent factors influencing their revolution has suddenly disappeared. A similar effect would result if the motions of Jupiter were suddenly changed, enhanced or damped. This mutual dependence is so strong that thanks to the observed discrepancies between the actual planetary motions and the calculated ones (motions of Uranus) an English astronomer, Adams, was able purely by mathematical means not only to show the existence of a new planet unknown at that time, but also to point to the very place where this planet should be present. (Independently of Adams the French astronomer Leverrier calculated similarly). Neptune was actually found later there. If instead of moving Jupiter we were to remove or change the motions of Mars, then the rearrangements of plants would be different. The writer asks you to remember this, as we shall return to this example in the problems of fever.

The harmonic law of Kepler (the third law), to which this German astronomer came by pure harmonics (see his work *Harmonice Mundi*), can be applied not only to heavenly bodies, but also to atoms and molecules. If, for instance, we were to remove one molecule from a certain area where ten others are, then these ten would immediately rearrange their motions accordingly. The whole Universe, both atomic and astronomic in size, is ruled by this same law of the mutual dependence of the motions of bodies freely suspended in space.

Now the growth of a body, so long as it is not interfered with by some outside force, will peacefully follow this harmonic law. The matter will accumulate in relation to the forces acting in the interference pattern. This accumulated matter will have also an harmonically distributed field, which is the function of the vibration of material particles. Thus, for example, the liver will grow in the human body in harmony with its vibratory pattern and with the surrounding organs, or better with the surrounding wave-patterns of the environment. The molecules will accumulate in hips and troughs in accordance with the ruling pattern.

Suppose now that into this field an alien impulse is introduced, which vibrates in dissonance with the pattern of the liver and its natural law. It will produce a discord in this orchestrating field, and will influence by its own vibrations the molecular motions of the liver, producing a damping effect by shifting their phase angle or by enhancing some components and nulli-

fying others. A sort of forced vibration is imposed. If the liver is strong enough, that is, if its amplitude is of full strength and is undamped by previous wrong impulses, then it will resist and finally force the new impulse (or the alien matter) to vibrate at the liver's rate and pattern. The " stranger " will only slightly damp the vibration of the liver's molecules. If, however, the intrusive vibration should find in the liver's motions a resonating component and thus acquire some strength, then it will be able to impose its own vibrations on the liver (usually a resultant will follow), a new molecular arrangement will occur detrimental to the harmony of this organ, and hence to the whole body and its health or state of balance.

There are some reasons for believing that the blood has a strong absorbing capacity for such vibrational patterns. We shall return to this later. Thanks to its circulation it will spread such vibration all over the organism. However, as other organs are not in resonance with other patterns than their own, they will not resonate to it in full strength. It may, nevertheless, easily happen, that one of the most distant parts of the body will be in resonance with one particular component of the spreading vibratory rate and wave-form, and so this component will suddenly be enhanced. The amplitude will grow above the normal required for the harmonious (balance) health state ; the heat will there increase and an inflammatory state will arise. If the *phase* of the damaging factor is not exactly *in phase* with the enhanced vibration of the organ concerned, beats will emerge in the form of pulses. Now the nervous tissues of this resonating organ have grown in harmony with the former pattern of the organ and its amplitude. If then this amplitude should suddenly grow above the normal, and the pattern change, respective signals will impinge upon this nervous tissue, and it will be sent along them to the brain. Such signals will be most probably perceived by the brain as pulsating pain. If, however, there is no phase difference between the wave-form of the forced vibration and the one natural to the organ, by steady enhancement of one of the components a steady impulse will be sent to the brain, and the pain instead of being felt as pulsation will be perceived as steady. Personally the writer believes that all pains are pulsating ones, but some of the pulses are so quick that they are felt as steady. This opinion is the result of purely theoretical considerations.

What will happen when the invader of the organism finds in one of the organs a component resonating more fully to its own vibration ? From the theory of resonance, it is apparent that the amplitude of the resonating component should grow abnormally and tend to pass above some critical point—we shall call it the strain breaking point—and the molecules will then break asunder and the tissue will start to decay. This process again

finds an analogy in the singer singing into the glass. It will first respond by enhancing its vibration, but finally will break up entirely and splinter into pieces.

It may happen though that a tissue instead of decaying will grow, like the seed mentioned above, impelled by the vibration. Then an example of cancerous growth will occur. Just as matter, under a localised impulse breaks in a star-like way, so does a cancerous growth in some cases spread into its surroundings.

Returning to the decaying process, essentially it comes down to the processes involved in chemical decomposition.

Fever is actually a thermal process enhanced. In an organ, by the resonance principle, one of the components of its vibration pattern enhances the momentum of the molecules of that organ. The temperature grows as the momentum grows, that is the amplitude (intensity). At the moment the amplitude passes the strain breaking point the organ will start to decay. In order to prevent such a calamity the circulating blood comes to help, absorbs the heat that is a part of the momentum of the molecules, and by spreading it through the whole of the organism increases the surface of the radiation. Not only the localised amplitude of vibration, but the momentum is decentralised as much as possible, and so prevents decay, but it also permits the emission through radiation of the increased momentum of the body, simply because the surface of the radiation is larger. The stronger the resonance which produces the increase in amplitude, the higher the fever. The heart beats quicker, the circulation of the blood is stronger, and the radiation increases. It can be shown that all this is the mere function of the increased heat. As a matter of fact, the pulsation of the heart is a function of the temperature, or more exactly the function of the general amplitude of the molecular vibration. We see here how, by the principle of resonance and wave-theory, a great many things going on in the organism can be reasonably explained. It is indeed hard to deny the great advantages of such a theory.

In problems of fever it must be realised that it is not only a simple enhancement of the linear momentum. It also must result in a change of the pattern of the momentum of molecules. This change of pattern, however, will depend on what component of the general pattern has fallen into resonance with the new introduced vibration. Different invaders, having a different wave-form, will fall differently into resonance with various components of the complicated wave-form of any particular organ. Hence one would expect that the thermal agitation of the fever, in any particular illness, would produce a different pattern in the Brownian movement of the blood. Theoretically every man according to his particular health and psychological state should have slight differences in the pattern of his blood and its thermal

or Brownian movement. Strangely enough this can be mathematically proved.

An example will perhaps make this more clear. The reader may remember what has been said about the different rearrangements of planetary motions, according to whether Jupiter or Mars be removed from the planetary system. Well. a similar reasoning can be applied this time to molecular motions in the problems of fever. In *one* particular illness some harmonical components of the general pattern are cancelled and others enhanced. In *another* illness other components are subject to the same fate. Hence in both cases a different rearrangement of motions will follow in analogy with the example taken from the heavenly bodies. We see how temperature is basically a gravitational phenomenon. Dr. Benham in his paper called "The Nature of Temperature," is definitely right in his general claim (20). From the above it is concluded that there is no random element in the Thermal Motion, though it may appear as such in the microscope at the first glimpse. The law of the mutual dependence of the motions of bodies freely suspended in space is fundamental here.

An invader of the organism can by its new vibratory pattern not only enhance one of the components, but also cancel one of vital importance to the state of balance. This will happen when the respective frequency is out of phase by 180° with it. A standing wave will result which will nullify the action of this vital element, i.e., its vibration. No fever will result but pain or a lack of balance will be the effect.

As to the absorbing capacity of blood for different patterns of motions, you may remember what has been said about the sap of the plants and their crystallisation. It was presumed there that such sap should contain the vibratory patterns of the plants, and that it therefore should crystallise accordingly. Subsequent microscopic investigations seemed to give experimental support, anyway in some cases. *Mutatis mutandis* the same principle can be applied to the functioning of blood. By its crystallisation pattern we should be able to recognise, at least in the most general way, what is actually going on in the organism. A sample of blood taken from the body during a particular illness, when vaporised and conveniently dried, should, thanks to its absorbing factor, crystallise in accordance with the vibratory pattern it actually contains. The so-called groups of blood should find here their basic *physical* explanation. The actual crystallisation of blood, about which we know something from the interesting photographic slides obtained from the researches of such as Duranton and Countess Chrapowicki, can find also here its basis. It must be emphasized however, that the changes in crystallisation should appear in the accidentals and not in the fundamental crystalline network. Actually the so-called Laue method (with

X-Rays) when applied to blood crystalline structures, should reveal most promising results (21). The Duranton methods may also give further information. As all these researches are as yet in embyro, it is not yet time to make any definite statements. It is hoped, however, that the foregoing theoretical discussion is logical enough to be accepted as a working hypothesis.

The writer has investigated microscopically the crystallisation patterns of catarrhal mucus in its different stages. It was observed that slight differences could be found in the crystalline structure when the catarrh passes through its varying phases. The patterns are beautiful and mostly similar to leaves of fern or certain kinds of moss. In a different series of microscopic researches the crystallisation of the albumin of eggs of domestic birds was examined. It showed, in accordance with the theoretical predictions, that each species of bird has a different pattern of crystallisation, although the generic pattern of birds is always preserved. When one has become conversant with these, it can then be immediately recognised to what kind of bird this particular albumin belongs. Such researches were carried out with a veterinary doctor, Mr. Briks, in 1949-50.

In the light of what was said above, the mechanism of the curative action of drugs and plants is easily visualised. A plant which has a similar pattern or wave-form to that of the particular invader, or illness, but out of phase by 180° with it (i.e., the mirror picture of it), at the moment when it is properly introduced into the body, will automatically form a standing wave with the pattern of the illness, thus nullifying its activity. The Hahnemann principle of *Similia Similibus Curantur*, is explained at the same time. By " similarity " the complete similitude of the wave-form is intended.

As to whether homoeopathic doses can be explained by the present theory, we as yet abstain from any opinion. The writer would like, however, to emphasise as much as possible that he is not a medically trained man. It is only the purely physical side which is treated here. The last word as to medical matters we leave to those who have been trained in this branch of science and *art*. A general working hypothesis is here only proposed from a purely physical standpoint.

At the end of this present lecture a few words must be devoted to psychological problems, as we are dealing with a ***Psycho-physical law.***

We all know from our daily experience that by our thought we can set in motion certain portions of matter belonging to our bodies. In other words our thought disposes of an " amount " of force. By this force we can change the position of at least a globular amount of molecules of our bodies, as for instance a finger. We can move it. Can we, however, influence the very minute particles of our bodies, the molecules themselves, in the

same way as we do their globular assemblage accumulated in, say, a finger? Can we change their amplitude of vibration, that is, can we influence the temperature? Their rates of vibration and intensities? We have no doubt as to the former, being able to move a finger, a leg, and so on, but it is not so evident with the latter question. From the previous considerations we know that influencing the rate of vibration and amplitude would have a definite result on our health state. We could then change our health by thought. Actually it is believed that autosuggestion is based, at least partly, on such possibilities. The difficulty is to observe changes so minute in comparison with the actual movement of a hand.

Analysing, however, more closely some of the operations of our bodies, we see that change of temperature produced by thought can easily be observed. It is easily noticeable in sexual problems, where certain thoughts change the flow of blood and temperature in the respective organs. Strong emotions are another example. It has also been demonstrated on several occasions that an intensive thought, for instance about a particular finger, will raise the temperature in it, and this temperature change is measurable.

Let us consider the same problem from another angle in order to eliminate all possible objections. We definitely can send nervous impulses, by thought, to certain parts of our bodies. Such an impulse travelling along the nerve, will reach its end and will there change the molecular vibratory pattern, thanks to the physical law of action and reaction. According to the components and kinds of the impulses sent, the vibratory pattern of the molecules will be transformed in the environment of the nerve ending. Every type of action must produce a similar kind of reaction. A great many nerve endings in a certain area will change the pattern of molecular vibration in that area. If such impulses become automatic and subconscious as a steady habit (acquired usually by a repetition of this action), this will definitely and consistently change the molecular vibration pattern. These patterns will respond to particular impulses permanently in a particular way. Physically we can define this as the ability of thought to change through the respective impulses issued from the brain, the actual directional (axial) freedom of vibration, in other words, the ability to change the crystalline network structure. As a matter of fact, we do not see how one could move a hand without imparting well beforehand a certain motion to the molecules as well. Such motion must start from smaller groups and proceed to larger ones. We know that this is what actually happens.

From the study of psychology it is known that a habit consists of subconscious impulses sent to different parts automatically. It is acquired by long repetition, as we have said, of the same

action. The physical mechanism consists in an efficient response of a particular tissue (or muscle, or whatever it may be) and of its minute particles (molecules) to successive impulses. It must therefore be accepted that a habit is related to an efficient re-arrangement of molecular structural vibration in this tissue. Under such habitual impulses the further growth of this tissue and its arrangement will be definitely and permanently influenced. The accidental regrouping and re-arrangement of molecules will be subject to habits. Thus the mental process will influence the growth.

Let us now eliminate any thought interference with growth and its molecular arrangement. The body will grow then according to the law of harmonics. The chemical nature of molecules, their environment and their bonds, will influence growth, according to the vibratory pattern governing this area. It will arrange itself in exact analogy with the arrangements and rearrangement of planetary motions in harmony with their movements and fields. There would be no disharmony, no discord in such body, organs, tissue, &c. The musical field of such a body, as well as the body itself, would be a harmonious phenomenon. The field which is the function of our body's vibratory pattern would be beautifully and harmoniously distributed. The whole body can be compared to an orchestra, where each particular organ represents an instrument. Our thought is the conductor of this orchestra.

Now, the very moment that thought enters in, impulses are sent to different parts of the body, like electrical signals, through the nerves, and according to these impulses the molecules start to re-arrange themselves. This in turn will affect the environment, and the transmitted radiation will accordingly arrange the surrounding field of the body. By this explanation one can see how thought can influence the human field and the actual growth of the body. Permanent habits through their repeated impulses will influence the respective vibratory patterns of molecules, and the way they will accumulate in the body. Thus the character of the man, his mental habits, should be definitely reflected in the body, in his way of moving, in his eyes, on his face, hands, and so on. Even his way of working will be affected. Thought will affect the growth of the accidentals of the general shape of the body, will carve its lines. This is the reason why we can guess from the way a man is walking, from his face and his palms, the general lines of his character. Thought actually influences the whole reactive system of molecular vibration. The whole body is formed according to the thoughts and habits animating it. What we call soul is the preponderating factor, the essential FORCE which influences the whole and every part of it.

Now human thoughts can be either in complete accordance with the natural law of harmonics and the general pattern of the human being, the generic pattern of its vibration, or in

disharmony with them. In the first case the body will develop harmoniously, and its field will then represent a glorious harmony, containing no impurities and no damping effects. In the second case, the very moment that thought develops, impulses which are in complete or partial contradiction with the law of harmony, the proportions of the vibrations produced by dissonant impulses will not fit into the generic human pattern of vibrations, or into the individual pattern of the man. A human field of this kind will be full of discords and dissonances.

His evil thoughts will create wave-forms, which will contradict the law upon which human nature has grown; will damp the generic and individual pattern of the human being; will affect the balance; will spoil the perfect resonance, and therefore—speaking in terms of wireless circuits—a part of his energy will be released and go back to the GENERATOR. It will weaken the health and introduce into the body the stamp of illness and decay, which finally will result in death.

From the study of Theology we know that what we call a sin is nothing else than a violation of the law of nature, i.e., law of harmony. We thus have here a partial explanation of the mechanism of sin and its natural physical result. It shows us the natural side of it. There are other sides as well, but they will not be discussed here. Anyway sin, or any evil thought, which is not in agreement with the law of nature, will be reflected in the body and in its field, and will appear as a damping effect upon the living force. The resistive strength of the individual is weakened and decay starts. Evil is the first step and the very root of destruction and death. "The wages of sin is death" says St. Paul.

We have had a slight glimpse into the realm of natural theology. We have seen how natural philosophy, the world of science, does not contradict, but, on the contrary, supports the beauty of the teaching of Christ. This will be the subject of a special lecture called "Science and Religion."

To finish, we would like to say that the Creator, who is perfect beauty in Himself, that is, perfect proportion, must be reflected in His creation. Anything which violates this law of harmony is called a sin. It is a dissonance in the harmony of the spheres and the beautiful concerto of the Universe. It is in contradiction with Beauty, and therefore also with Goodness and Truth.

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