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*With best wishes
to Graham Bond*

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INTRODUCTION TO HARMONICAL FUNDAMENTAL RESEARCH

Sources and History

Fourteen years ago a new branch of science called "Harmonikale Grundlagenforschung (Harmonical Fundamental Research)" came into existence. At present it is only represented by a professorship and Research Institute at the "Hochschule für Musik und darstellende Kunst" in Vienna, and yet our publications have aroused world-wide interest. What is the purpose of this science? What, in fact, is "Harmonik"? The idea, that the universe originated in sounds or consists of them was widely believed in ancient civilizations. This was described in myths and symbols. When the ancient Greeks evolved from mythology to philosophy, this concept was also accepted and found its reflection in Pythagoreanism. The thinking was - from then on - rational, in proportions and harmonies. The Pythagoreans also incorporated analogies into their ways of thinking, and the representation of a universe consisting of sounds could thus have been formulated as follows: There are analogies between nature, Man and music. Meant were the musical intervals, that is, the numerical laws ruling our musical intervals, and with this it was claimed, that these are natural laws and correspond to psychic and intellectual dispositions of Man.

This theory did not emerge at once, since the school founded by Pythagoras in the sixth century b.C. exercised a very strict secrecy and the ancient Pythagoreans did not leave any written documents. Only about one hundred years later did fragmentary writings come to light, and closer connections could be evidenced even only by Plato, who codified most of the testimonies, some of which have not been deciphered completely. With the last Pythagoreans this strict secrecy probably became looser, since over five hundred years later, in the first centuries

of Christianity, Pythagorean doctrines appeared again, which have been proved to be authentic, so that a hidden tradition must be assumed. Nicomachus of Gerasa and Theon of Smyrna were the main representatives of this new Pythagoreanism and from them some isolated ideas reached into the Middle Ages.

Apart from the theory of music, there is no question of a consistent tradition in other branches, and it is to the humanists that we owe its re-emergence in the Renaissance period. To the scholars, well into the Baroque epoch, the concept of a world harmony with musical laws was familiar; they wrote on the subject quite matter-of-factly without producing any evidence or proof of the underlying theory. Only one of the great thinkers on the threshold of modern age made it his life's mission to demonstrate this world harmony. This scientist was Johannes Kepler, the famous astronomer and mathematician, who demonstrated in his "Five Books of the World Harmony" (*Harmonices mundi libri quinque*), that the orbits of the planets follow certain laws, namely simple intervals, predominantly consonant ones. His work is valid even today, although in his time it was misunderstood and later even derided. Thus at the end of the Baroque epoch, when the triumphal march of the natural sciences just was beginning, the Pythagorean theory of the world-harmony sank into oblivion.

It was only about one hundred years ago, that this situation changed when a scientist named Albert von Thimus picked up the old ideas again and rediscovered the ancient buried sources. He wrote a two-volume work entitled "Die harmonikale Symbolik des Alterthums" and brought to light many interesting ideas; he mixed them, however, with his own philosophy, inspired by ancient symbolism. His life-work would hardly have received a noteworthy success, had it not been for the German-Swiss private scholar Hans Kayser (1891 - 1964), who took up his investigations and correlated them with other scientific achievements, including those of Kepler.

This so-called "Kaysersche Harmonik" was a great synthesis of the Pythagorean tradition, overlaid with highly speculative and peculiar metaphysics. The modern Harmonical Fundamental Research arose from the above, setting clear limits, however, on philosophical speculation and with its main emphasis, instead, on inductive, empirical methods.

Harmonical Laws in Nature

The antique harmonical tradition holds that the most important basis of music, the intervals, also appear as natural laws and are firmly rooted

in the hearing disposition of Man. What are these laws? We know them from school, where we have been shown - maybe with the help of a monochord - that our intervals inseparably correlate with simple numerical proportions. The octave has the proportion 1:2, the fifth 2:3, the fourth 3:4 and so on. These proportions are at the same time general natural laws, as it has been demonstrated by modern harmonical research, above all in acoustics, especially in the overtone-series, which sound automatically with every tone produced.

Johannes Kepler had already demonstrated the existence of such interval-proportions in the planetary orbits, and, since then, astronomy has discovered others, namely in those planets, which were still unknown in Kepler's time. At the beginning of this century crystallography came up as an additional science, as a result of the observations of the crystallographer Victor Goldschmidt of Heidelberg, who discovered important proportional laws in the crystals' structure and identified their musical characteristics. But in physics and chemistry, too, there are important laws of proportions, which are to be interpreted harmonically. Max Planck was completely convinced of the fact that his discoveries of the Quantum Theory were an analogy of harmonics since only complete multiples of the Planck's constant (h) can occur - just as the harmonics are full multiples of the frequency of the fundamental tone. These same laws are also the basis of the Periodic Table of the elements, in relation to nuclear charge and number of electrons. Applying these laws to a monochord, the sounds produced are harmonics!

In botany and zoology there are harmonical laws, too. It is not obvious that birds' singing has the same basis as human music, since the birds' singing is not an imitation of it - which has been demonstrated - but it develops independently. The majority of the laws of proportion is found, however, in Man himself. Externally the human body is harmoniously proportioned, which has already been recognized in the ancient theory of art, and at present it can be confirmed by anthropometry. The fact is essential, above all, that the physiological rhythms of Man are based on simplest proportions, which can be represented by the numbers 1 to 4, so that without exceptions they are all consonant, as it has been demonstrated widely by Gunther Hildebrandt, M.D.: heart beat and breathing, for example, are in a proportion of 4:1; the many rhythms of the human body are similarly coordinated - especially during sleep - so that they don't run at random and in confusion.

Summing up these discoveries, one can see that the same proportional laws or very similar ones appear in all these sciences ; and in no case incidentally : they can rather be described as functions. Thus Harmonical Research indicates far-reaching analogies between different sectors, lateral connections that cannot be noticed from the individual sciences, but they evidently play an important role in nature. Besides, there are laws disposed in our hearing, about which we must talk in more detail.

Musical Disposition of Hearing

Already in Greek antiquity it was asserted that the human soul was "tuned" to musical intervals. Johannes Kepler professed a similar opinion that the origin of these intervals was to be found in the human soul. Hans Kayser, referring to this, spoke of prototypes, based on the theory of the archetypes of Carl Gustav Jung. For Harmonical Research it was hence an important subject to follow scientifically the question of such a disposition.

In doing so, relations were established to later empiric investigations of hearing by Heinrich Husmann, who verified that the anatomy of the ear adds new tones and intervals to those, which reach the eardrum ; these new sounds are harmonics again - called subjective harmonics - and combination tones, including some of higher order. In that way, complicated interferences which result differently for each interval, develop within the ear, so that characteristic differences are built up for each interval. The mathematic description of the results shows that in this way those intervals which are based on proportions of integers are preferred by the ear. It is, thereby, understandable that their use throughout the ages since the time of antiquity is no a coincidence. In addition an ability to distinguish consonance and dissonance results from this. By further evaluation of Husmann's experiments, one comes to the conclusion that the diatonic system, the chromatic and Major scales can also be explained by the physiological characteristics of the ear. The ultrashort memory should also be considered, as well as the psychic disposition of hearing. In the psychic sector of hearing, the intervals are disposed too, of course not as numerical proportions, because in this sector the numbers shift to sensual qualities or psychic sensations. On the psychic level it is important that here wider hearing ranges can be noticed for individual interval perceptions which can even amount to 80% of the distance between two half-tones. This explains why deviations from the proportions

which can nevertheless be associated with the correct intervals, are possible. The tempered tuning is only possible for this reason.

This very complicated psycho-physical hearing disposition confirms the Greek theorists to a great extent, although they presented this human hearing disposition in a much simpler way, namely purely psychic. Their ideas, however, were right to a great extent; and the Pythagorean theory of the identity of musical intervals with natural laws and hearing disposition had a true basis, as has been scientifically demonstrated today.

Furthermore, it has been demonstrated that the most important basis of our Occidental music are preferred by the ear, so that our music didn't develop accidentally in the way known to us, but teleologically, that is, subordinated to the human hearing. Composers of the past followed a reliable instinct and did not simply establish convention as it is often affirmed nowadays. Our Major scale is preferred by our hearing, as it links the five best consonances to a common fundamental tone. This same interval sequence reappears in the most important scale of Indian music, the Sa-Grama, and reversed, that is, from the higher to the lower note, it is identical to the old Greek Doric scale, which was the central scale; this scale also appears in the primitive races as the first step in the development of tonality. The hearing disposition has, thus, decisively influenced the musical basis of the different cultures, since such a striking coincidence cannot be explained in any other way. What music developed on these bases is a completely different question. It can be very different from ours and even sound strange to us - just as in painting, where the basis at all times was the same, namely colours; what was produced from them was varied and manifold.

The Application of Harmonical Fundaments

The philosophical theory of the conformity of musical and natural laws and human disposition led, already in Greek antiquity, to the application of these laws - that is, the proportions of the intervals - to other sectors where they do not appear naturally. We call this application "applied harmonics", and the most important sector of this was architecture. The Roman writer Vitruvius Pollio, who lived in the first century B.C. reports of this - and Hans Kayser has confirmed it through the analysis of the ruins of the Paestum Temples - that the measurements can be interpreted as intervals and represented as notes.

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It may be mentioned, incidentally, that in other cultures there were also constructions which followed musical laws, f.i. in China and in India. In Europe the proportions of the intervals were again taken into consideration for buildings in the Gothic, but the true revival of this ancient tradition took place in the Renaissance. But it is not only the description of Vitruvius that attracted interest, as seen in the various translations and commentaries of the time, but before the beginning of the Vitruvius-Renaissance the famous theorist of art and architect Leon Battista Alberti calls attention to the importance of musical proportions. During the whole Renaissance period and up until Palladio, one of the last great architects of this period, construction based on the intervals is widely known.

During the Neo-Classical period, which is also a retrospective to antiquity, this type of construction experiences a revival, and especially nowadays there are some architects in different countries who have taken up the ancient principles and build according to the proportions of intervals. One of the best known is the Swiss architect André Studer, in whose house Hans Kayser lectured to young architects about twenty years ago. The houses built by Studer were presented to the public by television in German-speaking countries.

Apart from architecture, harmonics are also applied to literature, also already in antiquity, where the entire metric of language, especially that of poetry was measured according to these proportions with respect to shortness and length. Since then, proportions and other musical laws have been used in manifold ways, apart from the fact that the contents of literature, as well, have been exposed to the harmonical ideas, particularly during Romanticism: even in the 20th century, in the novel "Glasperlenspiel" of Hermann Hesse, harmonical influences are to be found.

Of all sciences it is medicine, that has benefitted most from harmonics. The investigations of the human physiological rhythms of Gunther Hildebrandt, which we have already mentioned, were stimulated by the Harmonical Research of Kayser. In addition to that, the German physician Hans Weiers successfully experimented in the field of high frequency irradiations and built a so-called "Bioscillator", which applies irradiation treatment with two different frequencies, which form a fifth. He also used intervals in hydrotherapy and was able to apply his method in veterinary medicine. Harmonical principles, however, are most important in musico-therapy, which has been extended considerably in the last decades with more and more success. The fact

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that human physiology functions to a great extent harmonically and that the hearing is tuned on the harmonical basis provides for a very logical explanation of the therapeutical effect of music. It is surely not by accident that the Pythagorean tradition reports on the great significance of music for the harmonization and cure of the human psyche.

The Significance of Harmonical Knowledge

Harmonical Research verifies the theories of antiquity, particularly the Pythagorean doctrines on the extensive validity of musical laws in the universe. It draws up a theory of life, which is not only accessible to the intellect but whose laws can also be perceived psychically with human hearing, and that is related to the arts, especially music. It is of especial importance that this harmonical conception of the world does not set the human being in opposition to nature as is often the case in the natural sciences, but the human being is a part of it in its own very special way. The natural harmonical laws are known as consonances, intervals and even the Major scale appears in nature. These, however, are criteria which appear not to be permitted, since everyone knows that specific sensitivity to the intervals or to the consonances occurs only in the human being, whereas, in nature, only the corresponding numbers exist. In the same way it is always affirmed that colours exist only in the human being; in nature on the contrary, they are only electromagnetic waves or other similarly quantities. This separation cannot be maintained because all these quantities can be discovered only through measurements carried out by Man and only he is conscious of them. Why then should colours, tones and other qualities be separate from the possibilities of cognition? The well-known Swiss physicist Walter Heitler therefore demands that all that is related to Man be integrated to his cognition and not only that which can be measured and understood intellectually as it has been maintained since the time of Descartes.

If the human sensual capacities were to be omitted, then with regard to the harmonics in nature only numeral pairs would remain. The integration of hearing clearly indicates that there are certain proportions as intervals, consonances, etc., which brings one to the assertion that without human hearing it would not be possible. The integration of Man brings cognizance of nature a step forward, and crowns it.

Through the categories of hearing, the conformity among the sciences, the analogies within nature, hearing and music are visible - or rather,

audible - and relationships are established, which could not have come to light from individual sciences. If we want symbolically compare nature with weaving, the natural sciences would be the longitudinal threads along which causal investigations of the different sectors are carried out; Harmonical Research would be represented by the transversal threads, indicating analogies, linking the individual sectors intellectually. Both directions together offer an integral view of nature; natural sciences give us a partial image only.

Because the theory of life of the natural sciences is one-sided - something that is being recognized more and more by leading scientists - the philosophical conclusions of this concept are also one-sided. This we refer, above all, to the materialism and the atheism which emerged in relation to the natural-scientific thinking and became more and more dominant. The harmonical perspective of the world leads one, however, to other results. This perspective admits the recognition that behind these natural laws there obviously exists, a great plan, which consists of simple numerical laws and which links sectors analogically all. In this plan, the human being is much more integrated than in the universal concept of the sciences, namely with psychical sensations and the basis of the works of art created by him. Johannes Kepler firmly believed in this plan and in the Creator who conceived it. On account of this belief he was the first to confirm some of the harmonical natural laws. We should follow his example and submit the abundant numerical material offered by the disciplines of the individual natural sciences to the harmonical perspectives. In this way we find the wayback to a harmonious and coherent concept of the universe.

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