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ORDER AND HARMONY IN CREATION: DEMONSTRATED IN EXAMPLES FROM MUSIC AND SCIENCE

by

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INTRODUCTION

It is a fact that even in past times scientists (Pythagoras, Kopernikus, Kepler) realized relationships between Music, Mathematics and our planetary system. I have taken some examples which show mathematical order and harmony connecting music, man and the universe.

Teachers of music will especially find this paper a useful tool to explain the intricate relationships in God's creations. However, for teachers of other disciplines, this paper will be easily understood with a basic knowledge of a few musical terms, e.g. intervals and the overtone series.

This paper will serve two purposes.

a) To help non-Christian students find access to an almighty God, who created the universe. This can be demonstrated by an abundance of relationships in nature that are beyond all probability calculations.

b) To enhance in Christian students the respect and awe for God's creation, to make them admire its diversity and to encourage further research of the manyfold relationships in creation.

A HISTORICAL BACKGROUND

> *The knowledge of God's works and ways we can only begin to obtain in this world; the study will be continued throughout eternity. God has provided for man subjects of thought which will bring into activity every faculty of the mind. We may read the character of the Creator in the heavens above and the earth beneath, filling the heart with gratitude and thanksgiving.* E.G. White

In Roman times, music - as one of the so-called "liberal arts" (artes liberales) - was counted among the mathematical disciplines ("quadrivium": arithmetic, geometry, music and astronomy). In later times, however, especially during the Age of Humanism (15th and 16th centuries), it was part of the original "trivium" (grammar, rhetoric,and logic). This was the "realm of the word".[1]

Aside from this historical development, the significance of music as a "mathematical science" survived far into the 18th century, especially in the German-Protestant regions. There is very strong evidence of the importance of numbers and numerical symbolism in the compositions of Heinrich Schütz and Johann Sebastian Bach.[2]

This "order of harmony" based on number and proportion is also the foundation for the division of music into three categories. (This division, which goes back to Boethius (about 480 - 524), was binding throughout the Middle Ages).

- **Musica mundana** (also 'Musica coelestis'), the harmony of the macrocosm, especially of the spheres
- **Musica humana**, the microcosm of the human body and soul, reflecting the harmony of the macrocosm

- Musica instrumentalis, the tones, the audible music perceived by the senses - the instrumental and vocal music

Around 1700 there is a change in meaning of what, up to that time, was understood by the word "music". The shift in the German language is a matter of pronunciation from "Musik" (Latin "musica"), as one of the liberal arts, towards "Musik" (French "musique"), as one of the fine arts.[3]

Since the Renaissance period there has been a noticeable and ever growing trend - resulting from the ideas of Humanism - towards a specialization of the various disciplines of science. In the Middle Ages, however, the ideal, as far as the imparting of knowledge at universities was concerned, was unity. This concept was strongly influenced by the Catholic church.

The consequences were far-reaching. De Jong says about this development:

> " ... the Cartesian-Newton paradigm breaks all knowledge down into its smallest parts and in the process isolates one part of knowledge from another ... all knowledge is divided into separate academic disciplines ... faculty members focus on smaller and smaller parts, becoming specialists in their own narrow fields."[4]
>
> "The second important feature of the Cartesian-Newtonian paradigm that has shaped the public university is that it held to a closed view of the universe. This paradigm holds that all information is available and knowable because the universe is a closed entity. In addition, many scientists ... have held to a reductionist view that reality can be known only through empirical observation. If something cannot be observed and verified, it does not exist. Transcendence is thus excluded; all mystery and awe ruled out of life."[5]

The Cartesian-Newtonian paradigm encouraged specialization through a narrow focus; it tended to lead away from education to training. The concept of individuation and the resulting isolation which developed out of this paradigm has had also a negative impact upon society.

It is true, though, that in the 20th century many scientists turned away from such an attitude. Instead of seeing a universe that is closed, knowable, and predictable, their world is open, infinite, and subject to random, unpredictable developments. This new paradigm creates a worldview that includes transcendence. Contrary to the earlier belief that each bit of matter is separate and independent, this new view holds that everything is connected and interrelated. This insight partly results from the fact that no one dimension of the created order can be harmed without harming the whole.[6]

A BIBLICAL APPROACH

In biblical times the Creation of the world was not some abstract hypothesis. Nature was like an open book before man, which unveiled the work of the Creator and His creative plan in all details. Thus the apostle Paul could say:

> "For since the creation of the world His invisible attributes are clearly seen, being understood by the things that are made, even His eternal power and Godhead, so that they are without excuse" (Romans 1:20).

Men in those days saw God's directing wisdom especially in the cosmic events. God was in control of everything.

> "He has made the earth by His power, He has established the world by His wisdom, and has stretched out the heavens at His discretion" (Jer. 10:12).

Both the movements of the sun and the moon and the mysterious constellation of the stars were part of a divine plan of creation.

> "He commands the sun, and it does not rise; He seals off the stars. He alone spreads out the heavens, and treads on the waves of the sea. He made the Bear, Orion, and Pleiades, and the chambers of the south" (Job 9:7-9).

For example, the lunar movements within the solar year are by no means arbitrary. They serve a higher purpose in the mutual relationships of the cosmic rhythms.

> "The day is Yours, the night also is Yours; You have prepared the light and the sun. You have set all the borders of the earth; You have made summer and winter" (Psalm 74:16,17).
> "He appointed the moon for seasons; the sun knows its going down" (Psalm 104:19).

With one word, the whole universe bears the stamp of a divine order:

> "Praise Him, sun and moon; praise Him, all you stars of light ... He also established them forever and ever; He made a decree which shall not pass away" (Psalm 148:3,6).

How is all this order made visible?

> "Where were you when I laid the foundations of the earth? ... Who determined its measurements? Surely you know! Or who stretched the line upon it?" (Job 38:4,5).

It is the ordering principle of numbers and of geometrical and arithmetical relationships that bring the facts and movements of the universe into harmony with the God-given laws.

M U S I C

> *Music has much similarity with algebra.* *Novalis*

The ancient nations considered music a divine power, and therefore it was for them an element of the whole world order.

Music, on the one hand, is now regarded as something that has to do with romantic emotions, heroic feelings or refined enjoyment of art. This permits access only to the soul. In reality, however, this mysterious realm of tones is based on strict laws and regularities.

The foundation in the tradition of western music, which has strongly been influenced by Greek antiquity, is made up of a scale of seven different tones. The tones which make up the simplest scale are: c d e f g a b c'. Every eighth tone is a repetition of a preceding tone but at a higher level. The range covered by these eight tones of the scale is designated by the word "octave" (Latin: octavus = the eighth).

The number of vibrations per second is greater with high tones than with low ones. No two tones contain the same number of vibrations. Each is unique. The lowest c in the western music vibrates 16 times per second. For instance, if one shortens the corresponding string on a musical instrument exactly half its length, this half vibrates exactly twice as fast, i.e. 32 times. The ratio of the resulting frequencies is 2:1. Shortening the string two thirds its length results in the note g. This frequency when related to the number of vibrations of the fundamental note c

is a ratio of 3:2. Each tone has a frequency ratio, which indicates how the frequency of this note relates to the frequency of the fundamental note. This is a simple numerical ratio that can be expressed as a fraction.

c	d	e	f	$\bar{g}$	a	b	c'
$\frac{1}{1}$	$\frac{9}{8}$	$\frac{5}{4}$	$\frac{4}{3}$	$\frac{3}{2}$	$\frac{5}{3}$	$\frac{15}{8}$	$\frac{2}{1}$

These accepted tonal ratios in the current western musical scale have been in use since the Middle Ages. In essence, these ratios formed the basis of the scale system of the ancient Greeks, who divided the scale into two tetracords.

In contrast, certain oriental and Asian scale systems have a different structure and, accordingly, different tone ratios. The reason is because in these areas of the world the human ear is "tuned" differently. Even these tone ratios have an entirely objective validity, which is established in the so-called overtone series. Each individual tone corresponds to quite a few other tones, which can be demonstrated with physical instruments. All these above-mentioned tone ratios can be found in this overtone series. Their objective existence lies anchored in nature itself.

Simple calculations will lead to amazing laws and regularities. Transforming the individual tones into frequencies, results in the following:

+c-d-e+f = +g-a-b+c' (left value = -1/24, right value = -1/24)
+2c-2e-a+b = +2d-2f-b+c' (left value = -7/24, right value = -7/24)

The form of these equations, as you can see, is perfectly symmetrical. Many other examples could be shown.

A comparison of the three tones of a major triad also shows an interesting regularity. The middle tone is the average of the sum of the two outer tones.

c e g

$\frac{1}{1} \quad \frac{5}{4} \quad \frac{3}{2} = \frac{4}{4} \quad \frac{5}{4} \quad \frac{6}{4}$

g b d'

$\frac{3}{2} \quad \frac{15}{8} \quad \frac{18}{8} = \frac{12}{8} \quad \frac{15}{8} \quad \frac{18}{8}$

Within a scale, there are five different possibilities for the interval of a fourth (c-f, d-g, e-a, f-b, g-c'). If one adds the sum of these frequencies, one gets the following results:

g + c = 84/24
f + b = 77/24
e + a = 70/24

d + g = 63/24
c + f = 56/24

No other interval shows a comparable regularity. It is interesting that it is the fourth that plays such a fundamental role within the scale. The eight-tone scale consists of two fourths of four tones each, thus symbolizing the symmetry of the scale.

If further examination of triads and scales are made, one is led to the discovery that the numbers 7, 12 and even 111 play an interesting and decisive role.

The scale can be compared with our planetary system. Venus, one of earth's close neighbors, has a synodic period (see p. 14) of almost exactly 584 days. This time span can be compared to that of Mars (780 days). If one relates them to each other, dividing 780 by 584, one gets the value of 1.335, which is the same as the ratio of 4:3 (= 1.333...) to within two thousandths. Acoustically, this

corresponds to the frequency ratio of a fourth* (see p. 8).

Another example: Venus (584 days) and the solar year (365 days) are related to each other as a minor sixth (8:5).

The miracles of the octave

When men and women sing together, they usually sing - more often than at any other interval - in octaves. The octave vibrates twice or half as fast, but is always the same tone. The octave, the symbol of unity, is also the first harmonic in the overtone series, of which it is the largest interval (the ratio being 1:2 to the basic tone). Next comes the fifth (a 2:3 ratio), then the fourth (a 3:4 ratio) etc.

The devil has been known as the destroyer of unity for many long ages. The interval that does this in music in a most conspicuous way is the tritone. It divides the octave into two parts. Evidently, that's why it was considered by ancient musicians as the "diabolus in musica" (the devil in music).

The octave is the most perfect of all integer ratios in the overtone series. One can find this in nature in such overwhelming abundance, defying all statistical probability.[7]

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* If the orbital period of Venus were 585 days, the result of the ratio 780:585 would be exactly the relationship 4:3. These minimal inaccuracies (in our example two thousandths) in no way harm the overwhelming overall impression of extreme precision and order. As we know that there is an absolute God as the originator and sustainer of all creation, such little inaccuracies leave behind the connotation of perfection marred by sin and the fall of Satan.

The Swiss expert Hans Cousto[8] has made use of the principle of octave transposition in order to make the music of the planets audible.

The frequency of the planets is the synodic time: For the earth 24 hours, for Venus 224 days, etc. Rotations are vibrations. In order to get from planetary vibrations into the vibrations of earthly music one has - according to the distance of the planet from the sun - to transpose by octave 26 to 50 times. Our solar system has a range of exactly ten octaves (like the human ear!).

According to Cousto's method time and frequency are proportionally inverse:

$$frequency = \frac{1}{time}$$

One can use the most important frequency here on earth, the earthly day (24 hours or to be exact: 23 hours, 56 minutes, 4 seconds = 86164 seconds), as a starting point. In order to get the frequency (vibrations in Hertz = Hz) of the average day on earth, one must first look for the reciprocal of 86164 seconds, that is .000 001 160 576 Hz. This frequency is far below the range of human hearing, which starts at about 16 Hz. If one transposes it up 24 octaves, one can hear it as a "g" of 194.71 Hz. (It is insignificant which concert pitch one refers to - the old English tone of 432 Hz, the Paris tone of 435 Hz or the present one of 440 Hz. The "g" is exactly in the middle so that in any case this tone is the result).

It is the "g" that the second line treble clef shows - the fifth from c and therefore the key-interval (most important) for most of the tuning processes. In the French language it is called "sol". It is strange indeed how in this word the two celestial bodies concerned appear: "sol" (= soil) and "soleil" (=sun).

In order to get (with this "g") into the range of visible light (which only spans one octave) one must add 40 more octaves. Then, in the 65th octave, one reaches a frequency of 427 trillion Hertz, which the physicists measure as 702 nanometers and which is the equivalent of a bright orange color. If one goes one more octave higher, one gets exactly to the sympathetic vibration of DNA (Desoxyribonucleicacid), as Fritz Albert Popp[9] has calculated it. The basic substance of the human genetic make-up vibrates in the 66th octave of the earthly day: Thus orange red vibrates at the interval of one single octave - the most direct and effective of all harmonical ratios - with human DNA. It vibrates in the "g", which is of central importance in our music and the dominant of the basic key, C major. It vibrates in relationship to the frequency of the earthly day.[10]

M A N

The part of a human being which one can most easily relate to numbers is the skeleton.

The upper part of the spinal column consists of 7 cervical vertebrae. Below them are the 12 thoracic vertebrae, which bear the

ribs. These 12 pairs of ribs are divided into 7 pairs of ribs, which are linked directly to the breastbone, and 5 pairs, which are not immediately connected with the breastbone (false ribs).

Let's study the skeleton of the human foot! The 7 tarsal bones form the most important parts of the foot. Most of the weight of the human body rests on them. Furthermore, the toes consists of 14 (2 x 7) so-called toe bones (or phalanges). This is exactly paralleled by the structure of the hand. The number 7 also determines the order of the bones of the scull.

All the bones of the human leg add up to 30, so there are 60 bones in both legs (5 x 12 bones). The human hands have the same number of bones. This is also true of the region around the chest and the spinal column (60 bones). Therefore, in a natural and systematic way, one can divide the whole trunk into three regions - the arms, the legs, and the region around the chest and the spinal column. Each of them consist of 60 bones. The systematics behind all this is quite obvious. The trunk (without the head) consists of 3 x 60 = 180 bones. A man and a woman put together, which is considered as a unit, consist of 360 bones. The comparison with the circle and its 360 degrees or the number of days in one year, the days of a week or the months of a year is inevitable.

There is no doubt that some parts of the human body and the outward appearance are subject to regularities and harmonical proportions.

For each proportion of the human body corresponding with a musical interval one can find a corresponding relationship between two or three planetary orbits. The two worlds of sound and planetary movements, which at first glance seem so unrelated to each other, find a visible expression in the human body. Musical relationships serve as links between man and the cosmos. In the true meaning of the word, this link represents a universal ordering principle.

THE PLANETARY SYSTEM

> *Everything in nature is closely linked and connected, and even what is separate in nature man loves to put and hold together..* *Goethe*

Watching the position of the sun and a planet during dawn or dusk, one becomes aware of the fact that the mutual position of the two celestial bodies constantly changes. One may start watching this at a time, when this particular planet and the sun are located in the same direction. For example the planet may be positioned in a small distance exactly above the sun on the same latitude in the sky. Then one may notice that with each day the planet's distance from the sun has increased. One day the planet reaches its farthest point, then it returns again, gradually getting closer to the sun, until it has reached again the original position right above it. This time period between two "conjunctions" is called the "synodic revolution" of a planet. It can also be called the "geocentric

revolution", because the earth is the focus, i.e. the mutual position of the earth and the sun.

The time needed for the various planets to complete one synodic revolution is:

Mercury	115.88 days	Jupiter	398.88 days
Venus	583.92 days	Saturn	378.09 days
Mars	779.94 days		

Taking also the movement of the moon (29.5 days) and the sun (365.25 days) into consideration, one can discover some very interesting facts:

Moon + Venus + Mercury = 2 solar years
Mars + Jupiter + Saturn = 2 Mars

The sum of the three inner planets is related to the sum of the three outer planets like the solar year to the Mars.

Saturn + 7 moon = Venus (left value = 584, right value = 584)
Venus + 5 moon = 2 solar years (left value = 731, right value = 730)
3 sun + 4 Mercury = 2 Mars (left value = 1559, right value = 1559)

Each of the seven synodic times enters, on the average, into more than twenty associations with other synodic times. These few examples give a picture of a harmonic whole. Within this whole all individual movements harmonize. A more comprehensive study of these phenomena has been presented by Thomas M. Schmidt.[11]

The order of the synodic times is characterized by simplicity, logic and a certain system. It shows a very impressive inner context. One may compare this fact with a sentence. The individual words have very limited meaning, unless they appear within the grammatical context. Only then do they convey the full meaning. It does not make much sense to pick out single words. It

also doesn't make much sense to study the individual synodic revolutions outside their context.

It is also very fascinating to study the relationships of the synodic times.

$$\frac{solaryear}{lunaryear} = \frac{Saturn}{solaryear}$$ (left value = 1.03, right value = 1.03)

$$\left(\frac{solaryear}{lunaryear}\right)^3 = \frac{Jupiter}{solaryear}$$ (left value = 1.09, right value = 1.09)

One could include many more similar examples!

The surprise is enhanced, if one examines the "sideric"[11] periods with the same point of view. One will make the amazing discovery that these orbital periods follow certain regularities and that there is a significant connection between the planetary orbits.

For example:

Uranus+Nuptune = Pluto (l. value = 248.8 years, r. value = 248.4 years)

$$\frac{Saturn}{Mars} = 2\left(\frac{Mars}{Mercury}\right)$$ (left value = 15.6, right value = 15.6)

Now the question arises: do the various periods of the individual orbits (synodic and sideric) cancel each other out in some way? The cancellation of two planetary rhythms always occurs, when after a certain number of days two planets have completed a "whole" number of orbits.

The lengths of time for the synodic periods are:

[11] The real time period of a planet to revolve around the center - the sun. It is also called the heliocentric orbit.

5 Mars = 11 lunar years (1 day difference)
11 Venus = 17 Saturn (4 days difference)
17 lunar years = 52 Mercury (1 day difference) etc.

If we arrange the many equations according to the numbers that appear in them (for example 52 = 4 x 13, 33 = 3 x 11 etc.), then one will find out that a certain group of numbers appears more often than the rest. These numbers are 5, 7, 11, 13, 17, 19, 23. These numbers are known in mathematics as prime numbers. Not only is it remarkable that there are numbers at all, which play a primary role in the relationships of the orbital periods, but it is also striking that this sequence of numbers itself conforms to a certain pattern. If one continues the examinations in this direction, one would further discover that the numbers 7, 12, 37 and 111 play a special role.

All the treasures of the universe will be open to the study of God's children. There the student of science may read the records of creation and discern no reminders of the law of evil. He may listen to the music of nature's voices and detect no note of wailing or undertone of sorrow. In all created things he may trace one handwriting - in the vast universe behold "God's name writ large", and not in earth or sea or sky one sign of ill remaining. And the years of eternity, as they roll, will continue to bring more glorious revelations. E.G. White

CONCLUSIONS

This paper is to encourage the study of discover even more regularities and ordering principles in music, the planetary system and the human body. It is a firm conviction that the sincere and unbiased researcher will, also in the fields of biology, chemistry,[12] physics, architecture and others, find many other impressive harmonies. God's handwriting will easily be discerned behind every discovery.

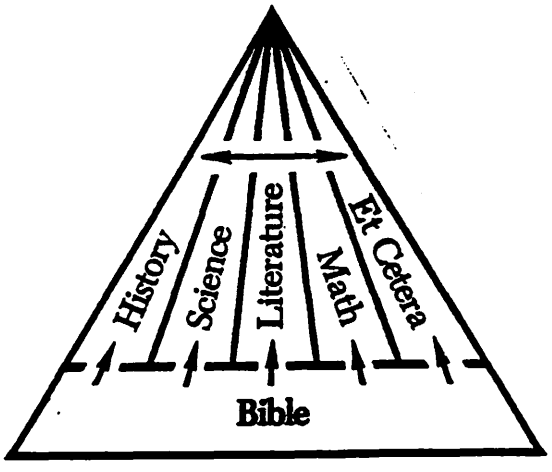
Old coins show, on the one side, a number that indicates the value. On the other side one sees the picture of the ruler who had the coins stamped and who in a sense guaranteed its value. This also happens with the world. Nature unveils to our inquisitive mind the side that can be described by numbers, i.e. by mathematical laws. Behind all these laws there is both a personal and universal God, who is the originator of them all: Jesus Christ, the creator of the world. Understanding the world, therefore, also means to grasp something of Christ's character and creative work.

> "For since the creation of the world His invisible attributes are clearly seen, being understood by the things that are made, even His eternal power and Godhead, so that they are without excuse" (Romans 1:20).

Through this insight one is able to restore the lost unity between faith and mind, religion and science. One need not sacrifice man's reason, if one wants to draw closer to God, nor must one dispense with the use of the mind in order to live in His

heart. Man's mind is his and, at the same time, God's great opportunity. This is especially true for those who have not met Him in any other way.

George R. Knight[13] in his book "Philosophy and Education" presents a curriculum model that may clearly show, in formal education, the results of the newly gained understanding.



This model implies that the Bible provides a foundation for all human knowledge. Its overall meaning enters into every area of the curriculum and adds significance to each topic. From this position the Bible is both foundational and contextual. It is the point of integration between the sacred and the so-called secular. Neither, as the horizontal arrow shows, are there any hard and fast divisions between the various subject matter fields. Every topic in the curriculum impacts upon every other topic, but all have their fullest meaning when seen from God's viewpoint.

NOTES

01. See De Jong, Arthur J.: *Reclaiming a Mission* (William B. Eerdmans Publishing Company, Grand Rapids, Michigan 1990), p. 85-88.

02. See Krones, Hartmut: *Vokale und allgemeine Aufführungspraxis* (Hermann Böhlaus Nachf. Ges.m.b.H, Wien-Köln 1983), p. 22-24.

03. Eggebrecht, Hans Heinrich: *Mayers Taschenlexikon Musik Bd. 2* (Meyers Lexikonverlag, Mannheim/Wien/Zürich: 1984), p. 299.

04. De Jong, Arthur J.: *Reclaiming a Mission* (William B. Eerdmans Publishing Company, Grand Rapids, Michigan 1990), p. 69.

05. Ibid., p. 74.

06. Ibid., p. 97-110.

07. See Berendt, Joachim-Ernst: *Nada Brahma* (Rowohlt Taschenbuch Verlag GmbH, Reinbek bei Hamburg 1985), p. 99-117.

08. Cousto, Hans: *Die Kosmische Oktave* (Synthesis, Essen 1984)

09. See Popp, Fritz-Albert: *Neue Horizonte in der Medizin* (Karl F. Hang, Heidelberg 1983)

10. Berendt, Joachim-Ernst: *Das Dritte Ohr* (Rowohlt Taschenbuch Verlag GmbH, Reinbek bei Hamburg 1988), p. 163-168.

11. Schmidt, Thomas M.: *Musik als Schöpfungswunder* (Verlag Thomas Schmidt, Frankfurt 1974)

12. See Krüger, Wilfried: *Das Universum singt* (Atom-Harmonik-Verlag, Trier 1991)

13. Knight, George R.: *Philosophy & Education* (Andrews University Press, Michigan 1980), p. 201.

FOR FURTHER READINGS

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