

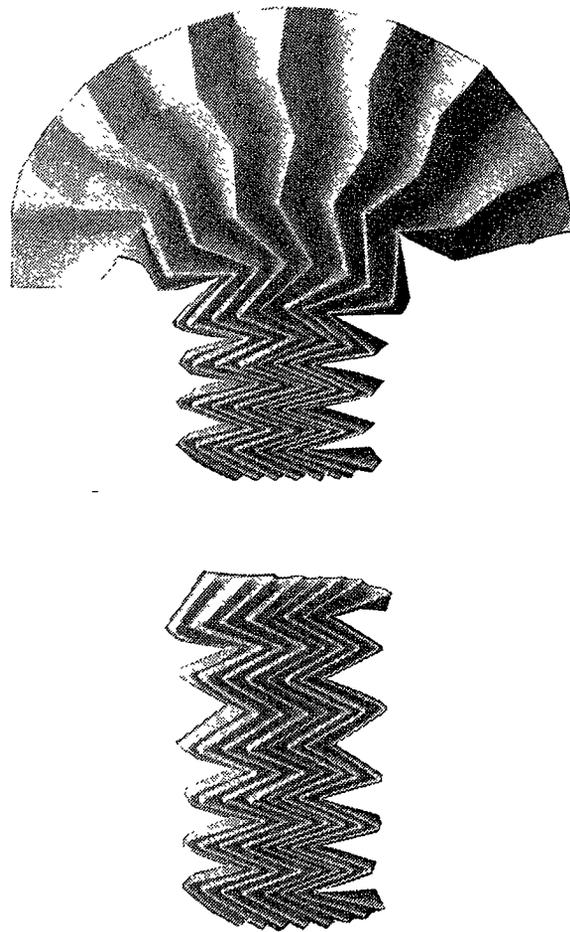
Symmetry: Culture and Science

In Memoriam
Ernő Lendvai

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The *Miura-ori*
opened out like a fan

LAMBDOMA — “I GING” — GENETIC CODE

Erzsébet Tusa

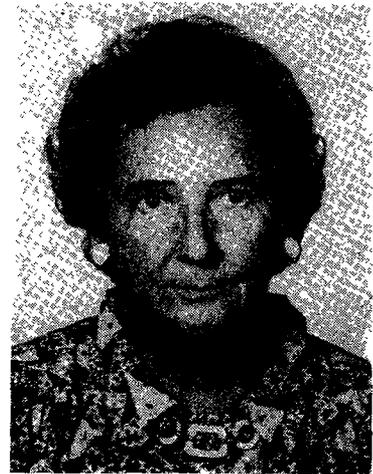
Pianist, educator (b. Budapest, Hungary, 1928).

Address: 1-2-13 No. 4, Hazawa, Nerima-ku, Tokyo 176, Japan;
and Kiss J. altb. u. 47, Budapest, H-1126 Hungary.

Fields of interest: Polyaesthetic education, integrative music pedagogy, comparative religion-philosophy.

Awards: Hungarian State Liszt Prize, 1968; “Merited Artist”, 1979; Bartók-Pásztory Prize, 1995.

Publications: *Magyarság és Műveltség*, (Hungarian Sense and Culture), Budapest: INTART, 1987, 188 pp.; *Spirál a Tudományban és Művészetben*, (Spiral in Science and Art), ed., Budapest: INTART, 1988, 160 pp.; “Lambdoma - I ging - Genetic code”, In: *Lépték és Mérték*, E. T., ed., (Scale and Measure), Budapest: INTART, 1989, pp 77-82; *Megtervezett Véletlenek*, (Planned but Free: About Improvisation), Budapest: the author's publication, 1989, 76 pp.; “... *Szigetre Mentett Magvak ...*” (“... Seeds rescued to island ...” Budapest: the author's publication, 1990, 83 pp.



Thinking about symmetries, scales and measures, it is worthwhile to pay attention to the coordinate system called *Lambdoma*, after the Greek letter Λ (lambda), which shape it resembles.

This ancient philosophical system was passed to posterity by Boëthius, “the last Roman”, in the following form:

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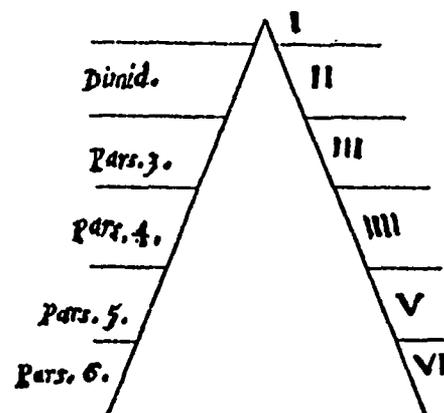


Figure 1

We can write it down in a more familiar modern format (obviously we are talking about reciprocal values) and we can transpose them into the inverse form:

| | | | | | | | | | | |
|-----|-----|-----|-----|--------|----|-----|-----|-----|-----|--------|
| 1/1 | 2/1 | 3/1 | 4/1 | 5/1... | or | 1/1 | 1/2 | 1/3 | 1/4 | 1/5... |
| 1/2 | 2/1 | 3/2 | 4/2 | 5/2... | | 2/1 | 2/2 | 2/3 | 2/4 | 2/5... |
| 1/3 | 2/3 | 3/3 | 4/3 | 5/3... | | 3/1 | 3/2 | 3/3 | 3/4 | 3/5... |
| 1/4 | 2/4 | 3/4 | 4/4 | 5/4... | | 4/1 | 4/2 | 4/3 | 4/4 | 4/5... |
| 1/5 | 2/5 | 3/5 | 4/5 | 5/5... | | 5/1 | 5/2 | 5/3 | 5/4 | 5/5... |
| : | : | : | : | : | | : | : | : | : | : |

Considering the fact that the frequency of a tone and the length of the string or, rather, the sound waves it produces are in reciprocal relationship with one another, we can conclude that the two charts are showing identical results. If one chart applies to the frequency, the other is valid for the wave length and vice-versa.

For the sake of visualization, let us write down the notes belonging to their frequency - for simplification, set 1/1 = C.

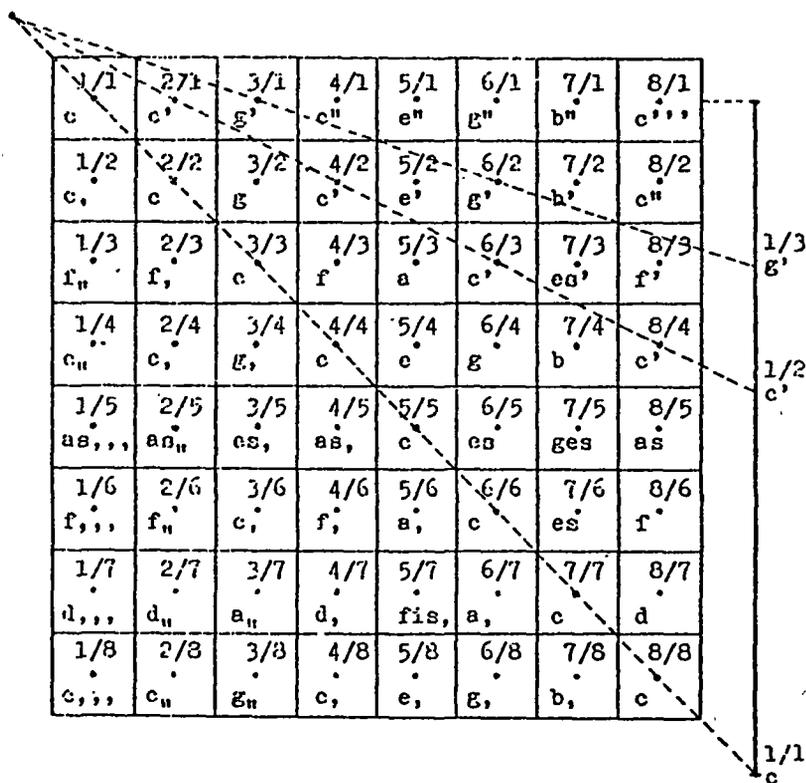


Figure 2

From the chart above, it becomes obvious that

- * above the diagonal representing the fundamental note are indicated values of the notes higher than the fundamental note, whereas, below the diagonal line are the values of lower notes.
- * the horizontal coordinate indicates the overtones of the fundamental note; the vertical coordinate indicates the notes for which the fundamental note is the overtone (the former is the "quasi" hidden future and the latter is the "quasi" hidden past);
 - the leading character of the horizontal is the major third (or 7th) triad -
in the case of C as the fundamental note: C-E-G (B^b)
 - the leading character of the vertical is the minor third (7th) - and none other than the subdominant minor! -
in the case of C: (D)-F-A^b-C.

If we attach the equivalent values expressed by different numerical forms (for example, $1/2 = 2/4 = 3/6$), we obtain a line through identical notes.

All the above point to two very important connections:

1. If we cut our chart vertically anywhere, the identical note line will show on the intersecting line the equivalent string length (we should not forget the reciprocity of the string's length and frequency).
2. The lines of identical notes are not going to meet at the origin of the fundamental note, but outside the 'system' at the 0/0 value.

The system has infinite continuation in both directions. Its arithmetic structure is obvious: the matrix of all the natural numbers and positive fractions. In this system the denominators of each horizontal line are constant, whereas the numerators comprise the whole numbers starting from 1. In the vertical lines, the numerators are constant and the denominators go from 1 to infinity.

This structure of the lines contains further mathematic regularity: the oldest known means.

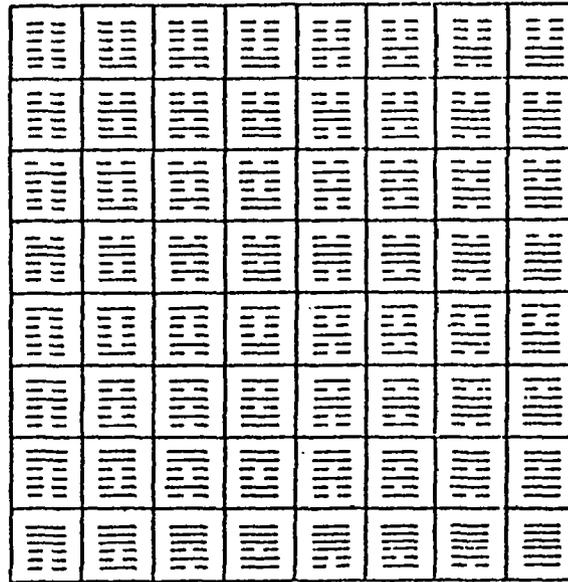
The arithmetic mean ($x = \frac{a+b}{2}$) describes the structural regularity of all horizontal lines. For example, in the case of $a = 4/1$ and $b = 2/1$, their arithmetic mean is $3/1$; or in the case of $a = 5/1$ and $b = 1/1$, the mean is $3/1$.

The harmonic mean ($y = \frac{2ab}{a+b}$) determines the structure of the vertical lines, as in the case of $a = 1/2$ and $b = 1/4$;

$$2 \frac{1}{2} \cdot \frac{1}{4} = \frac{2}{3} = \frac{8}{24} = \frac{1}{3}$$

Figure 3

In order to establish the geometric mean ($z = \sqrt{ab}$), the simplest way to view the *lambdoma* is as lambda with a vertical diagonal. Let us choose values at equal distances above and below the diagonal, such as 2/5 and 5/2 or 7/3 and 3/7. Their product of multiplication always results in 1 and their square root also will be equal to 1. The entire diagonal contains that value.



It is impossible to resist the temptation of pointing out the connection between the *lambdoma* and another chart, which has a similar structure, although it does not contain numbers. This is the Chinese "I Ging", hexagram chart, originating in ancient China in the *Book of Changes*.

Figure 4

The system incorporates 64 annotated hexagrams. Each hexagram (figures composed of 6 lines) is made of 2 triagrams (figures composed of 3 lines). There are eight possible combinations of the continuing and interrupted straight lines.

It immediately catches the eye that the denominators (lower 3 lines) in the horizontal rows are exactly the same, whereas the numerators (upper 3 lines) are changing in an orderly fashion similar to that of the *lambdoma*. Naturally, the situation is just the opposite in the vertical columns. It is interesting to observe that the equivalent of the "identical note lines" connects identically structured hexagrams with identical juxtaposition of triagrams. Further comparison, the relationship among hexagrams at equal distances on either side of the diagonal (geometric mean) verifies the perfect analogy between the *lambdoma* and "I Ging" up to the 8. These basic signs are the equivalent of the first 8 numbers.

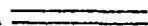
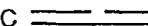
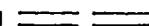
Comparing the *lambdoma* with the "I Ging" leads us further. Martin Schönberger discovered the relation between the "I Ging" structure and the genetic code. It is not in the grouping of the previously mentioned Fu-Hsi (2x3) order, but an older analogous order, the so called Wen order (3x2).

The discovery of the genetic code is one of the most important accomplishment of modern science (Watson-Crick, 1953). The genetic code serves as interpreter of the genetic information kept and carried in the DNA (deoxyribonucleic acid) of the various biological species. It possesses the capacity to encode all the different characteristics and biological possibilities that determine the individual. In most biological systems, the individual does not use all the available information, because it exists in a predetermined surrounding. However, it has the potential to survive in many different environments. In spite of the large number of genetic possibilities, only the most necessary information is used.

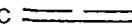
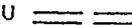
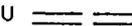
As if all the creation of world literature could be written with full value by Morse code (point, dash and space), the diversity of the living world can, in the same way, be interpreted by a four letter code. These are the so-called 4 bases: adenine (A), cytosine (C), guanine (G) and uracil (U). The four elementary signs in a triplet combination make up the code.

The genetic code by itself is a closed book, writing that has not been read. To read or interpret it means to translate it for its proper biological functions. The basis of its interpretation lies in its order. Of interest is that three of the triplet codes function as definite instructions, namely the "stop codons" that act like periods in a sentence. It is no coincidence that whenever a portion (gene) of the information in DNA is being utilized, a transcription of this section has to be made of RNA (ribonucleic acid), which is then translated into protein. Protein is the functional molecule and the genetic code makes this translation possible. It is impossible not to notice the existing analogy with reading and writing!

Martin Schönberger used the 4 basic combinations of the 2 types of lines from the I Ging to represent the 4 chemical bases in the following manner:

A  C  G  U 

The logical conclusion, therefore, is that a hexagram can be created not only by the previous Fu-Hsi 2x3 format, but by the Wen 3x2 grouping as well, which could be the basic paradigm for the combination of triplets composed of 2 lines. For example:

A  C  U 
 A  G  U 
 A  G  U 

My contribution to the subject was to combine the information from the book of Rudolf Haase about the connection between *Lambda*, the overtone system and "I Ging", on one side, with the Martin Schönberger analogy between the "I Ging" and the genetic code, on the other side, and incorporate them in a single visual system.

| | | | | | | | |
|---|---|---|--|---|---|---|---|
|  $\frac{1}{1}$ A A A |  $\frac{2}{1}$ C A A |  $\frac{3}{1}$ G A A |  $\frac{4}{1}$ U A A |  $\frac{5}{1}$ A C A |  $\frac{6}{1}$ C C A |  $\frac{7}{1}$ G G A |  $\frac{8}{1}$ U C A |
|  $\frac{1}{2}$ A G A |  $\frac{2}{2}$ C G A |  $\frac{3}{2}$ G G A |  $\frac{4}{2}$ U G A |  $\frac{5}{2}$ A U A |  $\frac{6}{2}$ C U A |  $\frac{7}{2}$ G U A |  $\frac{8}{2}$ U U A |
|  $\frac{1}{3}$ A A C |  $\frac{2}{3}$ C A C |  $\frac{3}{3}$ G A C |  $\frac{4}{3}$ U A C |  $\frac{5}{3}$ A C C |  $\frac{6}{3}$ C C C |  $\frac{7}{3}$ G C C |  $\frac{8}{3}$ U C C |
|  $\frac{1}{4}$ A G C |  $\frac{2}{4}$ C G C |  $\frac{3}{4}$ G G C |  $\frac{4}{4}$ U G C |  $\frac{5}{4}$ A U C |  $\frac{6}{4}$ C U C |  $\frac{7}{4}$ G U C |  $\frac{8}{4}$ U U C |
|  $\frac{1}{5}$ A A G |  $\frac{2}{5}$ C A G |  $\frac{3}{5}$ G A G |  $\frac{4}{5}$ U A G |  $\frac{5}{5}$ A C G |  $\frac{6}{5}$ C C G |  $\frac{7}{5}$ G C G |  $\frac{8}{5}$ U C G |
|  $\frac{1}{6}$ A G G |  $\frac{2}{6}$ C G G |  $\frac{3}{6}$ G G G |  $\frac{4}{6}$ U G G |  $\frac{5}{6}$ A U G |  $\frac{6}{6}$ C U G |  $\frac{7}{6}$ G U G |  $\frac{8}{6}$ U U G |
|  $\frac{1}{7}$ A A U |  $\frac{2}{7}$ C A U |  $\frac{3}{7}$ G A U |  $\frac{4}{7}$ U A U |  $\frac{5}{7}$ A C U |  $\frac{6}{7}$ C C U |  $\frac{7}{7}$ G C U |  $\frac{8}{7}$ U C U |
|  $\frac{1}{8}$ A G U |  $\frac{2}{8}$ C G U |  $\frac{3}{8}$ G G U |  $\frac{4}{8}$ U G U |  $\frac{5}{8}$ A U U |  $\frac{6}{8}$ C U U |  $\frac{7}{8}$ G U U |  $\frac{8}{8}$ U U U |

Figure 5

From the above chart, everyone can draw further conclusions. It becomes obvious that every such system that can be formulated as a matrix belongs here. This summary is far from being complete. With my essay, I would like to stimulate everyone to search for further analogies and newer connections!

ACKNOWLEDGMENTS:

1. A portion of the above-mentioned information I gained from the book of Rudolf Haase, *Harmonikale Synthese*, with the permission of the author.
2. I wish to thank Mrs. Maria Eliason who was kind enough to help with the English translation.

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