

DIAGRAMS in SCIENCE SCIENCE in DIAGRAMS



Daniel Muzzolini

ISTITUTO SUPERIORE DI ARTE DI ZURIGO

Roma 15 June 2021

[online]

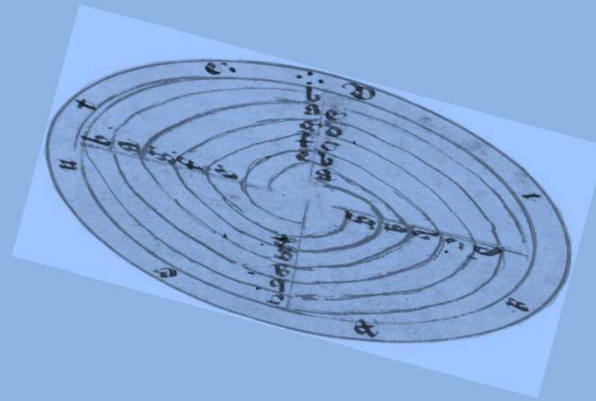
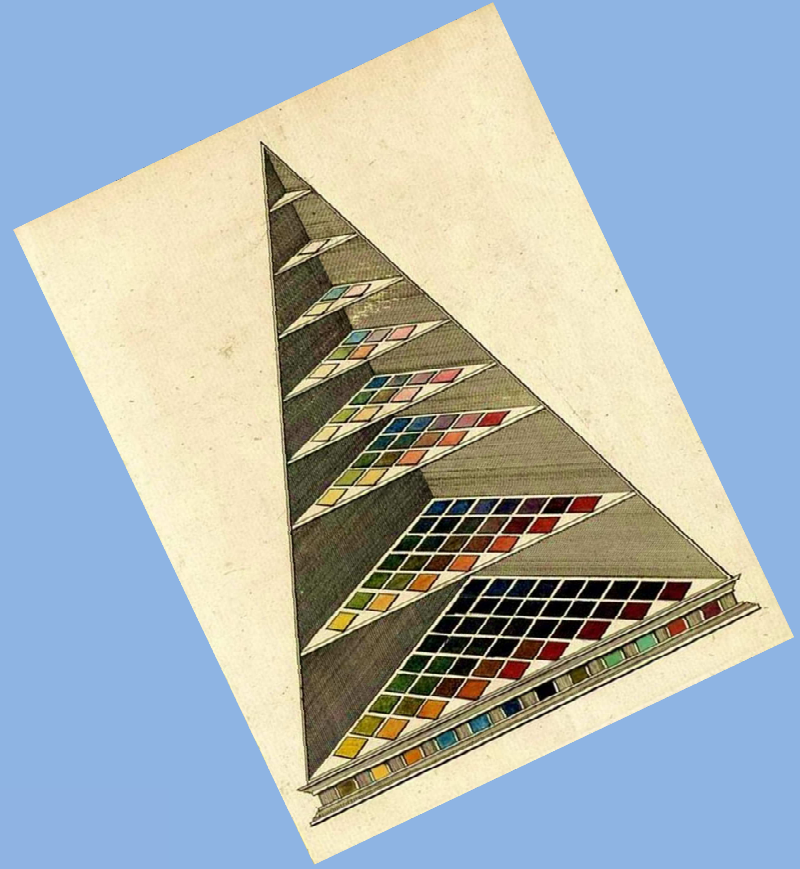
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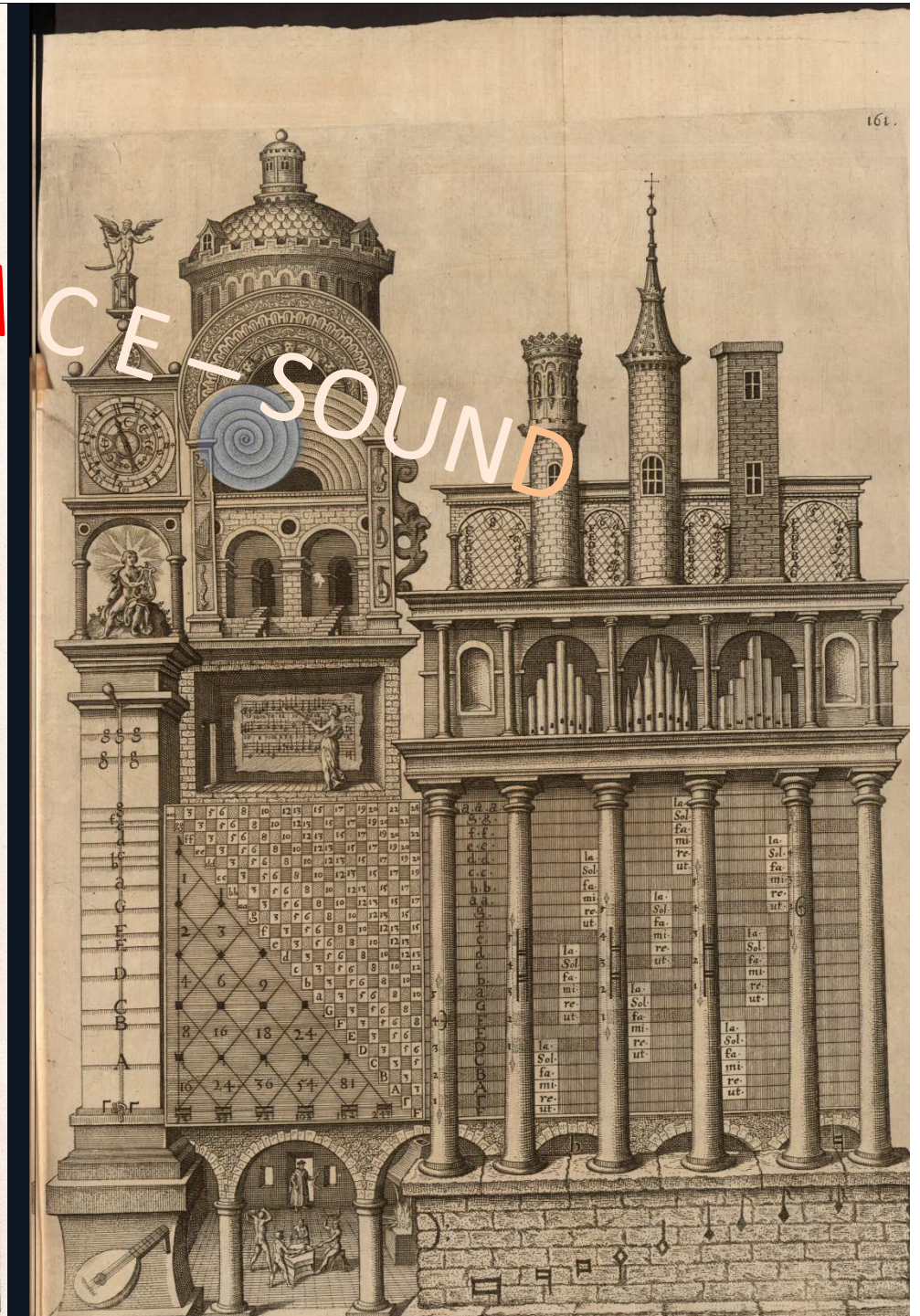
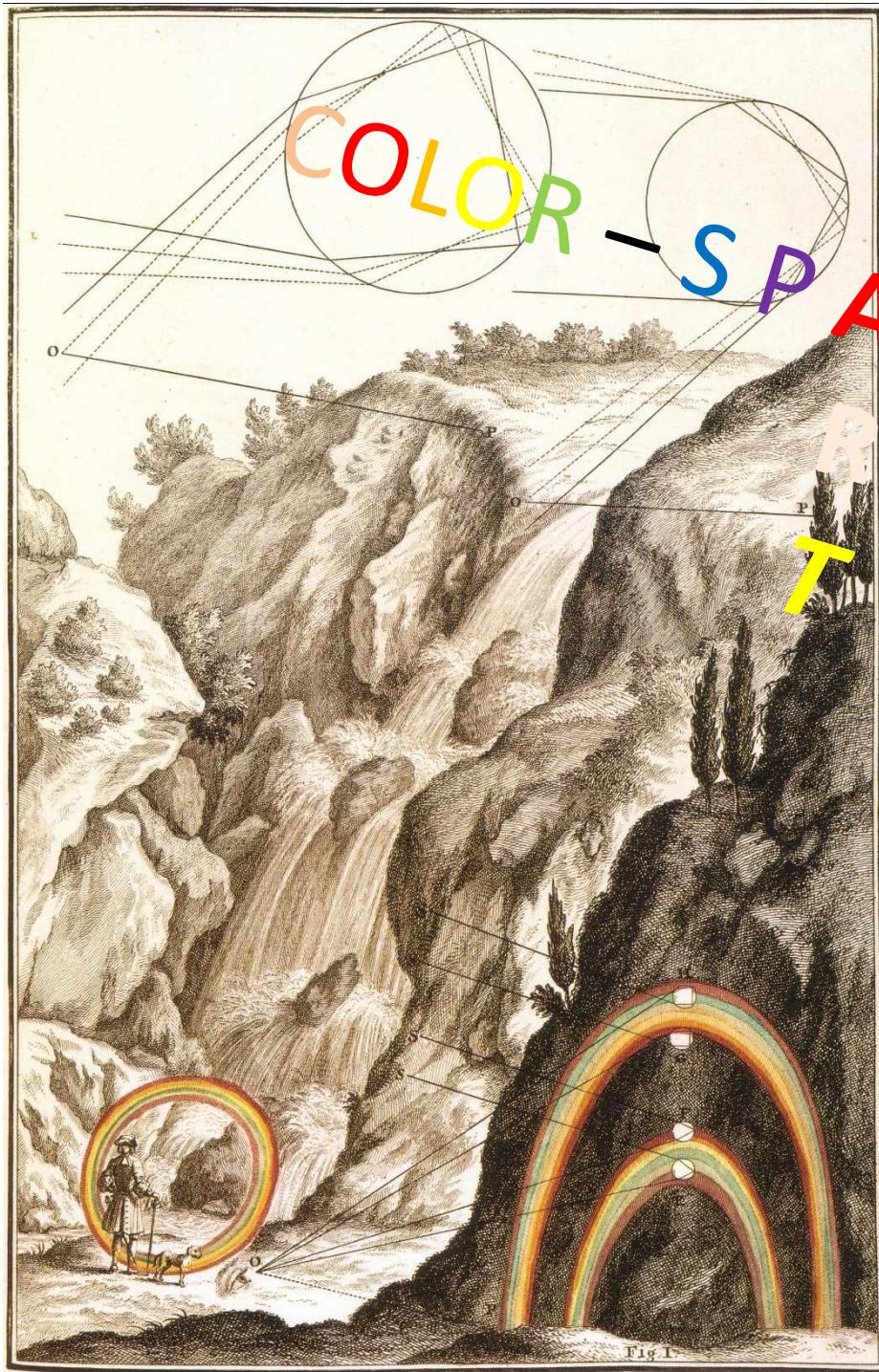
hdk

Zürcher Hochschule der Künste
Zurich University of the Arts

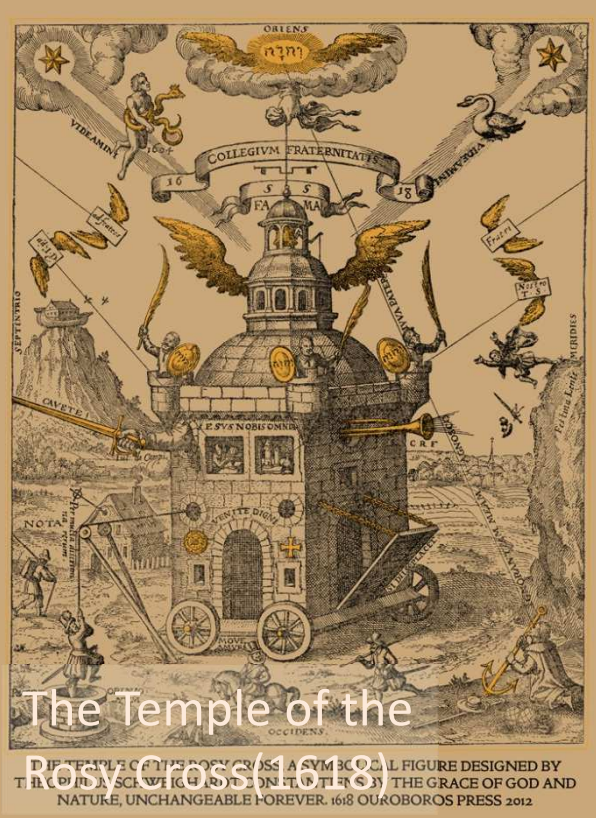
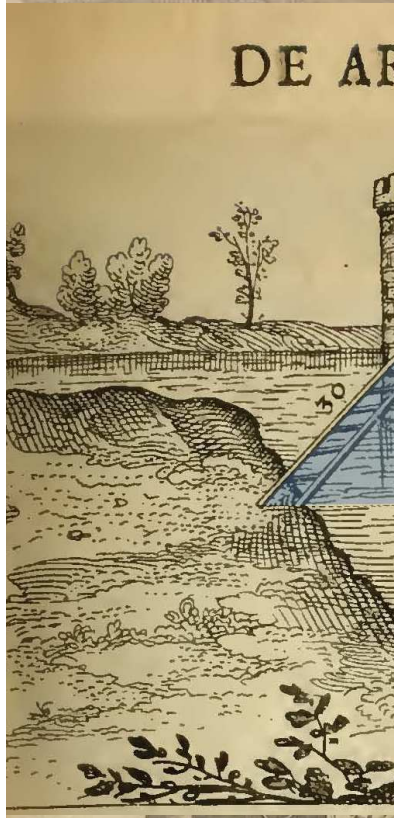
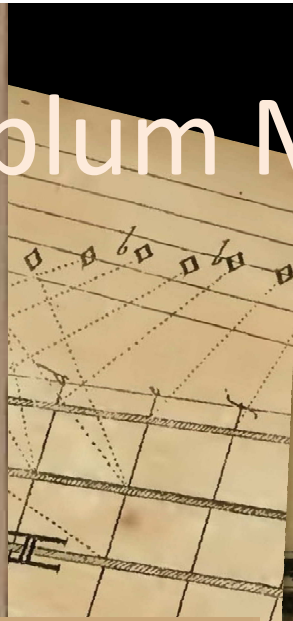
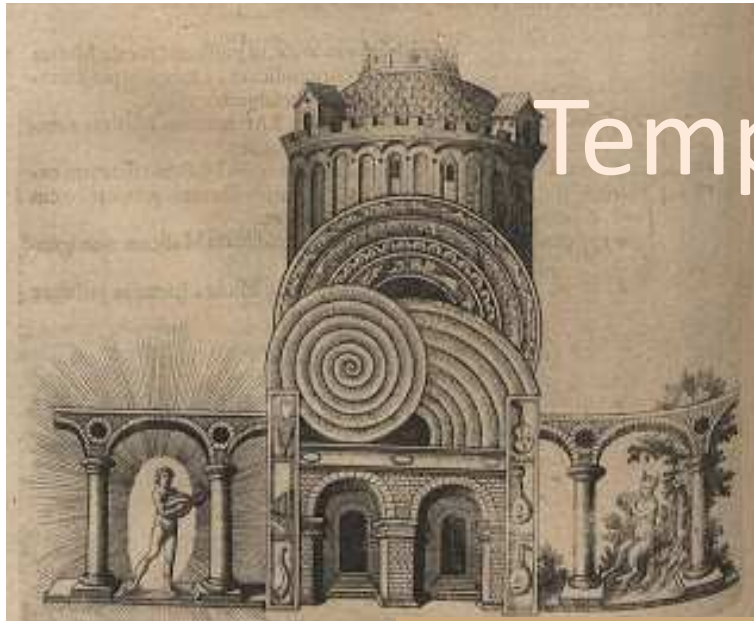


SOUND COLOUR SPACE



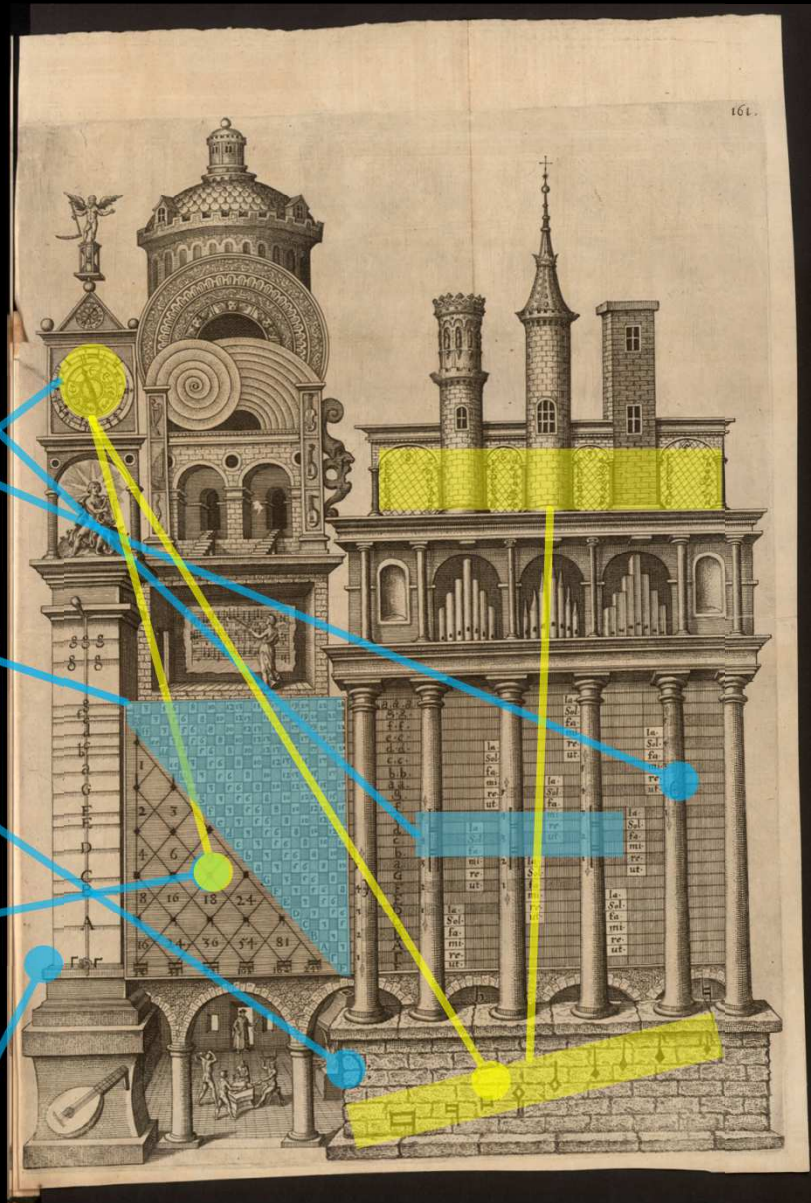
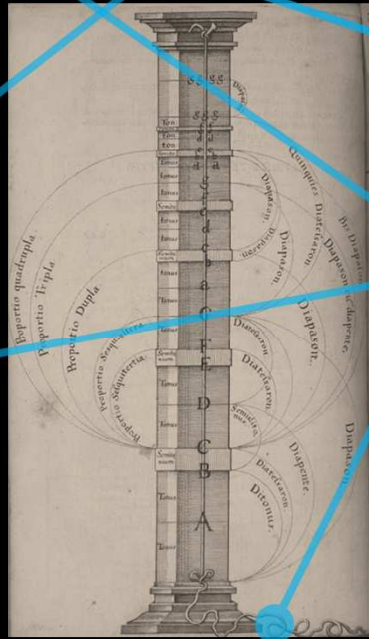
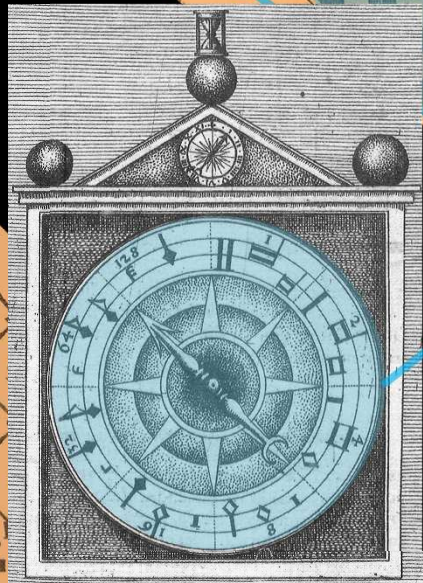
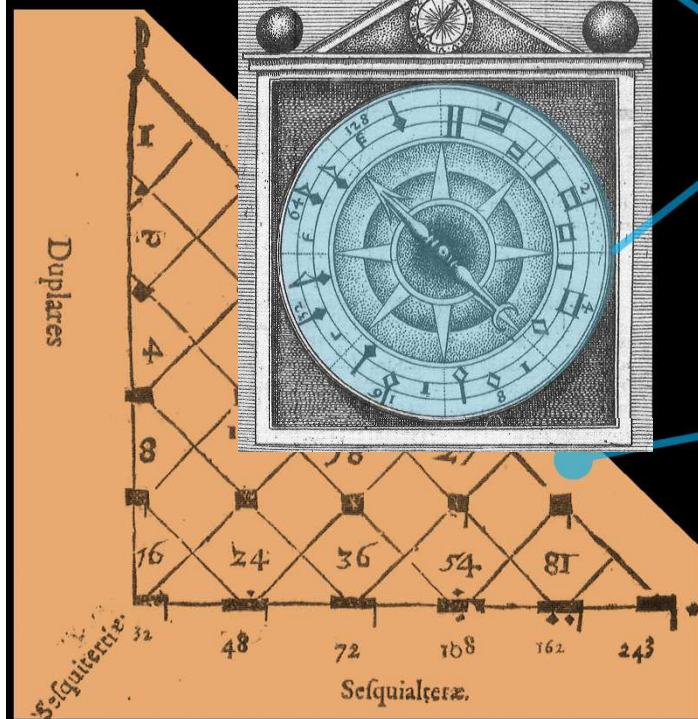
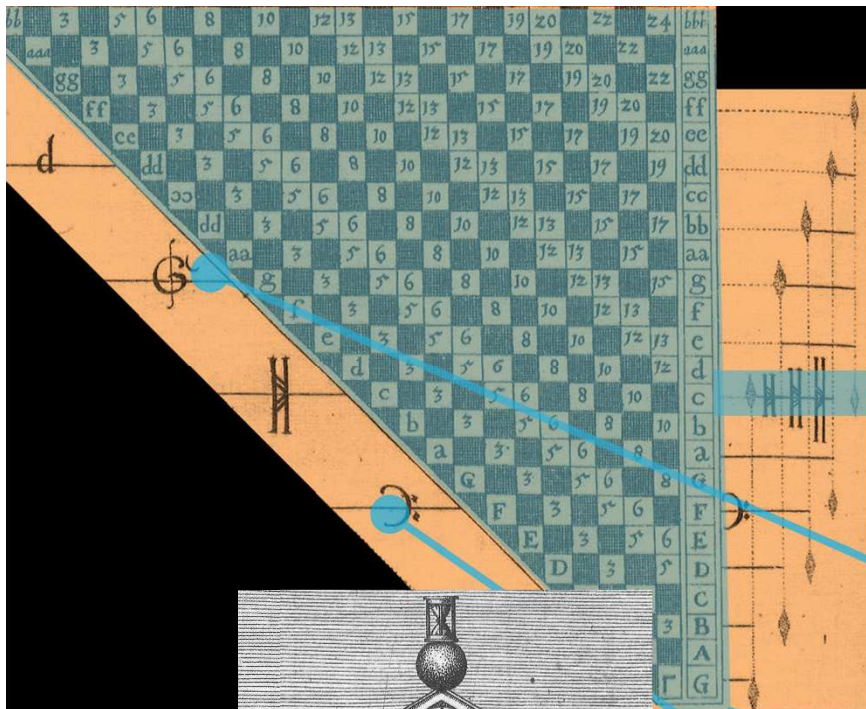


Templum Musicae



1617-1624

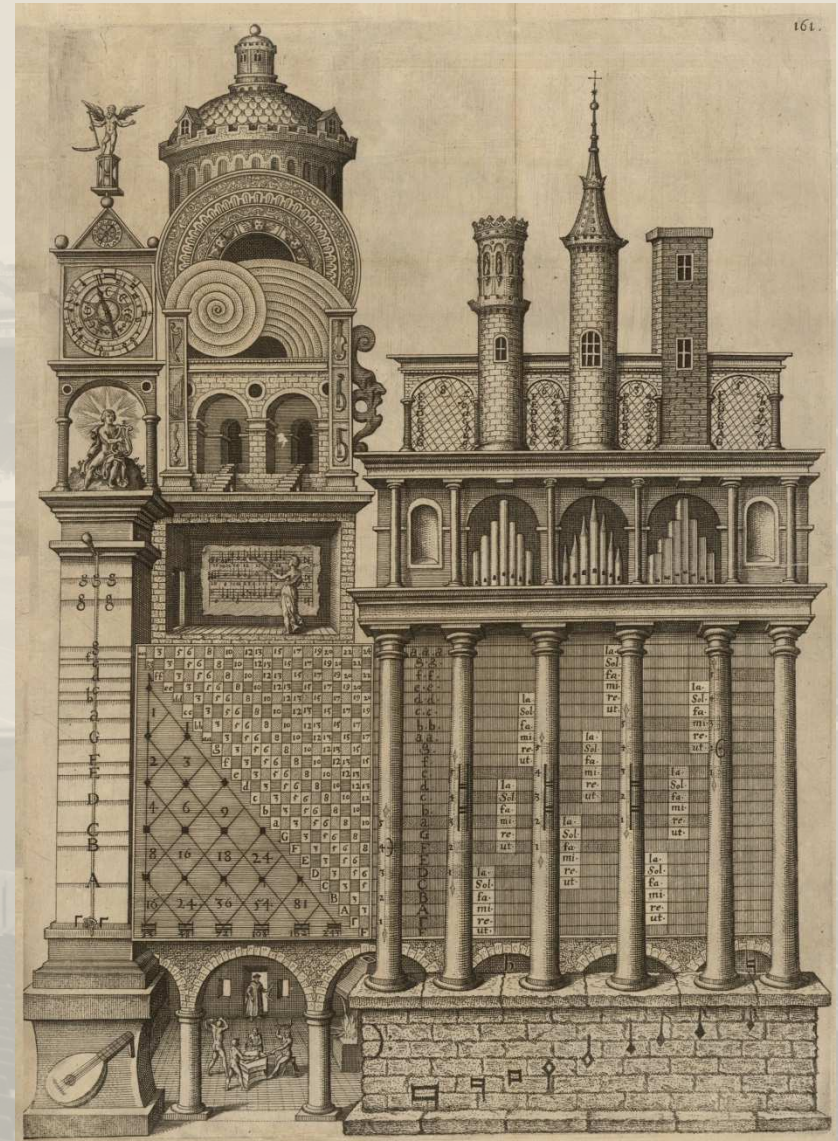
MUSEO VIRTUALE



CARTOTECA

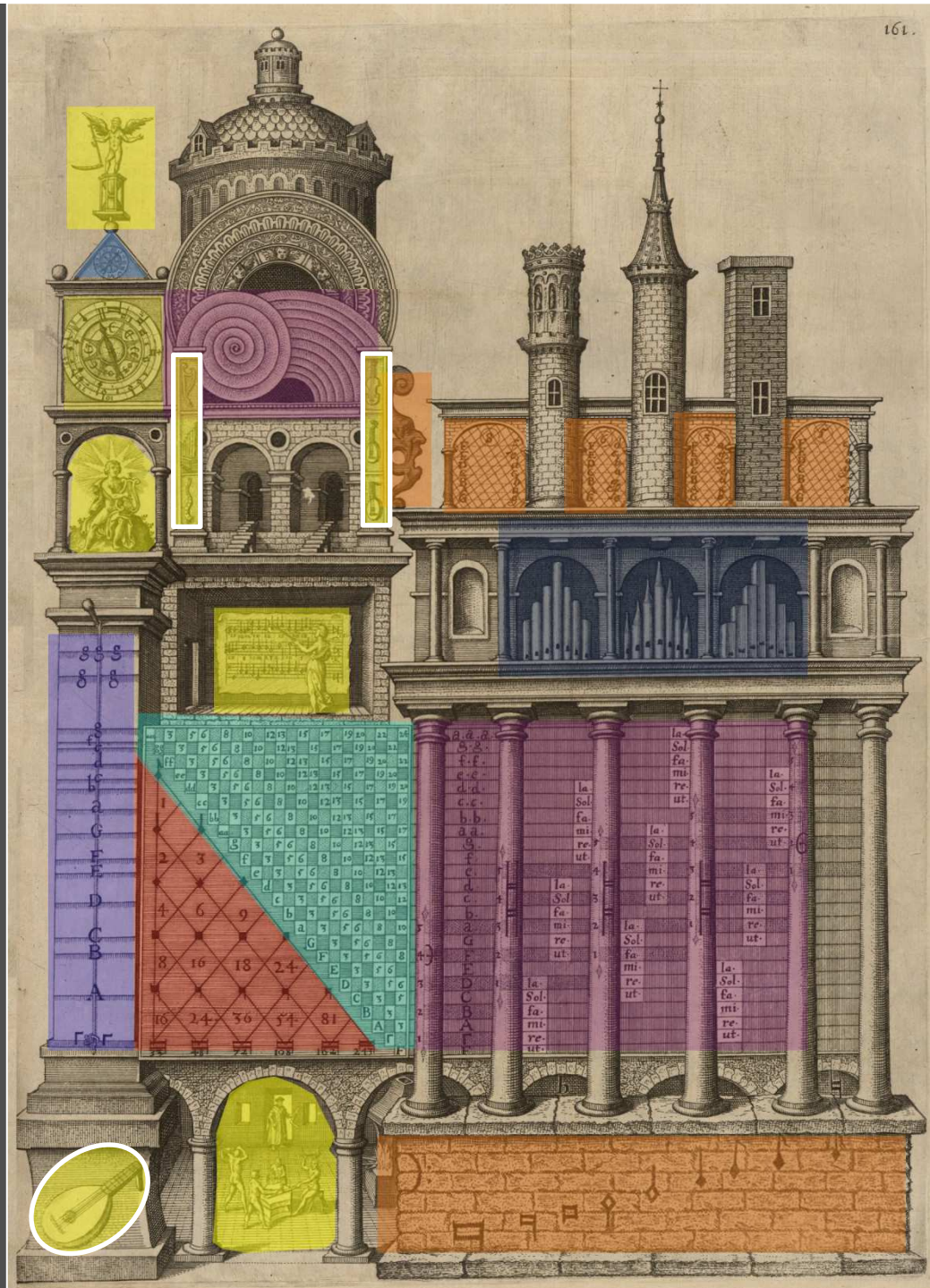
Partners

- Christoph Reuter (Wien)
- Benjamin Wardhaugh (Oxford)
- Sybille Krämer (Berlin)
- Gerhard Dirmoser (Linz)
- Robert Fludd (Oxford)

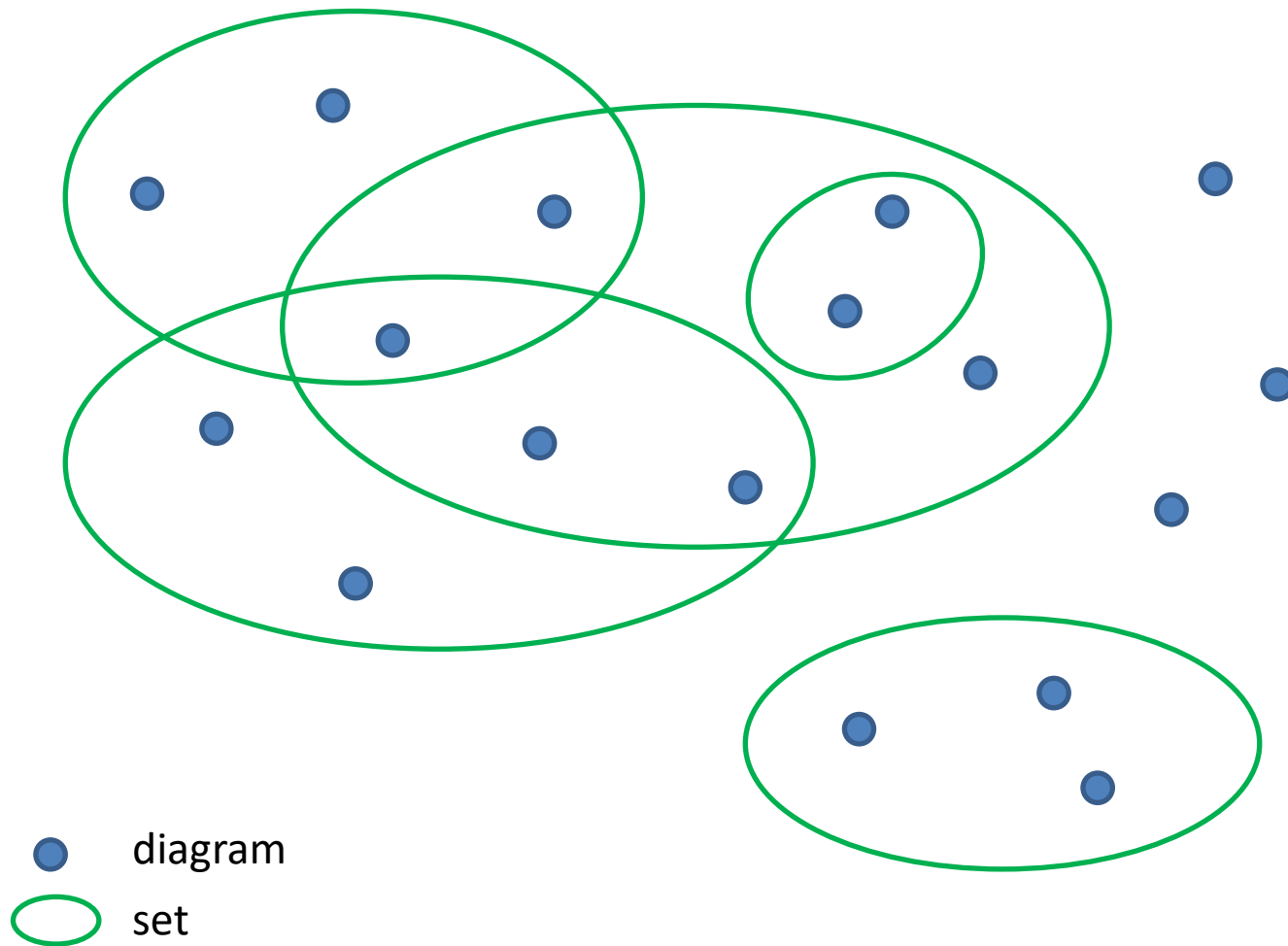


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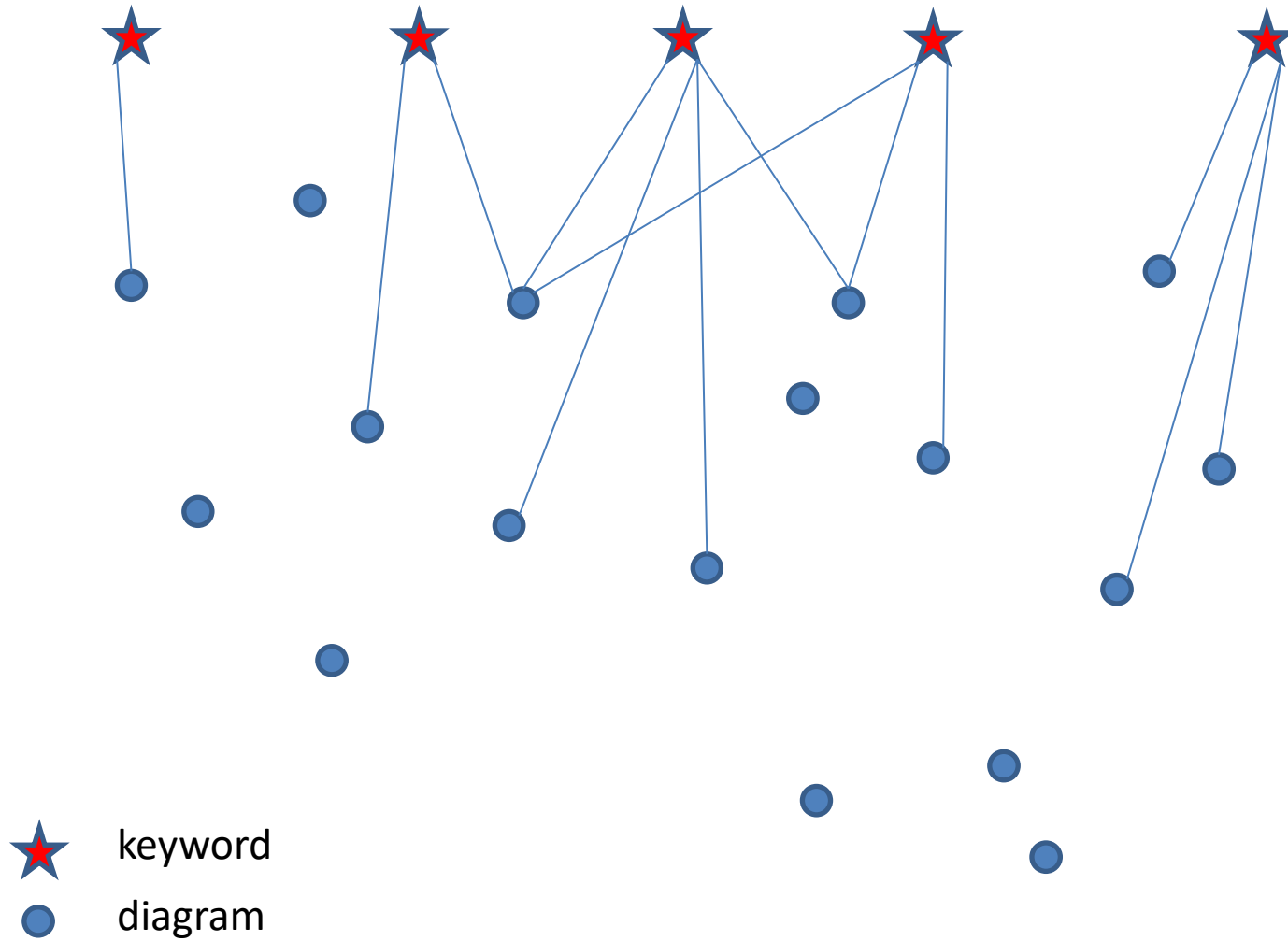
Robertus de
Fluctibus (1618)
Templum Musicæ



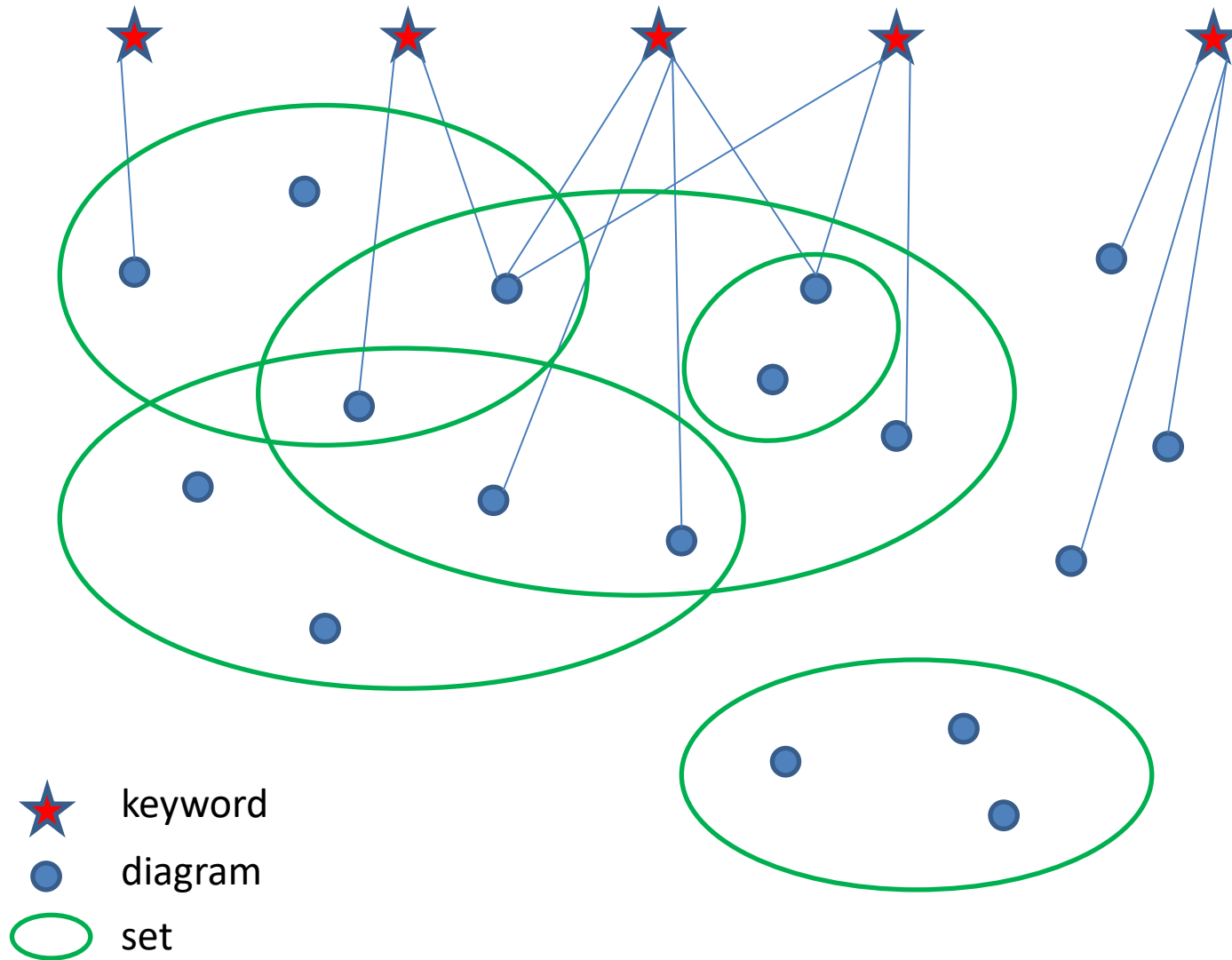
Diagrams and sets



Diagrams and keywords



Diagrams, sets & keywords



Diagrams

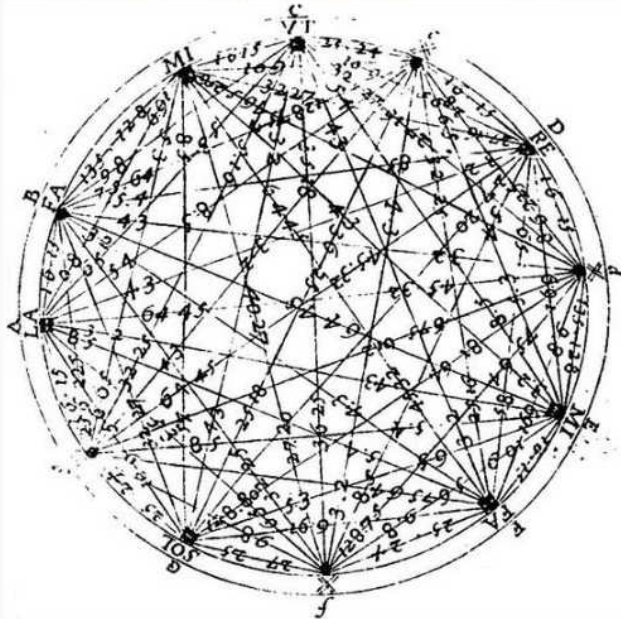
Keywords

Links to diagrams

Syntonic Chromatic Scale



Tags: circular pitch diagram, kappa-12, syntonic chromatic scale



Syntonic chromatic scale of twelve notes arranged on a circle. The structure of the scale is different from [210]. It has four different semitones:

Chromatic semitones: 25:24 and 135:128

Diatonic semitones: 16:15 and 27:25.

The arrangement of the notes on the circle reflects a logarithmic understanding of pitch. However, the angles are neither equal to 30° (12-tet) nor do they express the four different sizes of the semitones.

The resulting scale is C-C#-D-Eb-E-F-F#-G-G#-A-Bb-B-C. Mersenne uses only sharps as alteration signs. The underlying C-major scale has a flat second degree and is of the form t-T-S-T-t-T-S, so that the solmisation agrees with Descartes's solmisation [316, 208, 209].

A solmisation syllable is given for both Bb (B-FA) and B (MI).

The diagram is a complete analysis of the scale, where for each pair of notes (except for the semitones) both possible ratios are indicated on the connecting line. For example, B-D (MI-RE) has the ratios 32:27 and 27:16 corresponding to a Pythagorean minor third and a Pythagorean major sixth.

This diagram was probably inspired by a similar diagram for the syntonic diatonic scale by Johannes Lippius (1612) [515]. Mersenne's estimation of the octave as a multiple of the syntonic comma [210] has also its predecessor in Lippius: "Octava comprehendit Commata ultra quinquaginta" [Lippius 1612, fol. C7r].

Related sets:

Combinations: kappa-n

Solmization

Syntonic chromatic scale

Source: Mersenne, Marin (1636), Harmonie Universelle, contenant la Theorie et la Pratique de la Musique, Paris 1636, Traitez des Consonances, des Dissonances, des Genres, des Modes & de la Composition, Livre Second, Des Dissonances, p. 132

Quotation

Set memberships

Sets

Links to diagrams

Link to experiment

Link to set

Elements of the set:
diagrams

Archive Sets Timeline Keywords Exhibitions Virtual Lab About

Syntonic chromatic scale




The task of defining a chromatic scale in the syntonic tone systems has many different solutions. Since C# and Db are different pitches in the syntonic system, it is not a priori clear that a chromatic scale should consist of twelve pitch classes. Suggestions by Fogliano [502] and Salinas [48,46] had 14, 15 or even 24 different pitches per octave.

Various chromatic scales with twelve notes were given by Kepler [559], Mersenne [211,212], Newton [75,76,77,78], Holder [222] and Euler [94,95].

The problem with these scales is that most of the diatonic scales on different keys are distorted forms of the original C-major scale: they contain fewer perfect major triads (4 : 5 : 6) and perfect minor triads (10 : 12 : 15). Positively said, the different keys have specific interval structures. For example, Holder's chromatic scale contains seven structurally different major triads. Experiment: [Syntonic Grid and Spiral]

Arthur von Oettingen (1917) proposed a syntonic tone system of 53 pitch classes [558], which contains 39 diatonic scales of the standard structure T-t-S-T-t-T-S, see [10029].

☰ ☲ ☱

Title / Author	Date	Diagram	Annotation
Keyboard: Divided Keys Giuseppe Zarlino	1562		Keyboard with 19 keys per octave. Each black key of the modern piano corresponds to a black and a white key. Furthermore, there are extra white keys between the...
Totius harmoniae vis hoc diagrammate fulget Francisco Salinas	1577		Chromatic scale of 24 pitch classes per octave. The indicated string lengths admit an interpretation in terms of Pythagorean fifths (3:2) and syntonic major thirds (5:4)....
Triangle over chromatic scale Francisco Salinas	1577		Chromatic scale of 14 pitch classes per octave. There are two ambiguous pitches D and b. #E should be read as Eb; it is a chromatic semitone (25:24) lower than E. There are fiv...

<http://sound-colour-space.zhdk.ch/sets/10027>

Keywords

Archive Sets Timeline **Keywords** Exhibitions Virtual Lab About

«bisection of musical intervals»

back

Dividing an interval in two equal halves. The ratio of the halved interval is the square root of the ratio of the given interval, usually an irrational value. It is impossible to divide an interval of a superparticular ratio, as 3:2 or 5:4, into equal parts with a rational ratio.



Title / Author	Date	Diagram	Annotation
Bisection of the syntonic comma Lodovico Fogliano	1529		By using Euclid's altitude theorem the geometric mean of the line segments of lengths 80 and 81 is constructed. In other words, the syntonic comma is halved geometrically. This ca...
Geometric division of musical intervals Jacobus Faber Stapulensis	1551		The construction is used to illustrate that any ratio can be divided geometrically, so that the given musical interval is exactly halved:


<http://sound-colour-space.zhdk.ch/keywords/bisection-of-musical-intervals>

Exhibitions


Sound Colour Space - A Virtual Museum

Archive Sets Timeline Keywords Exhibitions Virtual Lab About


Chromatic Scales



Circular Pitch Diagrams

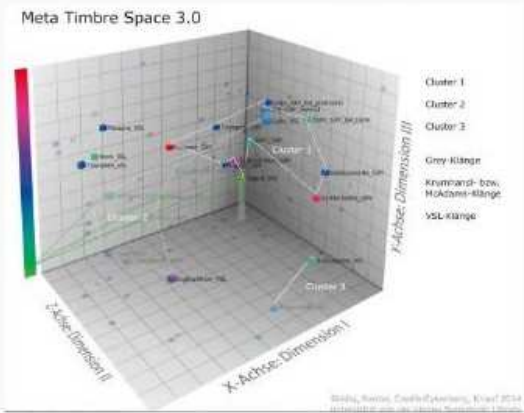


Gerhard Dirmoser



Timbre Spaces

Meta Timbre Space 3.0



Cluster 1
Cluster 2
Cluster 3
Grey Klänge
Klavier- bzw. Holzblas-Klänge
VSL-Klänge

© 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022, 2023, 2024
www.sound-colour-space.zhdk.ch

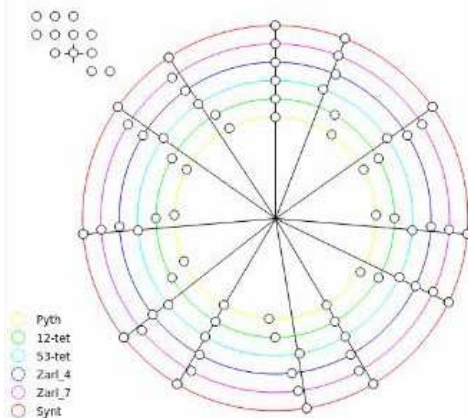
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Experiments

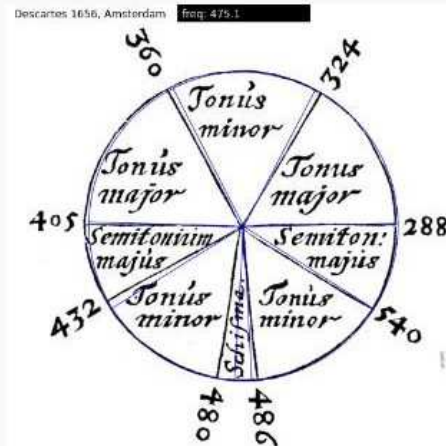
Sound Colour Space - A Virtual Museum

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Chromatic scales



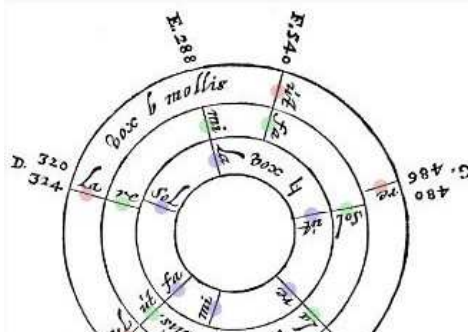
Descartes - Diatonic Scale 1



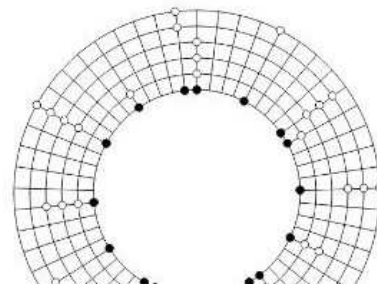
Descartes - Diatonic Scale 2



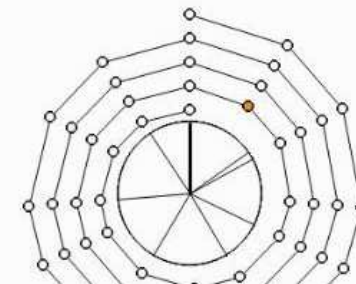
Descartes Hexachord Circles



Newton's tone system



Syntonic Grid and Spiral



<http://sound-colour-space.zhdk.ch/virtuallab>

Experiment: Syntonic Grid and Spiral

Archive Sets Timeline Keywords Exhibitions Virtual Lab About

Syntonic Grid and Spiral

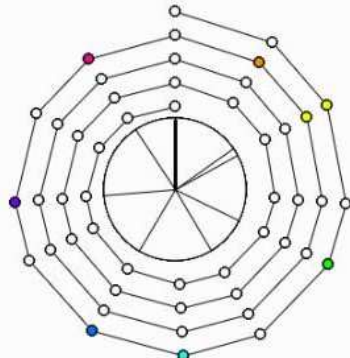
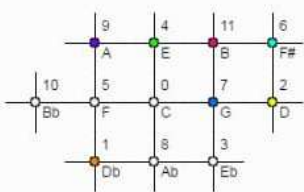
In the syntonic tone system, defined by Pythagorean fifths (3:2) and major thirds (5:4), there are many ways to define a chromatic scale [10027]. Two scales given by Salinas have 14 and 24 pitches per octave. With 24 pitches also the Greek tone system can be mapped. The scale with 14 pitches has two ambiguous notes, D and Bb, each with two pitches separated by a syntonic comma.

Kepler, Mersenne, Newton, Holder and Euler gave different solutions for chromatic scales with 12 pitches per octave. Necessarily, there are only few keys in these chromatic tone systems which realise the diatonic scale in its best form.

With the interactive application the different chromatic scales can be explored systematically. The user can choose between single tones and various chords to be played simultaneously at different pitches. When the tones are clicked with the right mouse button, the chords and scales are played successively up and down. The tones are shown and played in the syntonic grid (one octave) and on the spiral (four octaves). The pitch classes are given saturated colours (HSB): C = red, C# = orange, D = yellow, ...

Furthermore, there is a short musical example with two voices, which can be transposed into different keys [+/-] in order to make the distortions audible. The example can also be played in a syntonic tone system of 53 pitches per octave "chi_53", which contains 39 diatonic scales of the standard structure. An equivalent scale with D in the centre was proposed by Arthur von Oettingen (1917) [558].

Mersenne 1 diatonic scale JSB: 0 + -



Settings

Audio

on

Base-Frequency (Hz):
180

Oscillator

Choose type:
triangle

hold

volume:

attack:

decay:

sustain:

release:

Master

volume:

Archive

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Search

Match: All of the terms

Author Descartes

Fulltext hexachord

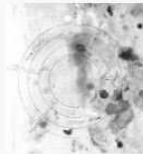

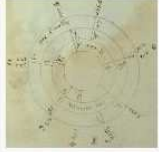

Add search field

Refine Search

Date (oldest first)

Search

8 results for: Descartes AND hexachord

Title / Author	Date	Diagram	Annotation
Hexachords René Descartes	1627-28		At first sight, this diagram seems to be the most accurate of the Middelburg manuscript. However, the fifth E-B is on the vertical diameter of the circle and the semitone B-C is muc...
Hexachords René Descartes	1635		
Hexachords René Descartes	1640		This diagram necessarily distinguishes the major from the minor tones.
Hexachords René Descartes	1650		

<http://sound-colour-space.zhdk.ch/archive>

Timeline

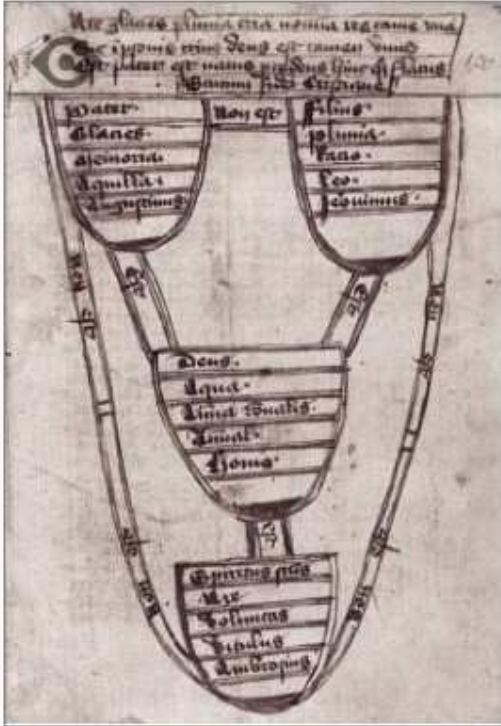
Sound Colour Space - A Virtual Museum

Archive Sets **Timeline** Keywords Exhibitions Virtual Lab About

15th century

10th
13th
14th
15th
16th
17th
18th
19th
20th

Scutum fidei
Christianae



Arithmetic, geometric

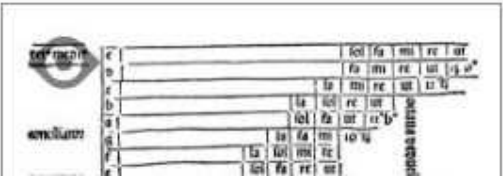
Musical wheel

1492

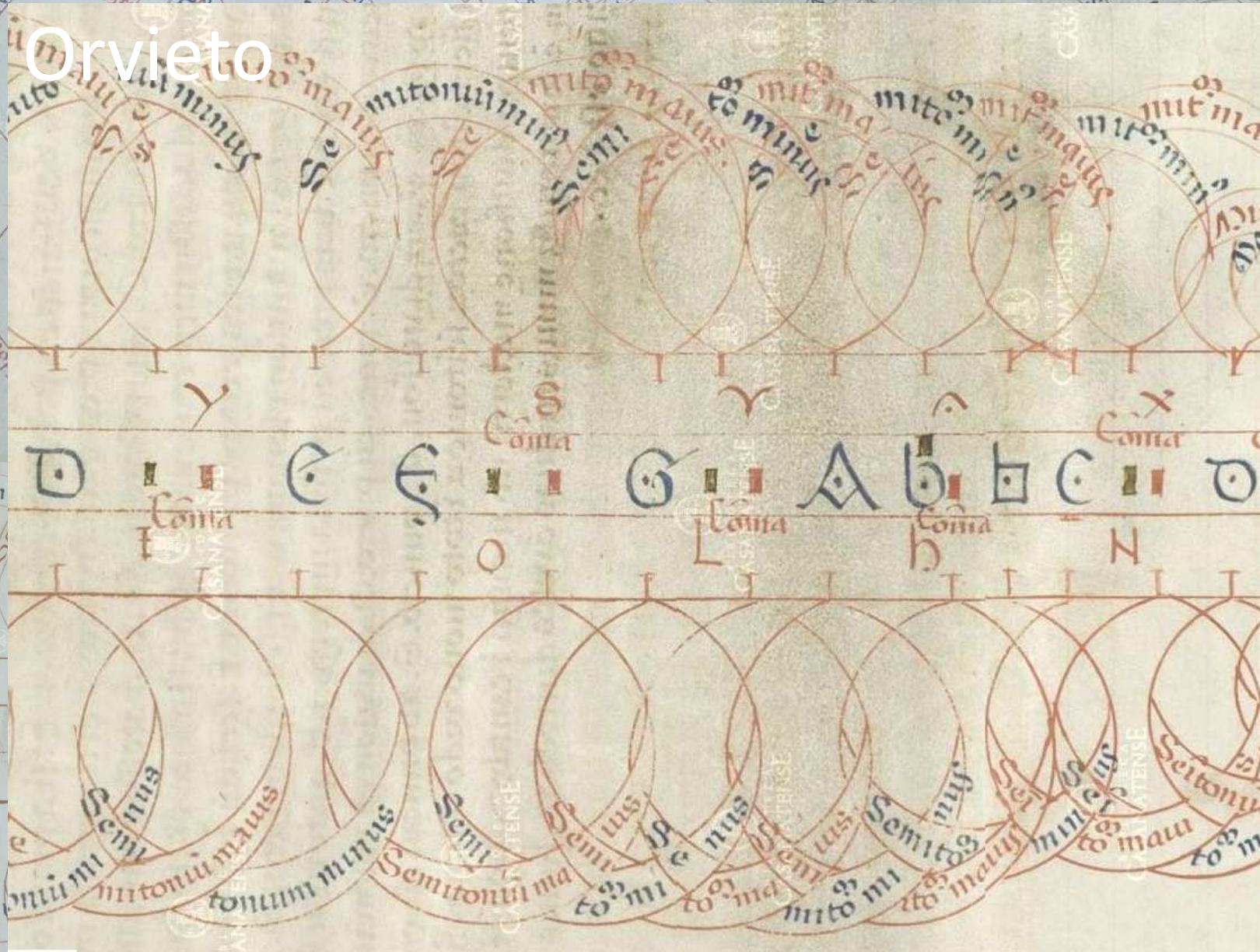
Domingo Marcos Durán

Extension of Guido of Arezzo's hexachord system. Three octaves of a diatonic scale G-A-Bb-C-D-Eb-F are arranged anticlockwise around a circle. From each of these pitches a hexachord ut-re-mi-fa-sol-la

Hexachords of musica ficta

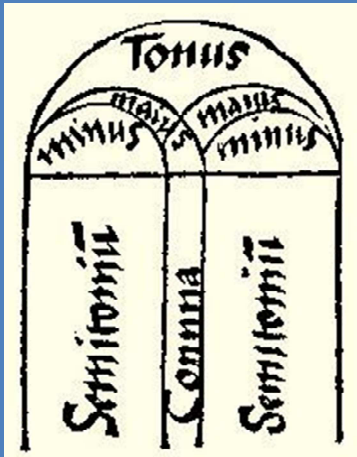


Ugolino di Orvieto



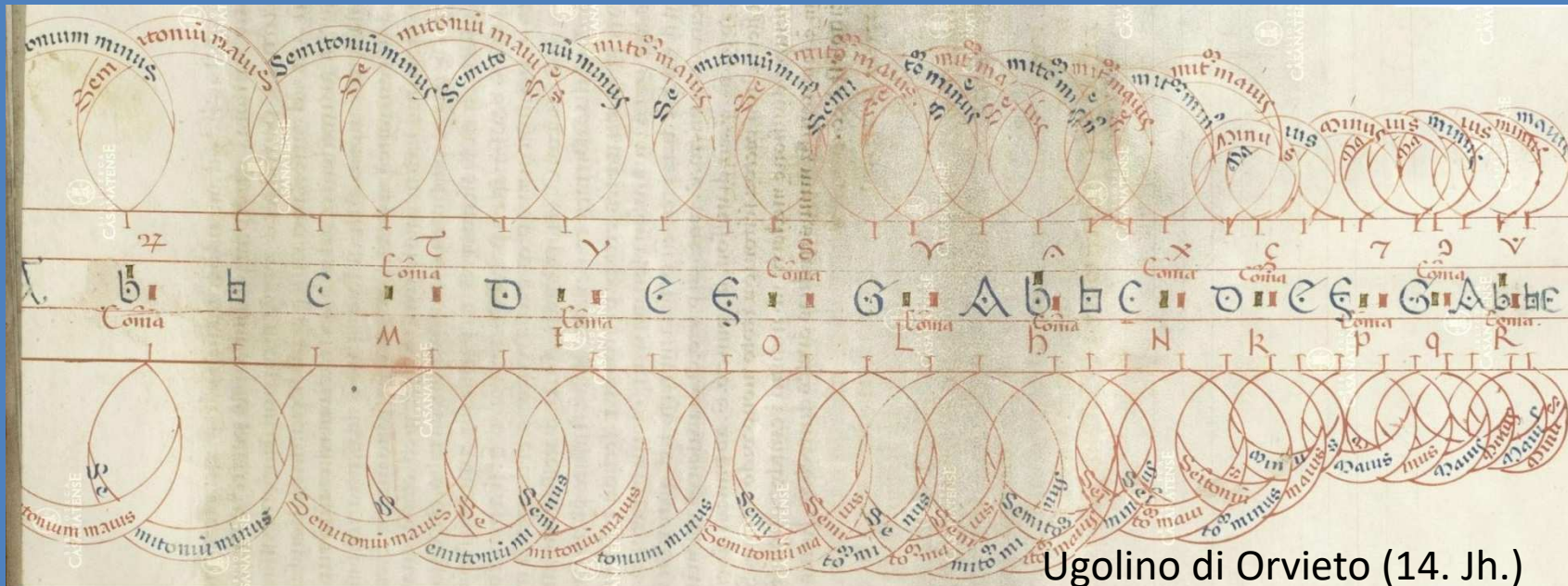
Sistema enarmonica pitagorico divisione simmetrico del tuono

Cochlaeus (1512)



Tonus =
2 semitoni minori
+ 1 comma pitagorico

Ottava =
5 Tuoni + 2 semitoni =
12 semitoni + 5 commata
17 cromata pitagorici *)

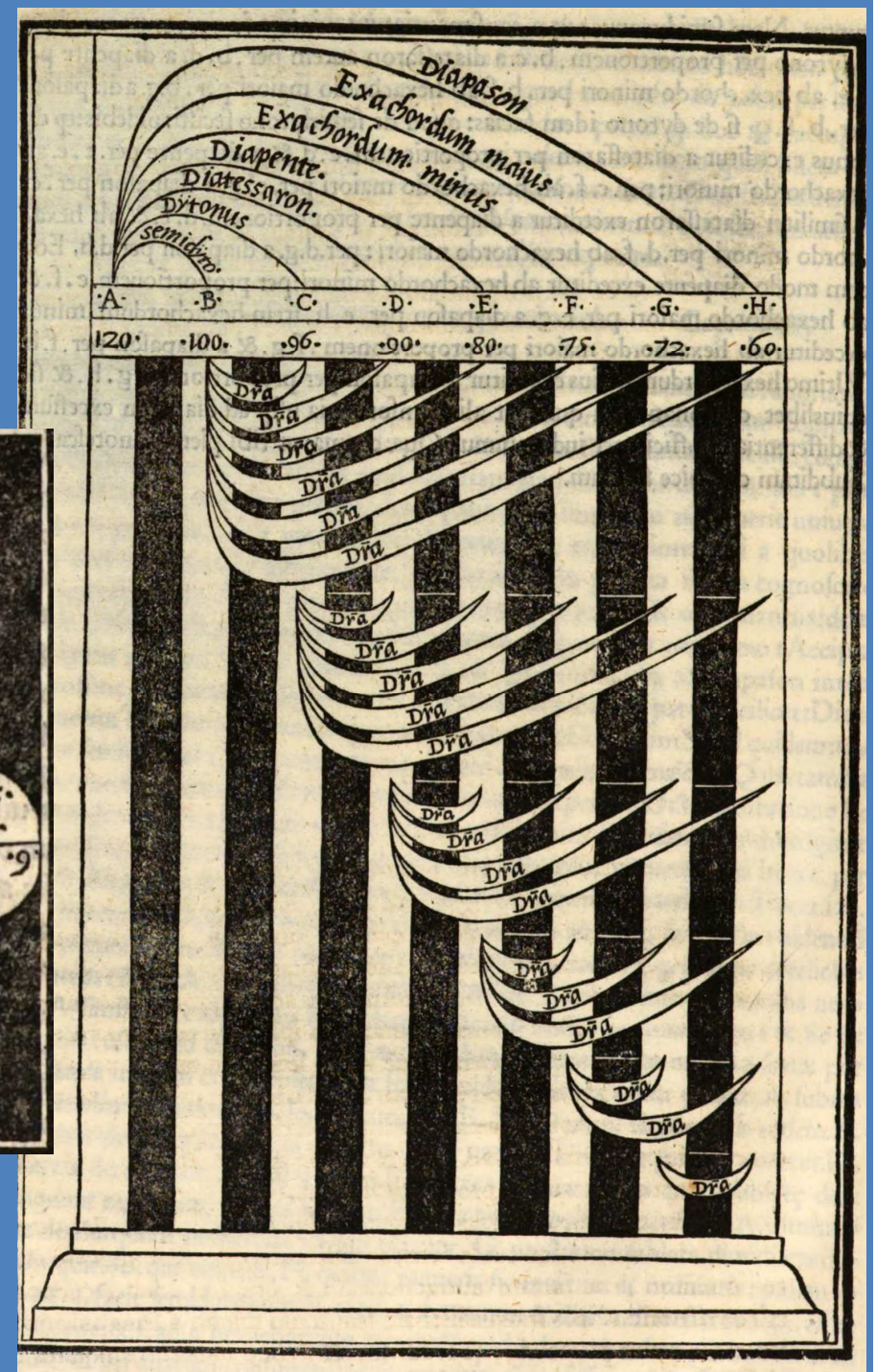
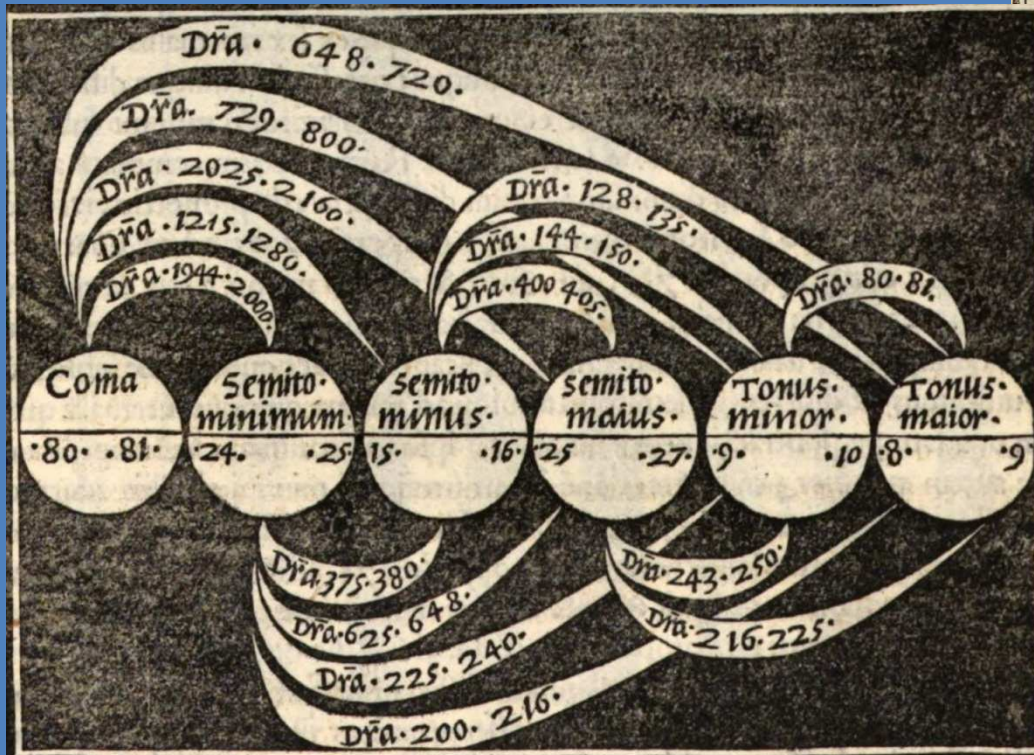


Ugolino di Orvieto (14. Jh.)

*) croma = pitch class mod octave

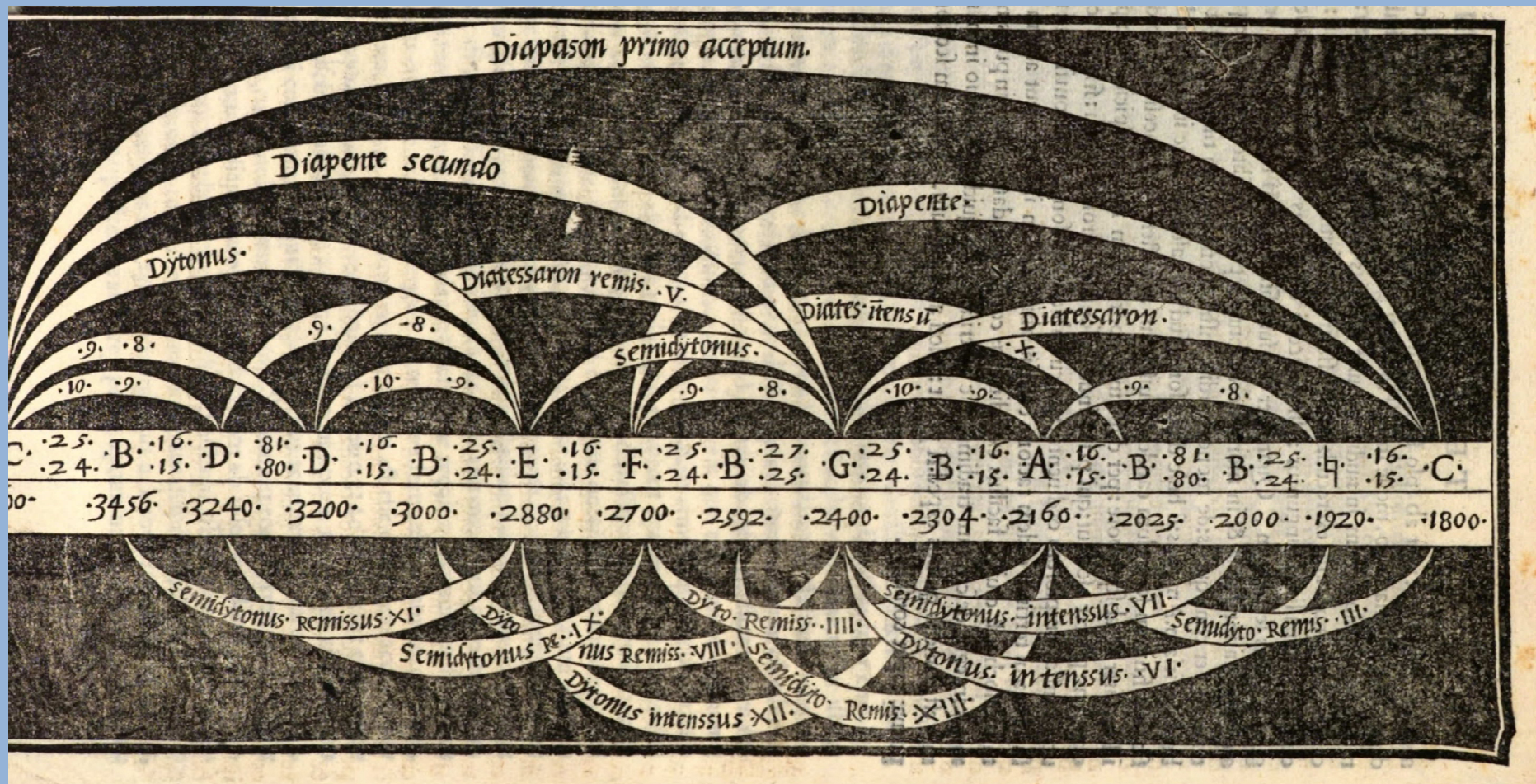
Lodovico Fogliano (1529)

just intonation: complete graphs

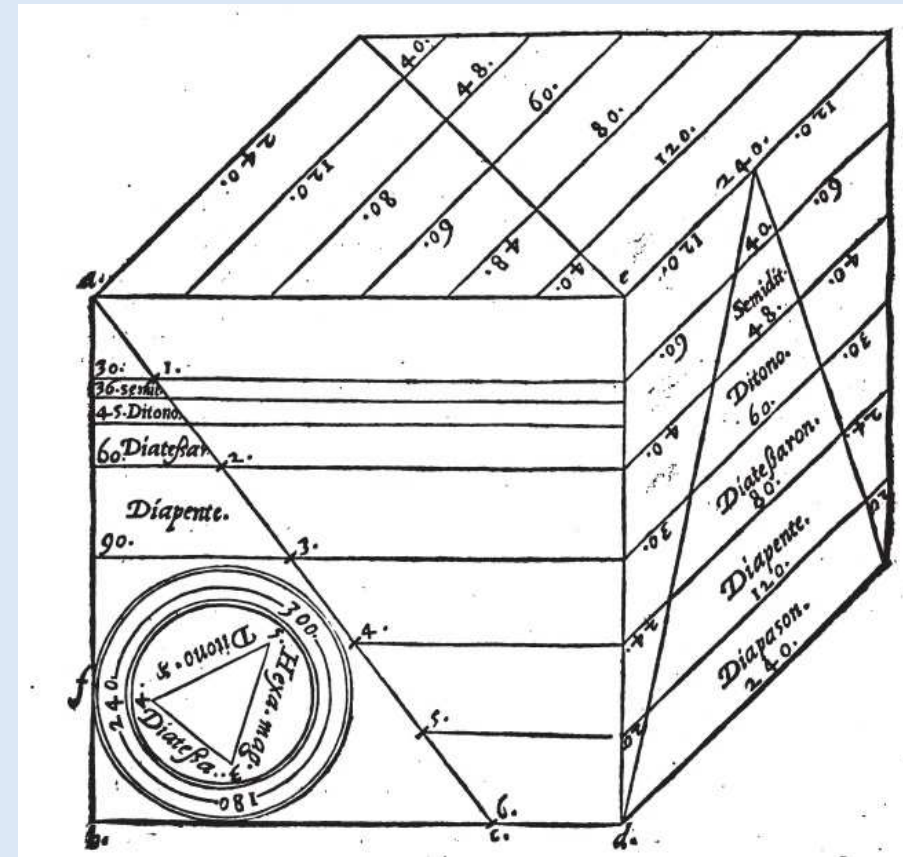
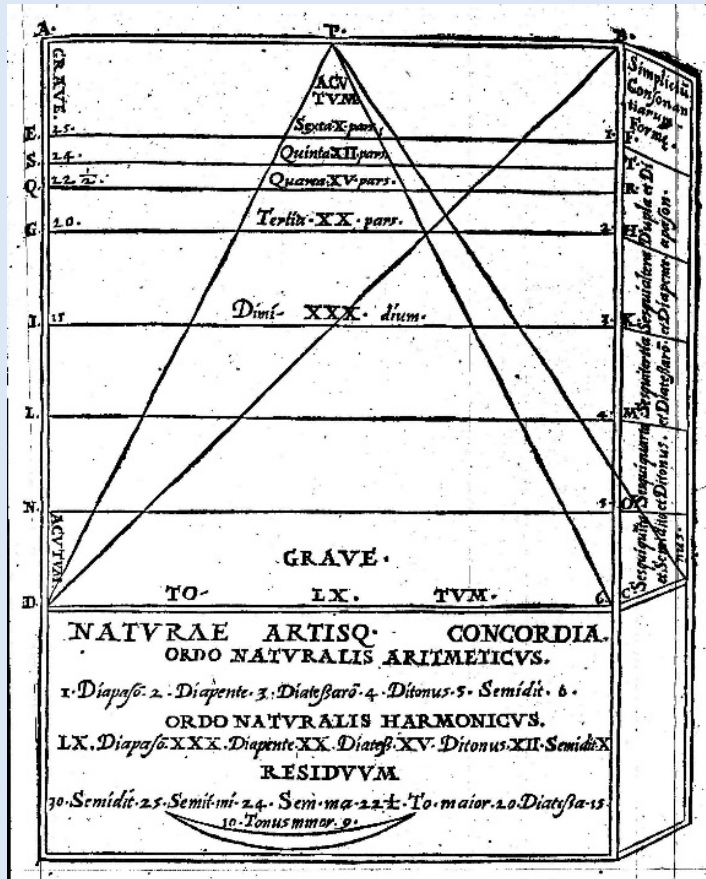


Lodovico Fogliano (1529)

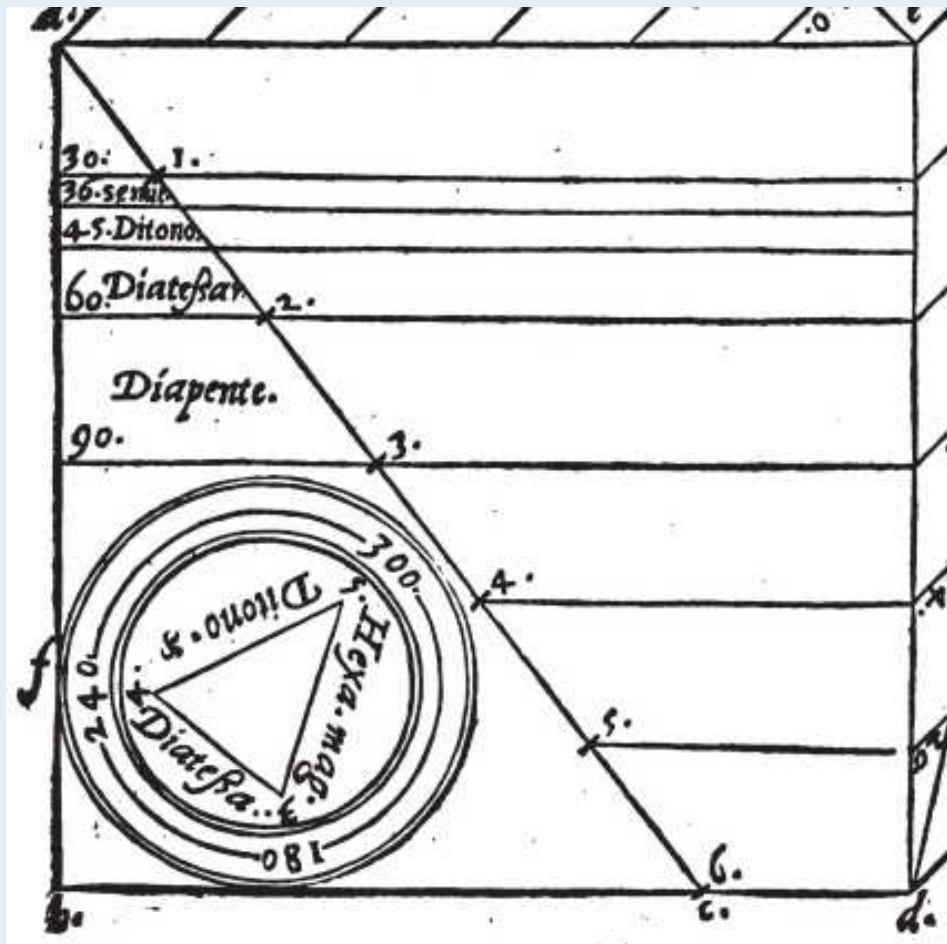
Monochordi in puris numeris rationi tantum subjecta Divisio



Gioseffo Zarlino: Heliconae



Zarlino interattivo (2020)



[Zarlino: Helicon/Volvelle: synthetic](#)

Daniel Muzzolini (2019)

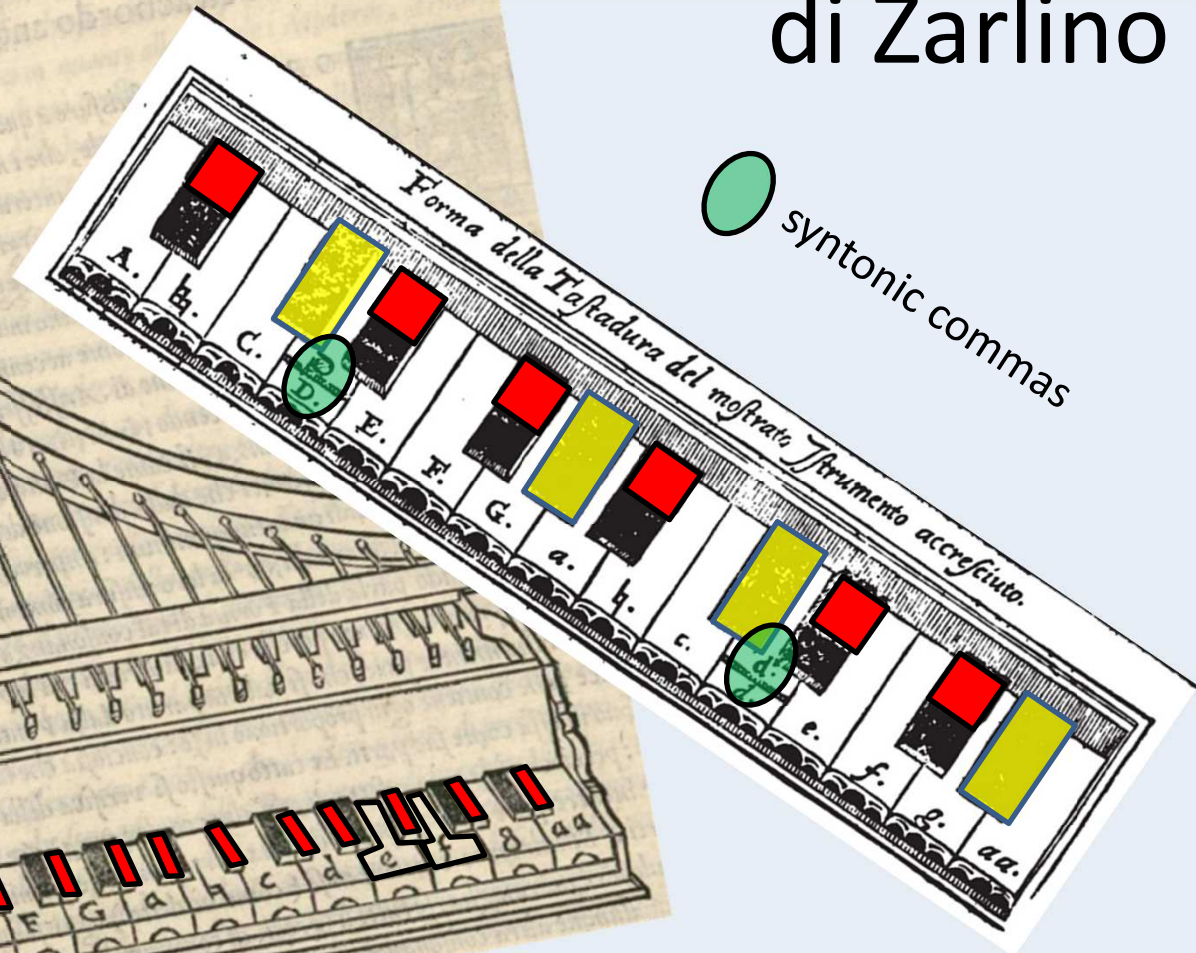
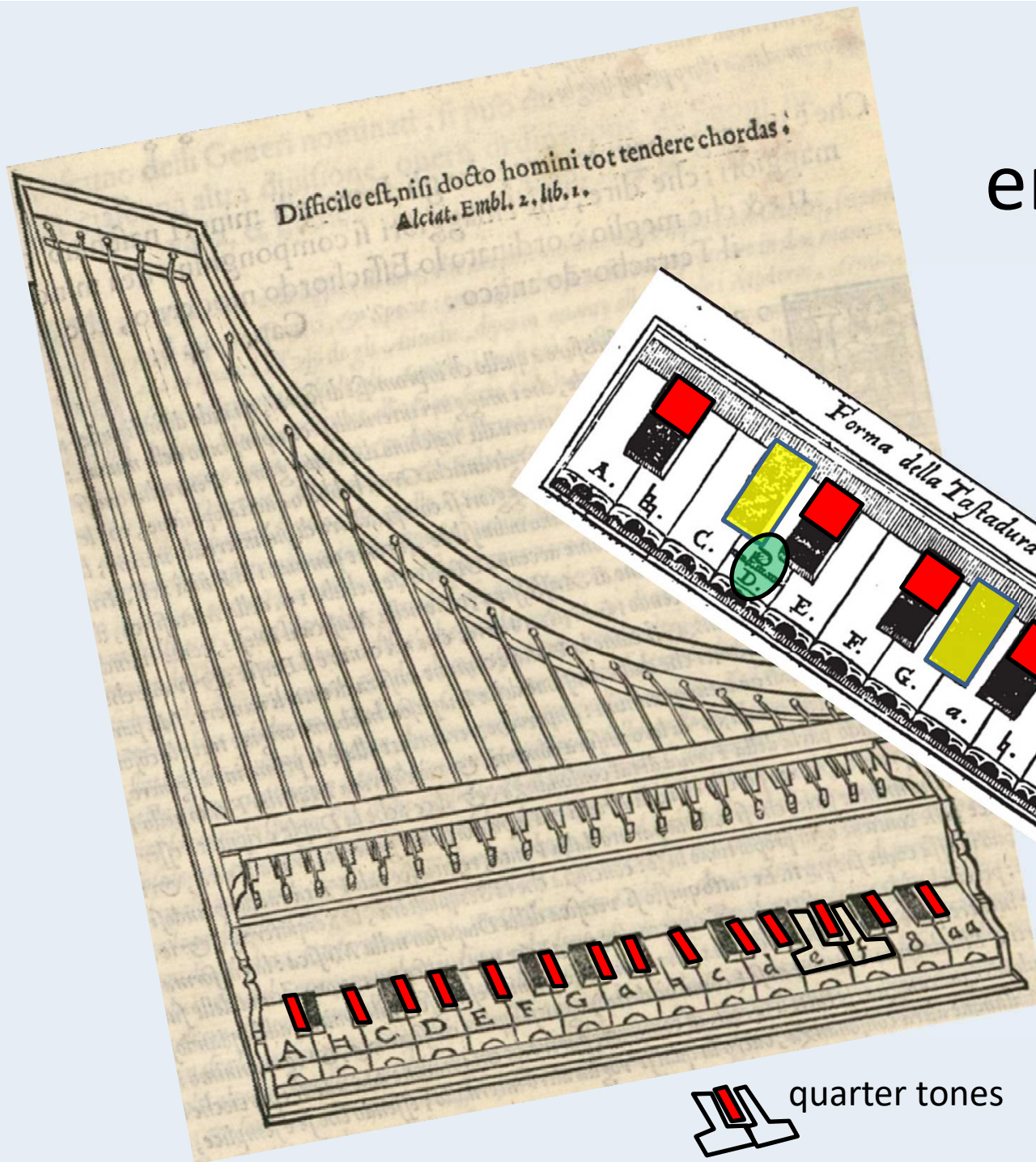
[Zarlino: Helicon/Volvelle: analog](#)

Daniel Muzzolini (2020)


<https://muwiserver.synology.me/zarlino/>

Christoph Reuter 2020. Polyphonic Clavichord with 19 just intonation pitches per octave (approximated through 53-EDO)

Tastiere enarmoniche di Zarlino

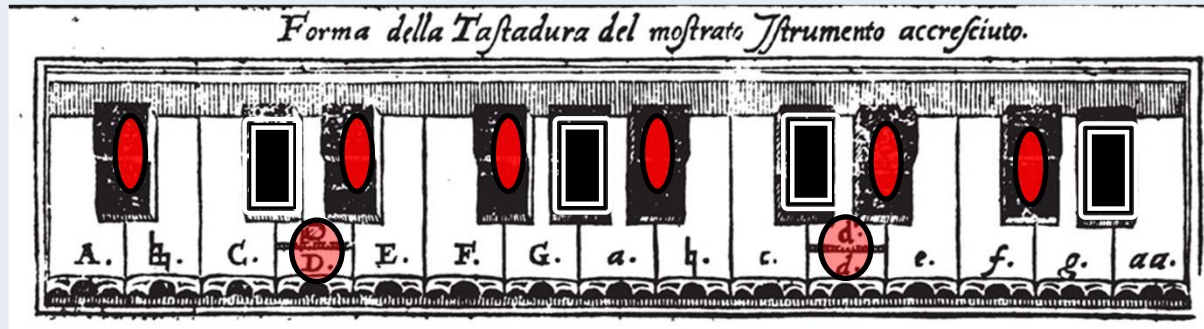





○ syntonic commas

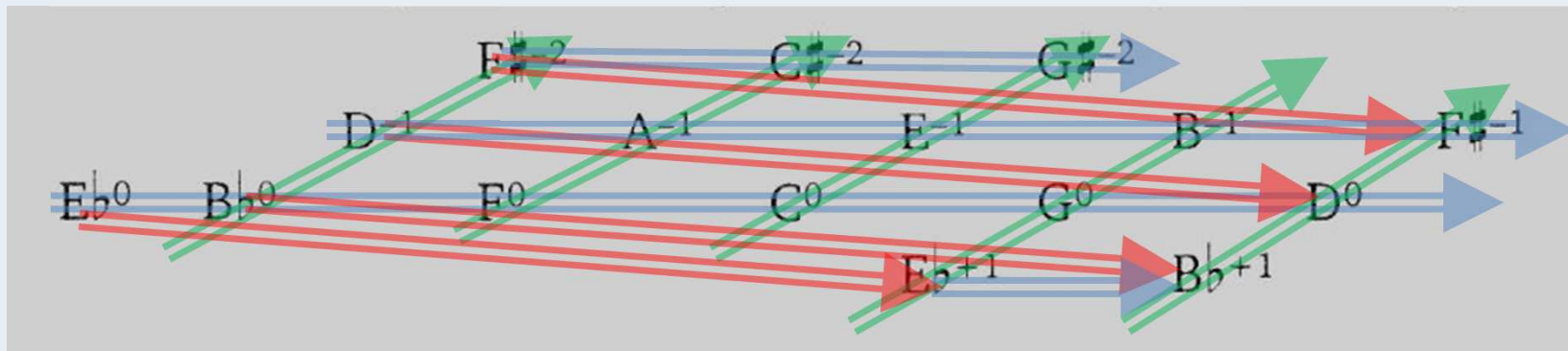
 quarter tones

 enharmonic changes

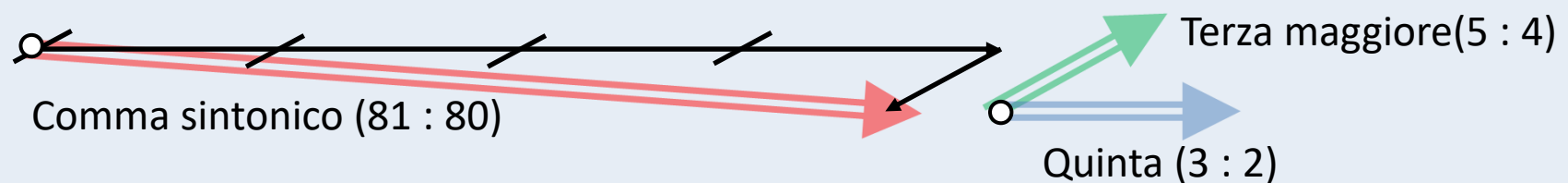
Tastiera con 16 suoni sintonici per ottava



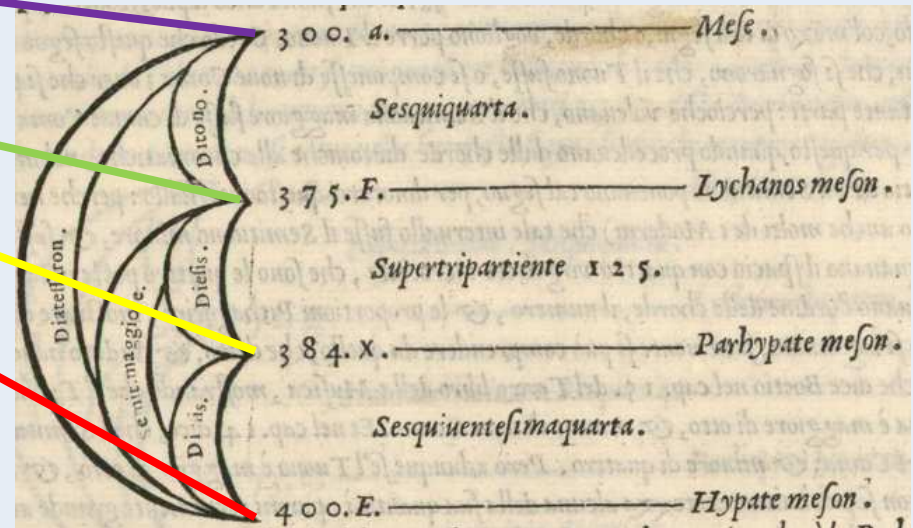
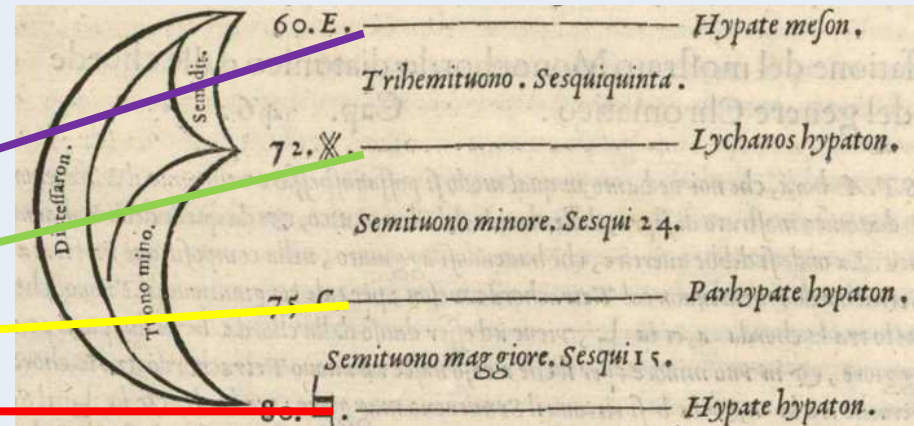
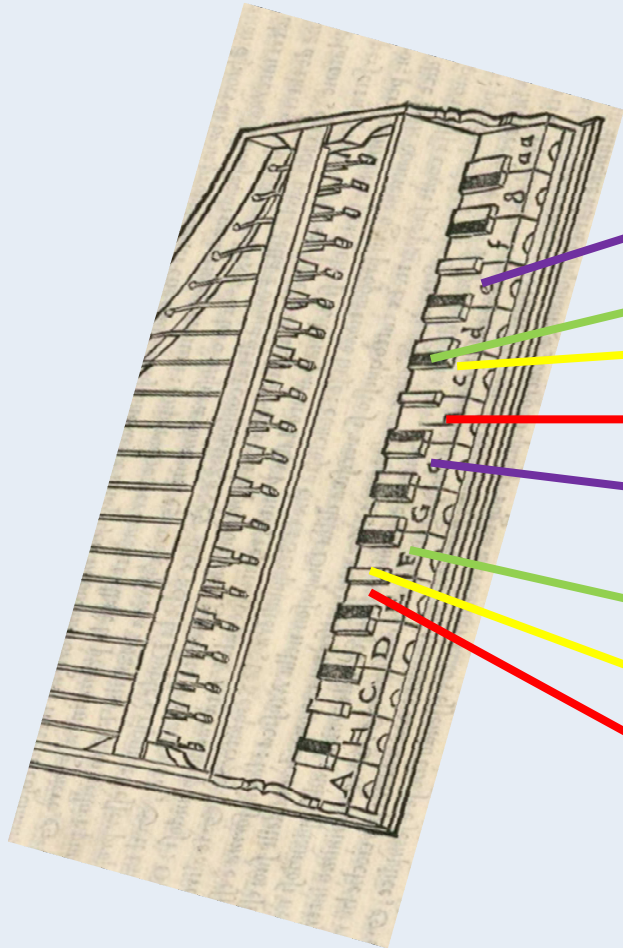
-  comma sintonico (81:80)
-  (81:80)
-  Singleton (1 : 1)



Interpretatione di Patrizio Barbieri (2002, p. 161)



Zarlino_19: syntonico?



Mapping: Zarlino 16 – 19 via 53-EDO

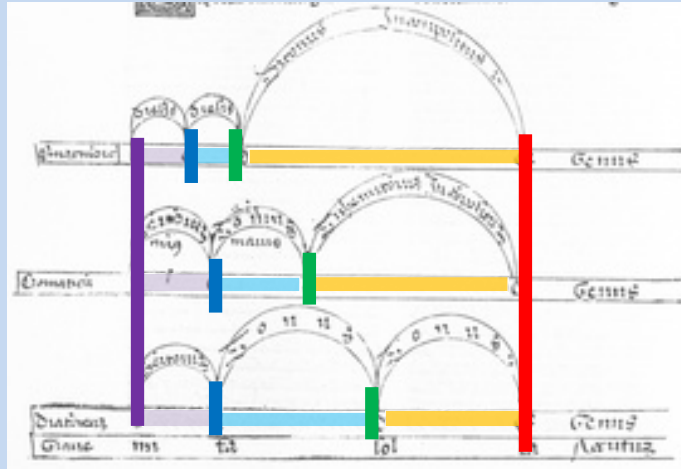
[Analoge Hellicona/Volvelles](#)

[analog, 2020 Klavier/53-EDO Clavichord]

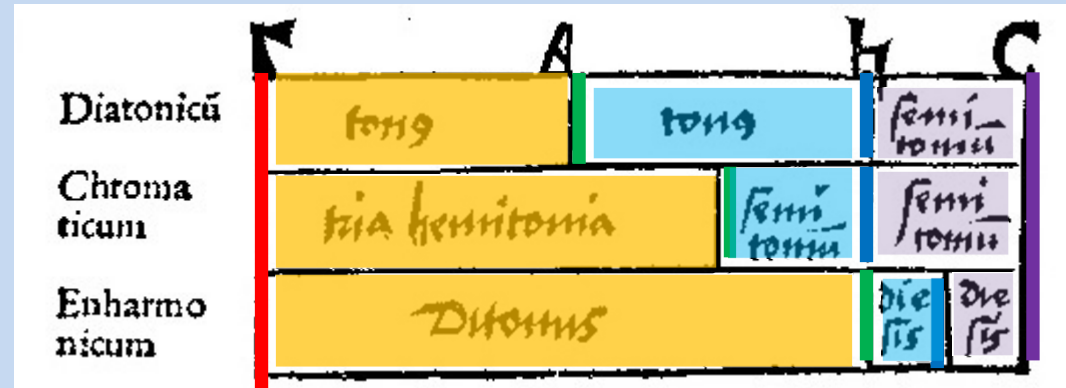
[Keyboard mapping: Zarlino 19 => Zarlino 16](#)

[Keyboard-Vergleich zweier Tastaturen bei Zarlino]

Greek Tetrachords



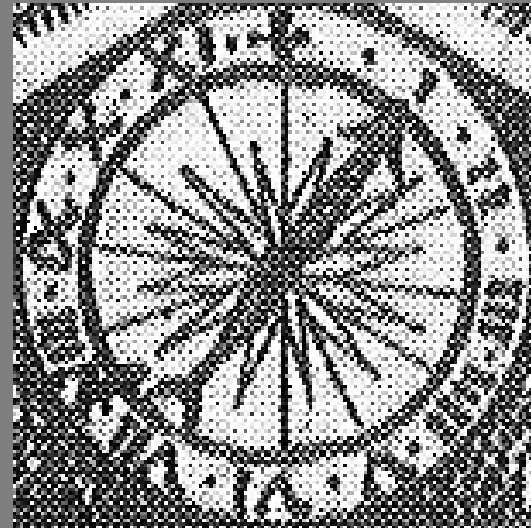
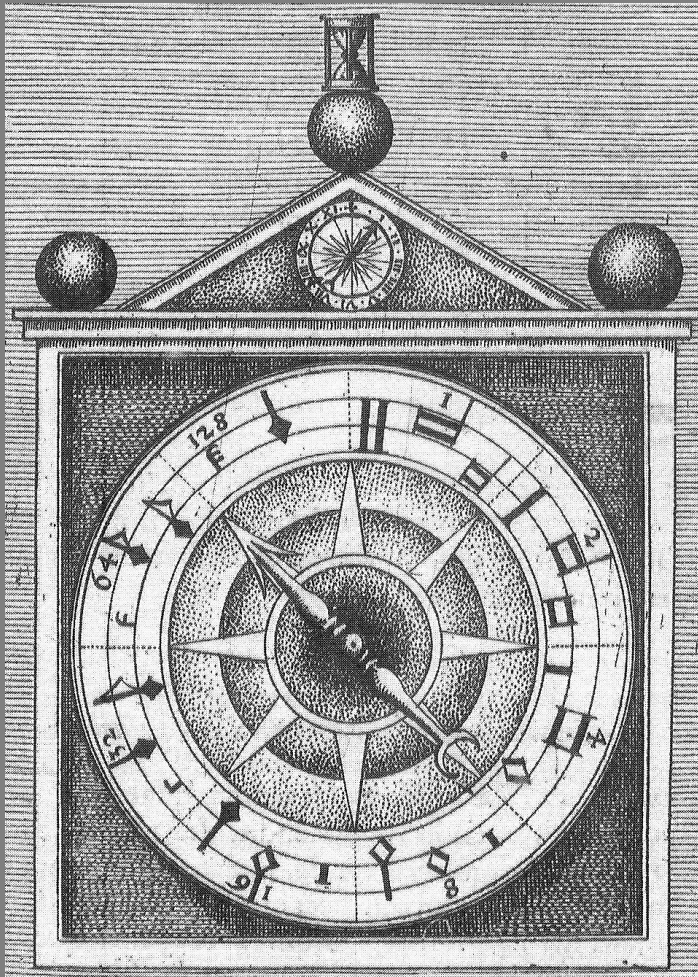
Guillermo de Podio (1495)



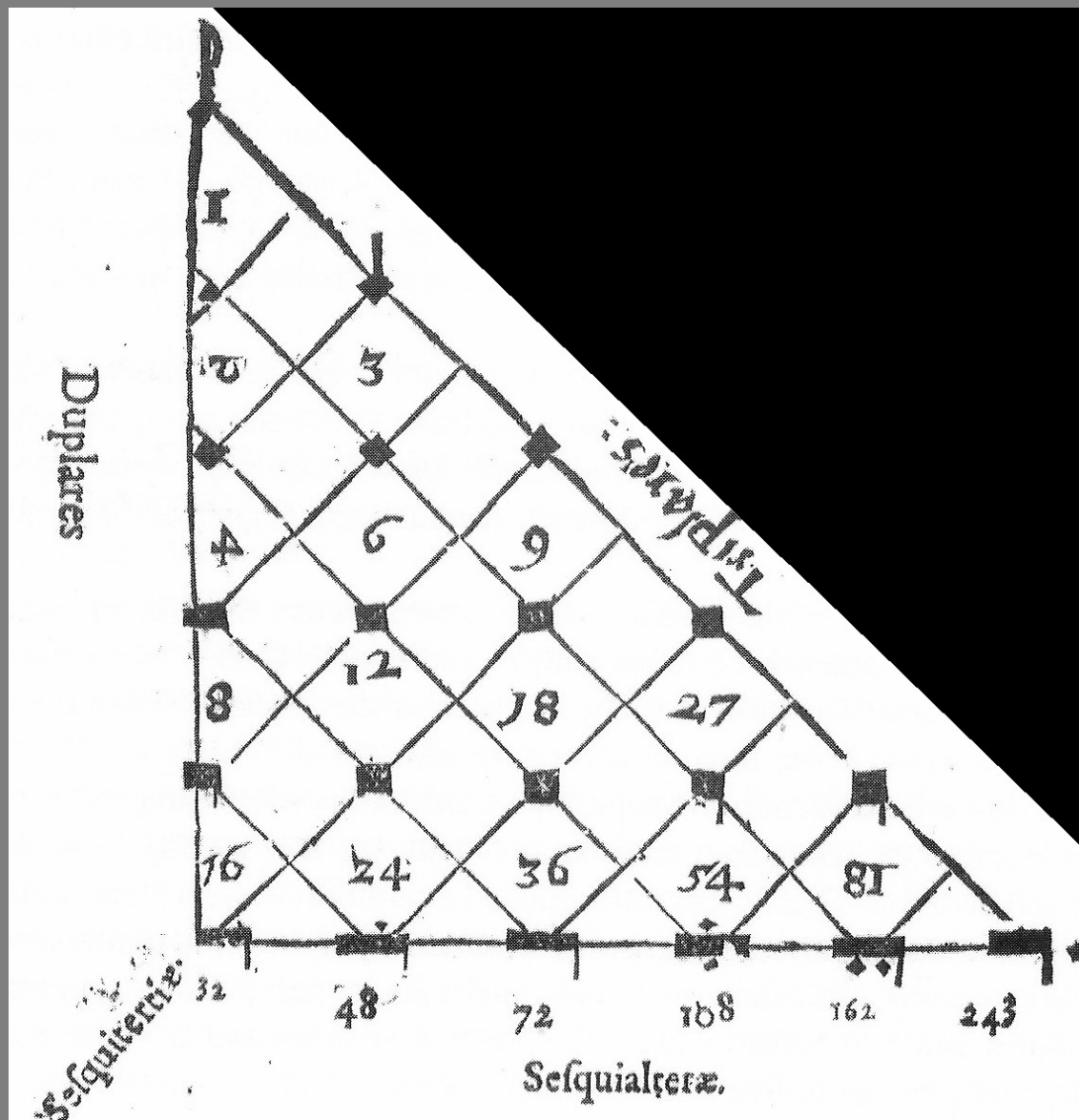
Johannes Cochlaeus

Fludd: binary durations

[←]



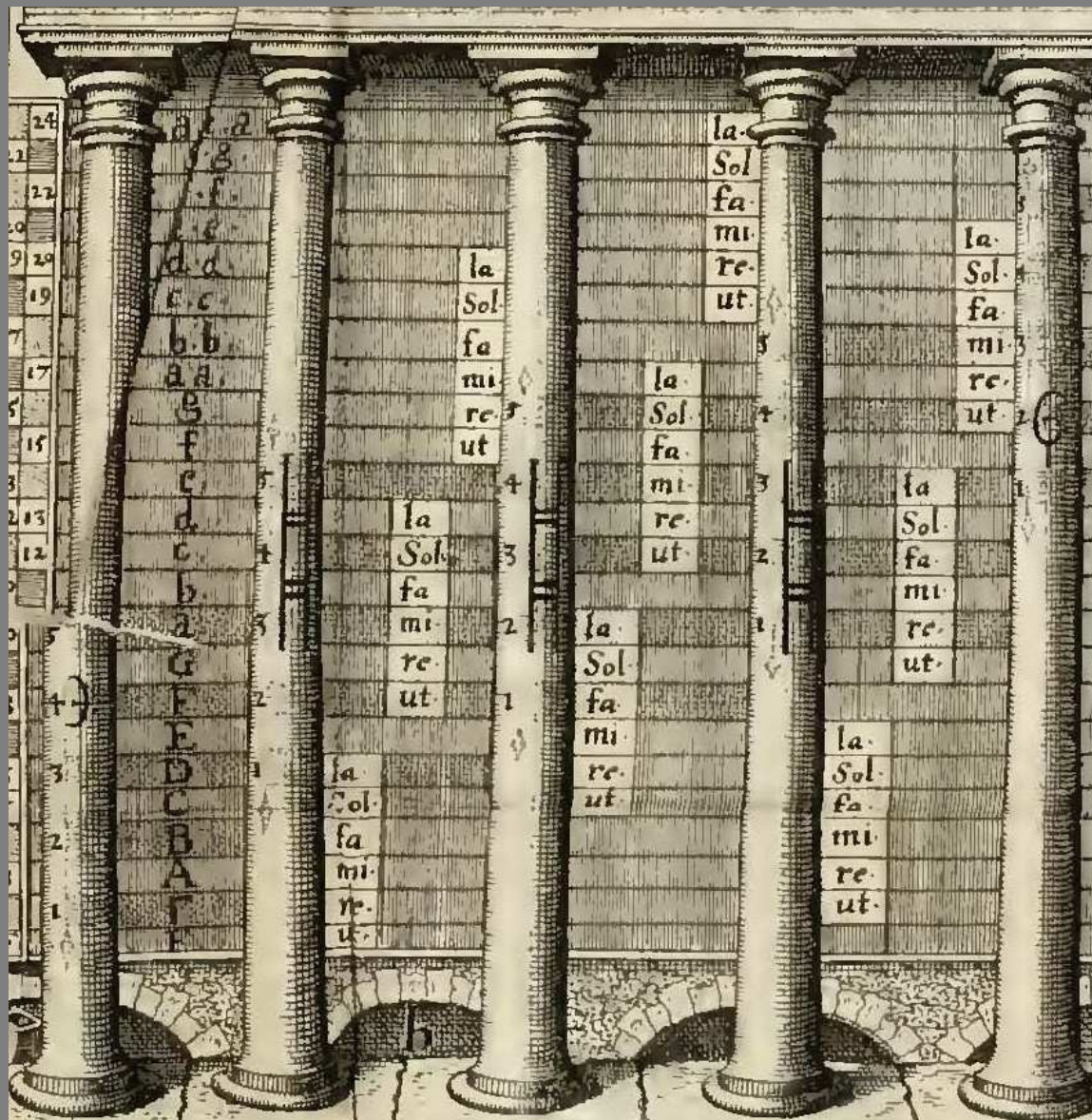
Fludd: lower triangle



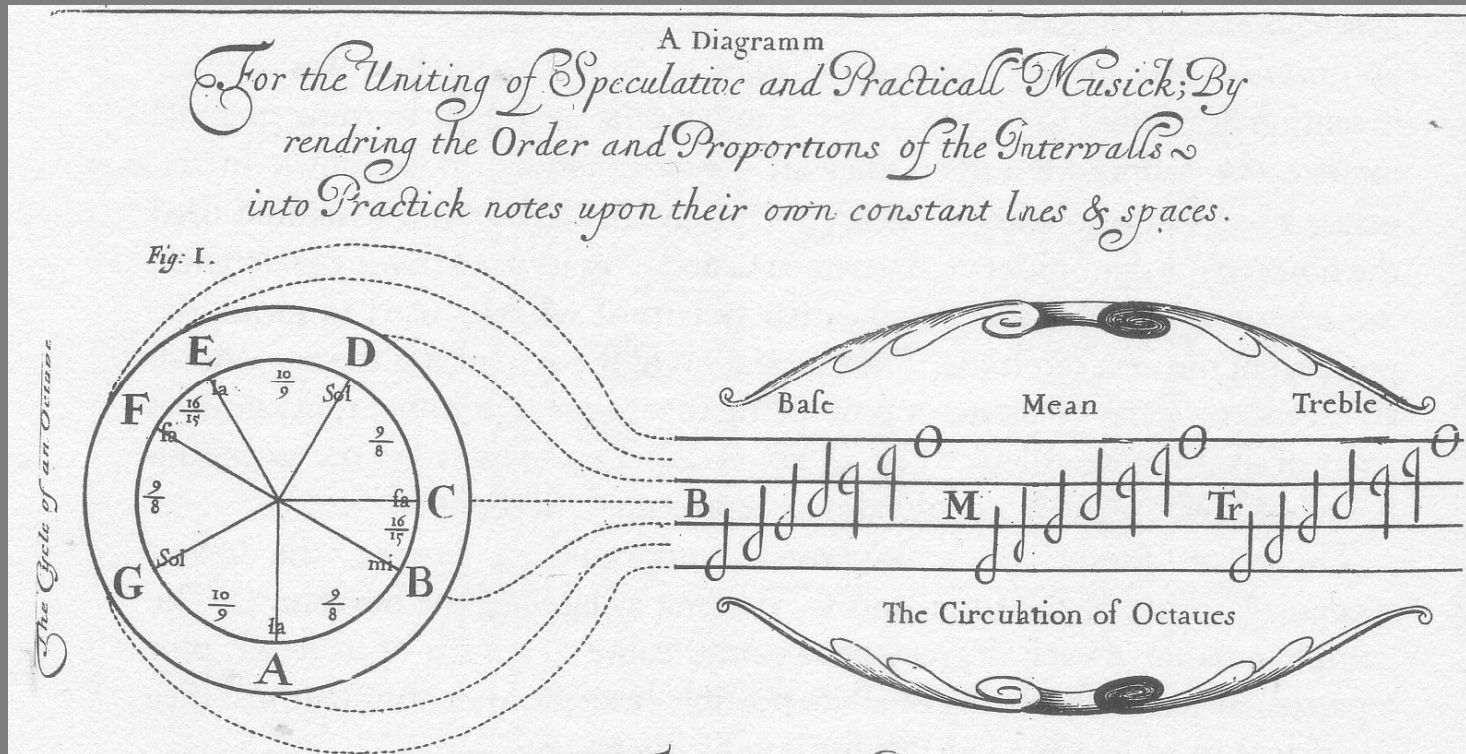
Fludd: upper triangle

The diagram illustrates the 'upper triangle' of a musical instrument, likely a lute or similar stringed instrument, as described by Fludd. It features a grid of 24 numbered frets (3 to 24) and various lettered positions. The letters 'bbb', 'aaa', 'gg', 'ff', 'cc', 'dd', 'aa', 'g', 'f', 'e', 'd', 'c', 'b', 'a', 'G', 'F', 'E', 'D', 'C', 'B', 'A', 'Γ', and 'G' are arranged in a pattern that suggests a specific tuning or fingering system. The grid is overlaid on a musical staff with a treble clef and a bass clef, and various note heads and stems are placed on the lines and spaces, indicating the placement of notes on the instrument's strings and frets.

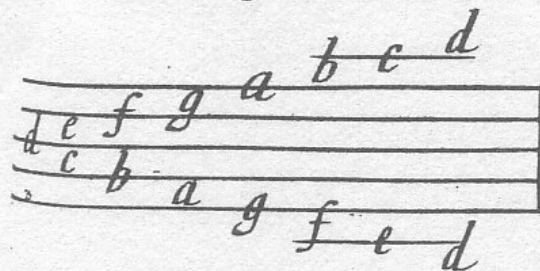
Fludd: Hexachords



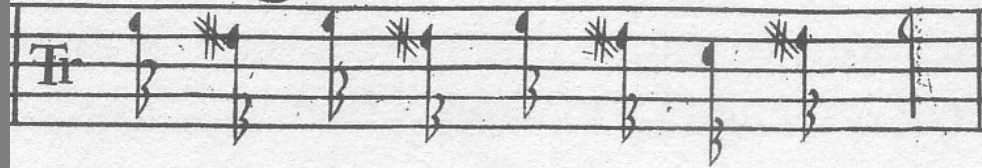
Thomas Salmon 1672



*Two entire Octaves are con-
 tained in every Systeme by
 help of the Leiger lines.*

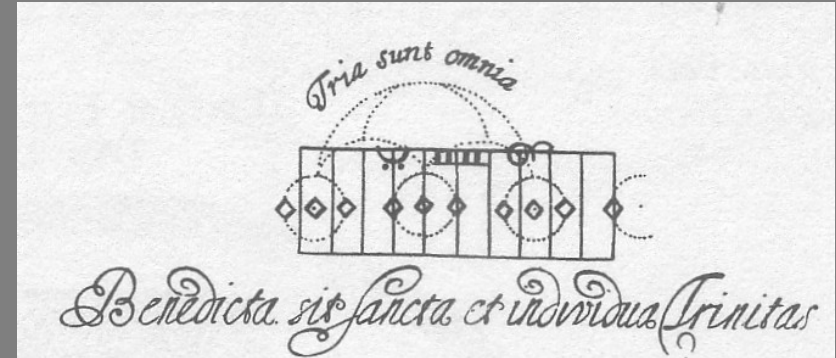
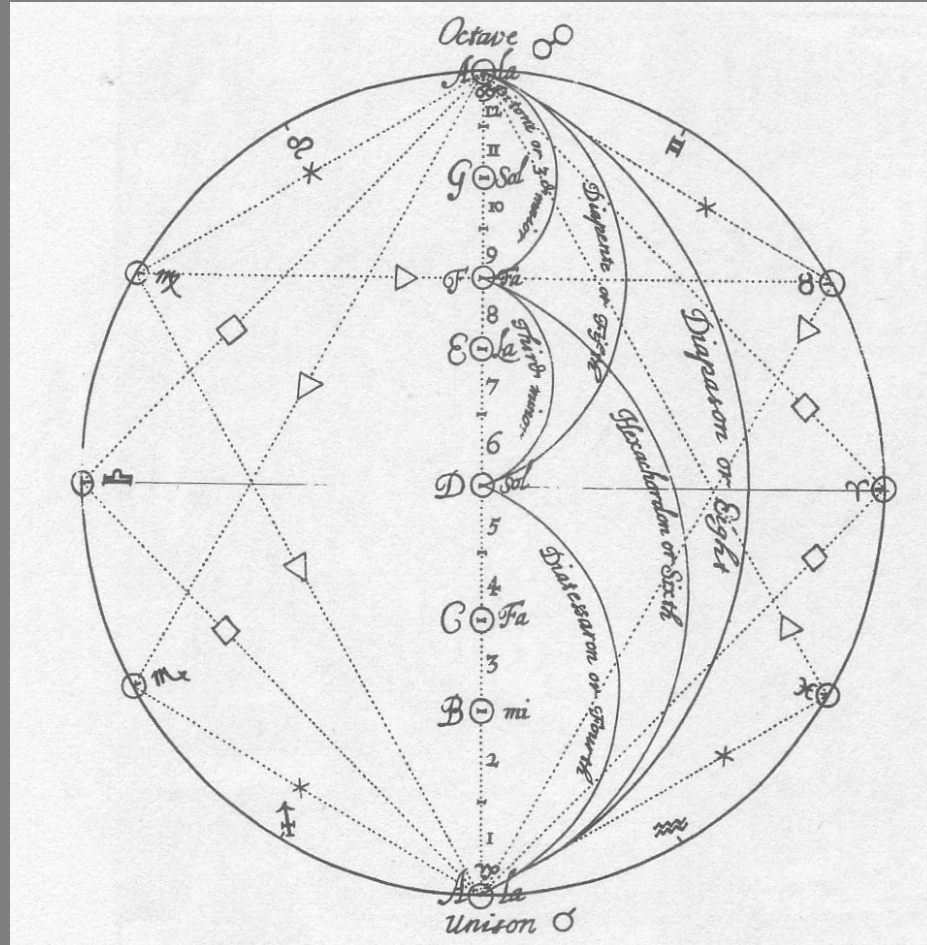


The Double Relish.



Oct.

Christopher Simpson 1667



Networks and dimension

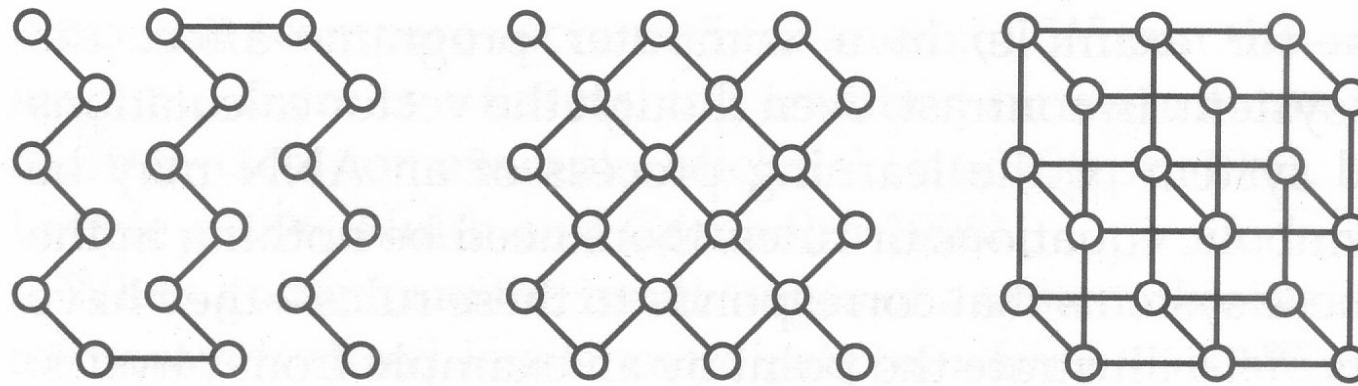


Figure 7.1

Different topologies implemented on the same 2-D pattern of neurons (based on Morasso and Sanguineti 1996, 291).

