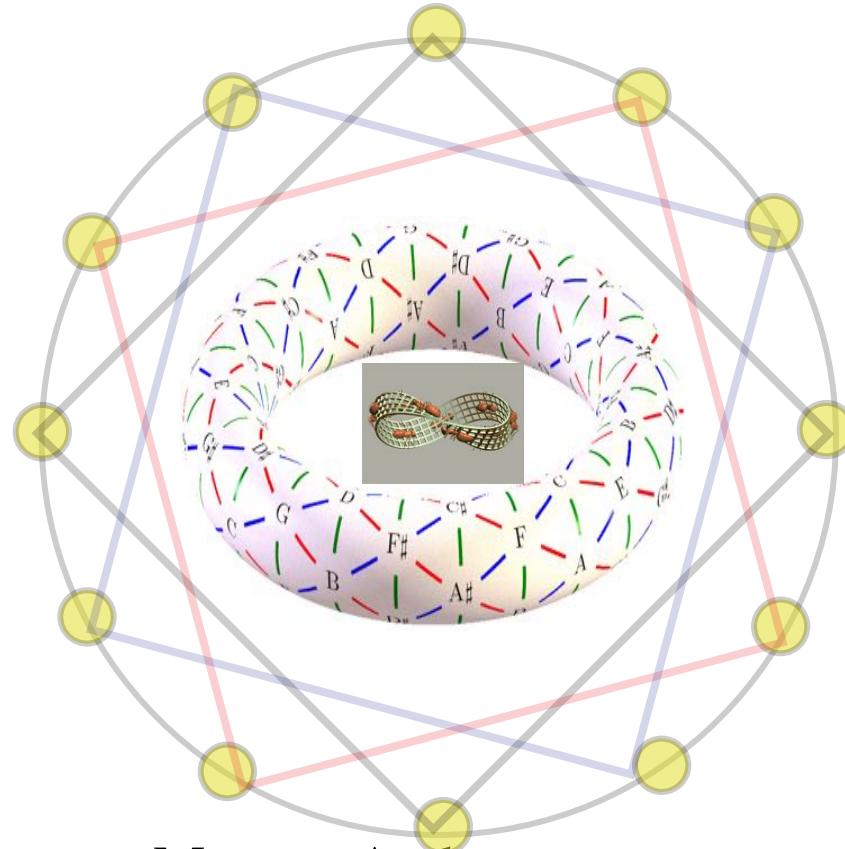


The Music of Maths!



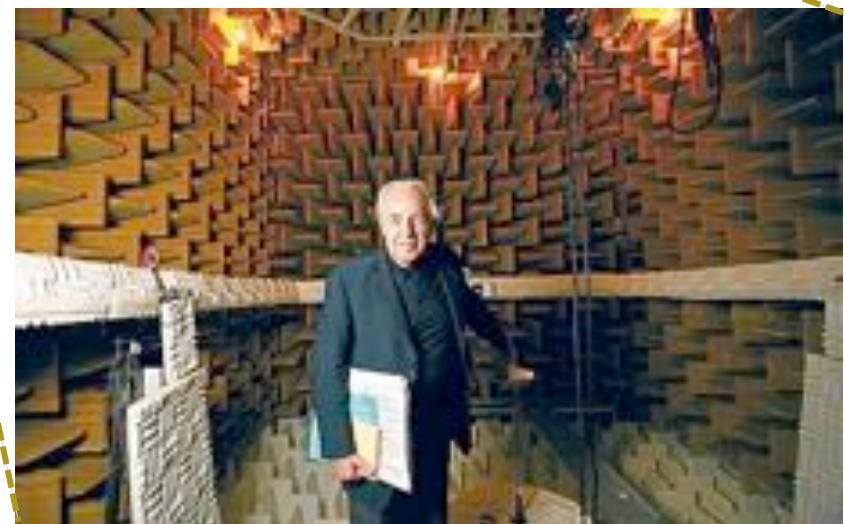
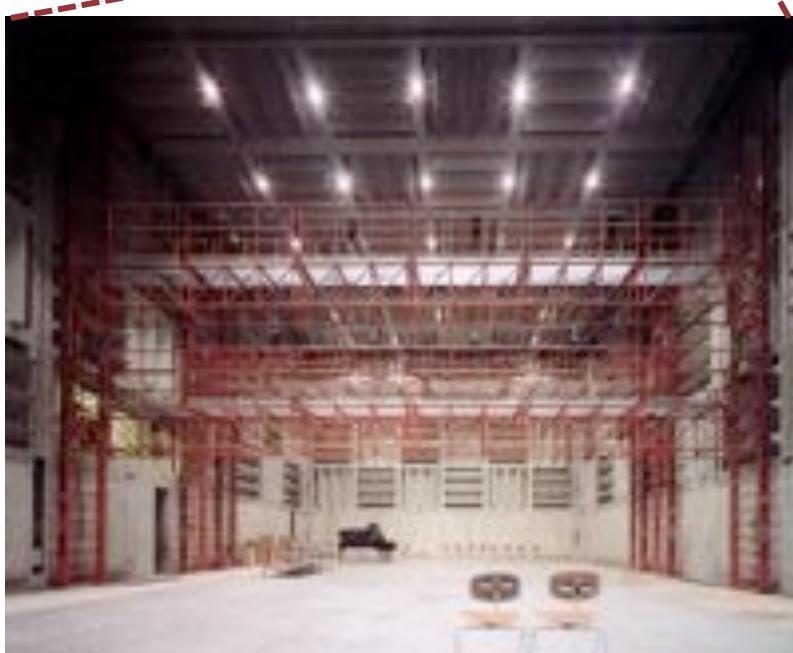
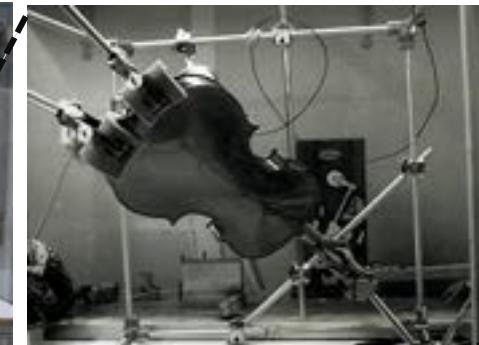
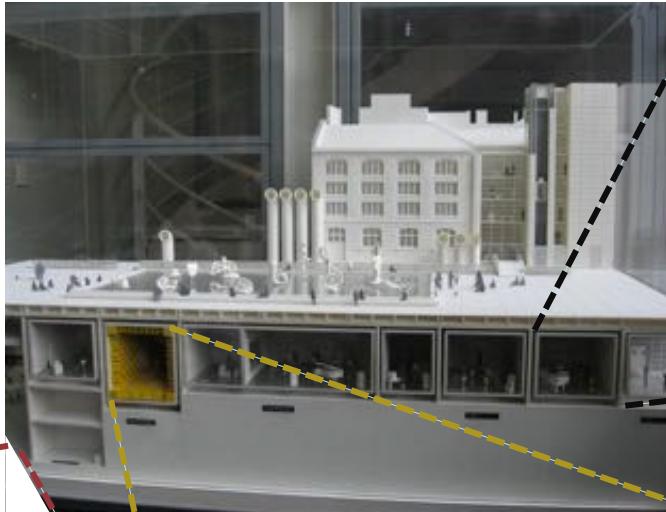
Moreno Andreatta

Equipe Représentations Musicales

IRCAM/CNRS/Sorbonne University & IRMA/GREAM/USIAS

<http://repmus.ircam.fr/moreno/smri>

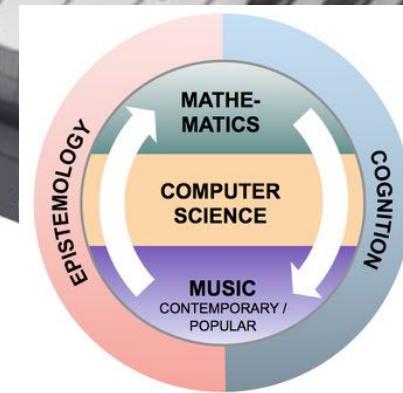
The musical and scientific research at IRCAM...



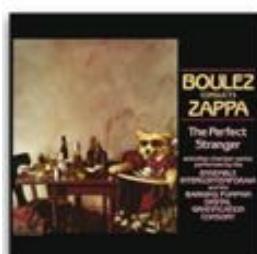
... at the interface between art and popular music



MusiqueLab 2



OMAX (computer-aided impro)



A permutteral song: one sentence...

Una volta soltanto una storia d'amore finisce (M. Andreatta. tr. E. Lecroart, OuBaPo)

Una volta una storia d'amore
soltanto una storia

Una storia d'amore
soltanto una storia d'amore

Una storia
soltanto una storia

Una storia d'amore
soltanto

Una volta soltanto
una storia d'amore soltanto

Un amore soltanto una volta
soltanto una storia d'amore soltanto

Una storia d'amore
soltanto una volta una storia

Un amore
una volta soltanto

Un amore finisce
soltanto

Una volta una storia d'amore finisce
Un amore soltanto

Una volta soltanto una storia d'amore
finisce

Une fois une histoire d'amour
rien qu'une histoire
Une histoire d'amour
rien qu'une histoire d'amour
Une histoire
rien qu'une histoire
Rien qu'une histoire
d'amour
Rien qu'une fois
rien qu'une histoire d'amour

Un amour, rien qu'une fois
rien qu'une histoire d'amour, rien que ça
Une histoire d'amour
rien qu'une fois une histoire
Un amour
rien qu'une fois
Un amour ne se termine
rien...
...qu'une fois une histoire d'amour ne se termine
Rien qu'un amour



Une fois rien qu'une fois une histoire d'amour
se termine

A permutional song: one sentence, **one note...**

Una volta soltanto una storia d'amore finisce (M. Andreatta)

Una volta una storia d'amore soltanto una stori

Una storia d'amore

soltanto una storia d'amore

Una storia soltanto una storia

Una storia d'amore soltanto

Una volta soltanto una storia d'amore soltanto

Un amore soltanto una volta soltanto una storia d'amore soltanto

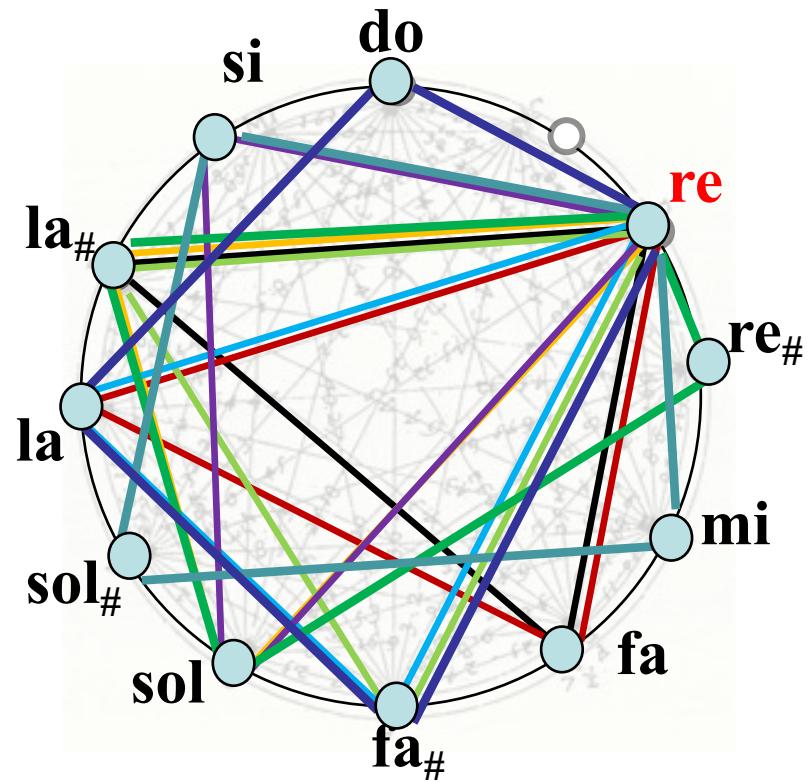
Una storia d'amore
soltanto una volta una storia

Un amore una volta soltanto

Un amore finisce soltanto

Una volta una storia d'amore finisce Un amore soltanto

Una volta soltanto una storia d'amore finisce



A permutational song: one sentence, one note (one note left!)

Una volta soltanto una storia d'amore finisce (M. Andreatta)

Una volta una storia d'amore
 soltanto una storia

Una storia d'amore
 soltanto una storia d'amore

Una storia
 soltanto una storia

Una storia d'amore
 soltanto

Una volta soltanto
 una storia d'amore soltanto

Un amore soltanto una volta
 soltanto una storia d'amore soltanto

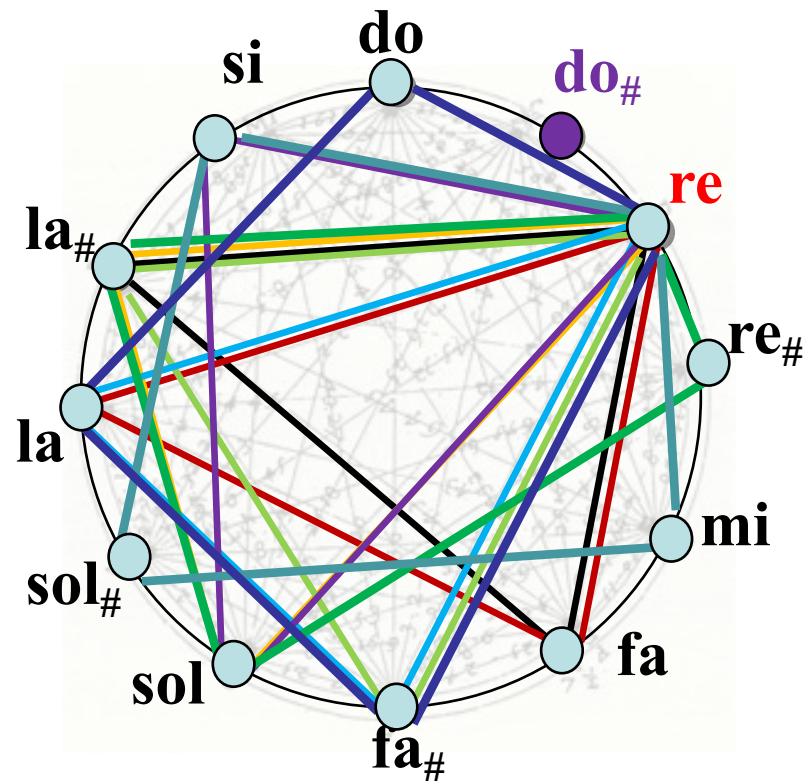
Una storia d'amore
 soltanto una volta una storia

Un amore
 una volta soltanto

Un amore finisce
 soltanto

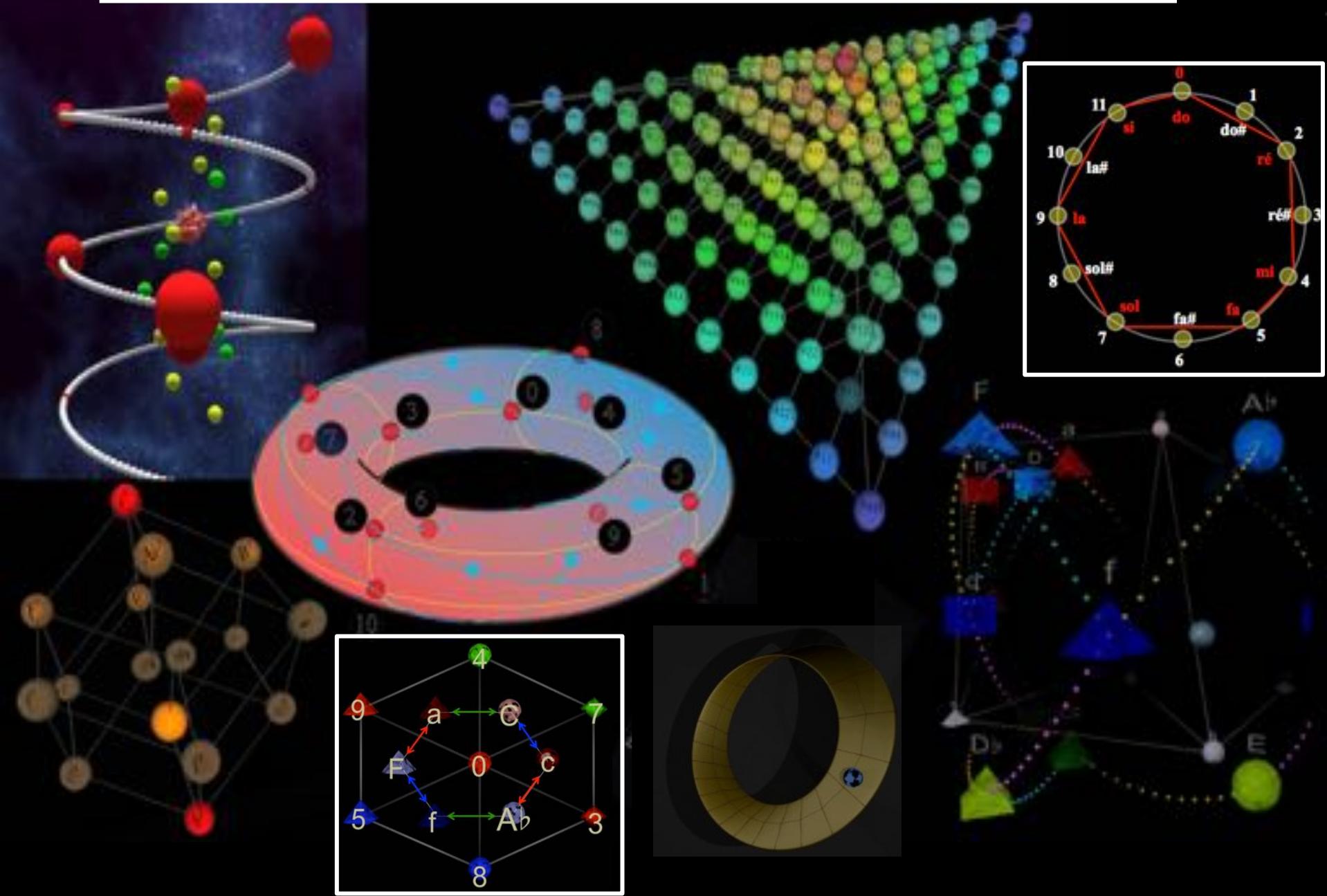
Una volta una storia d'amore finisce
 Un amore soltanto

Una volta soltanto una storia d'amore finisce

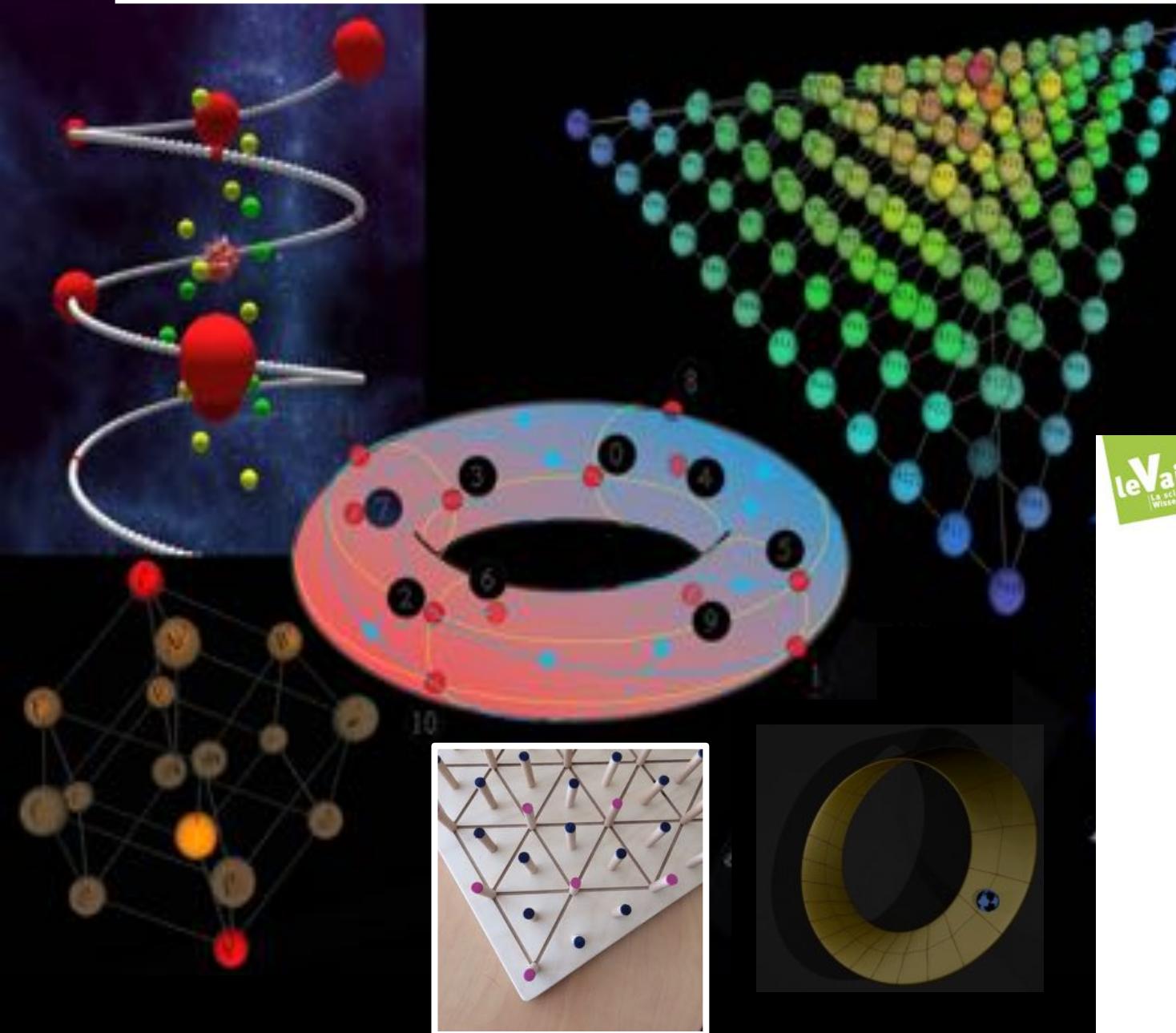


→ demo

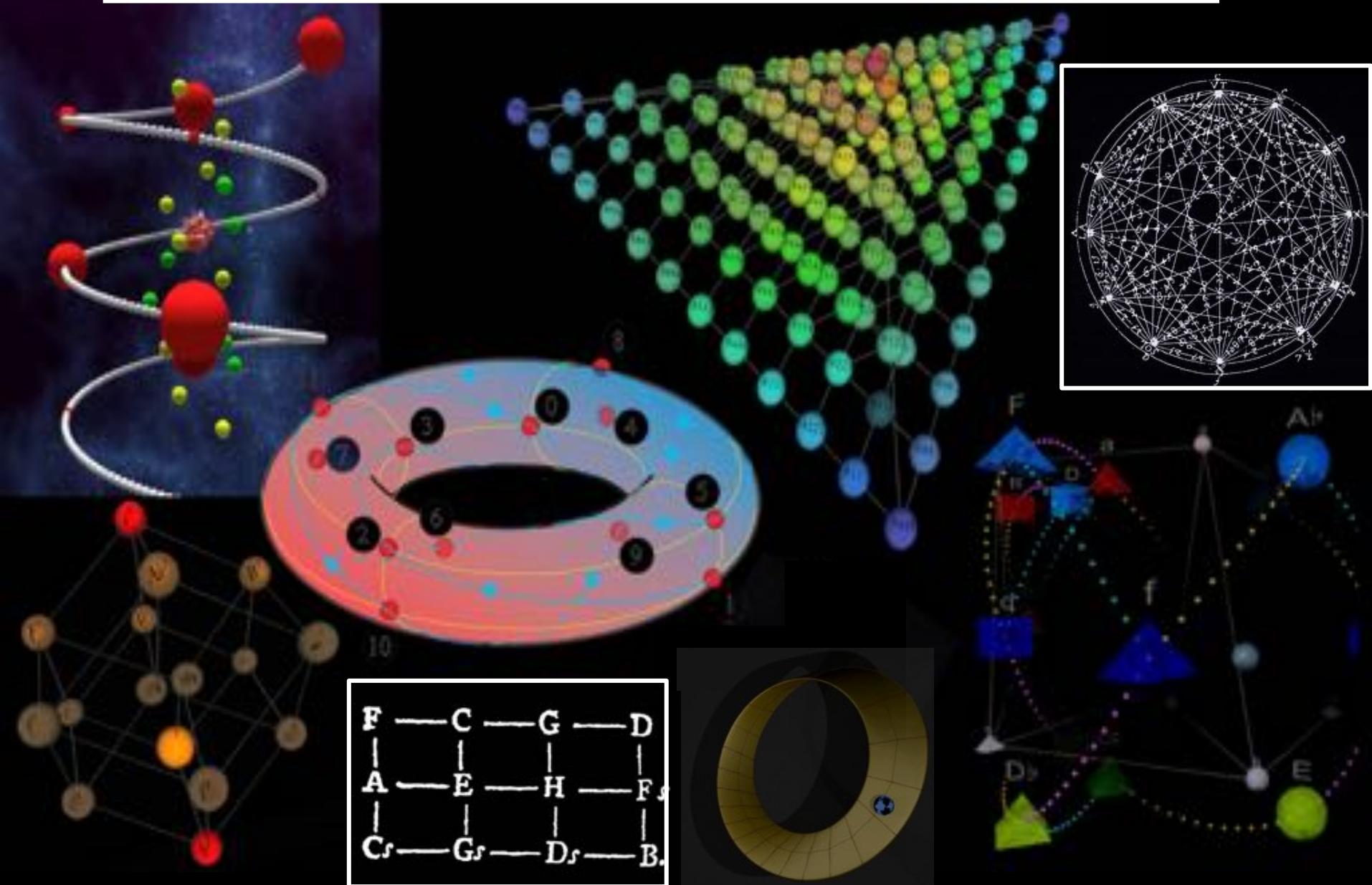
The galaxy of geometrical models at the service of music



The galaxy of geometrical models at the service of music



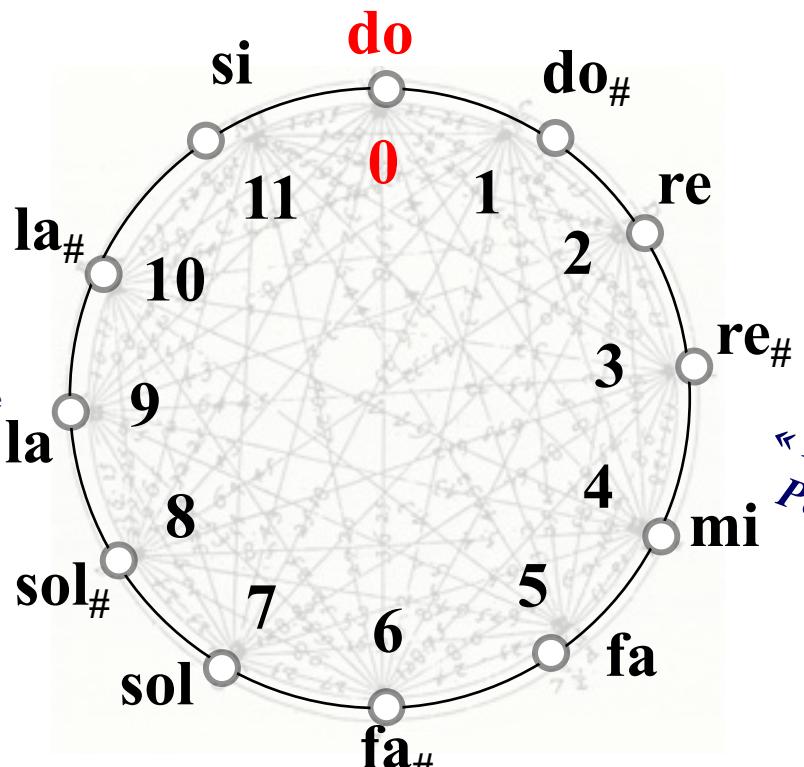
The galaxy of geometrical models at the service of music



Music and the birth of combinatorics



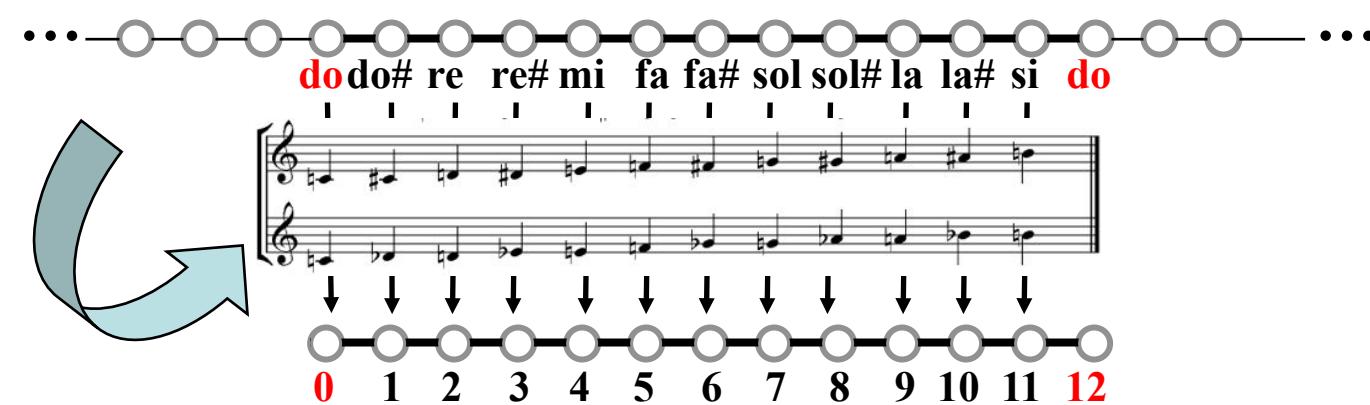
Marin Mersenne



Harmonicorum Libri XII, 1648



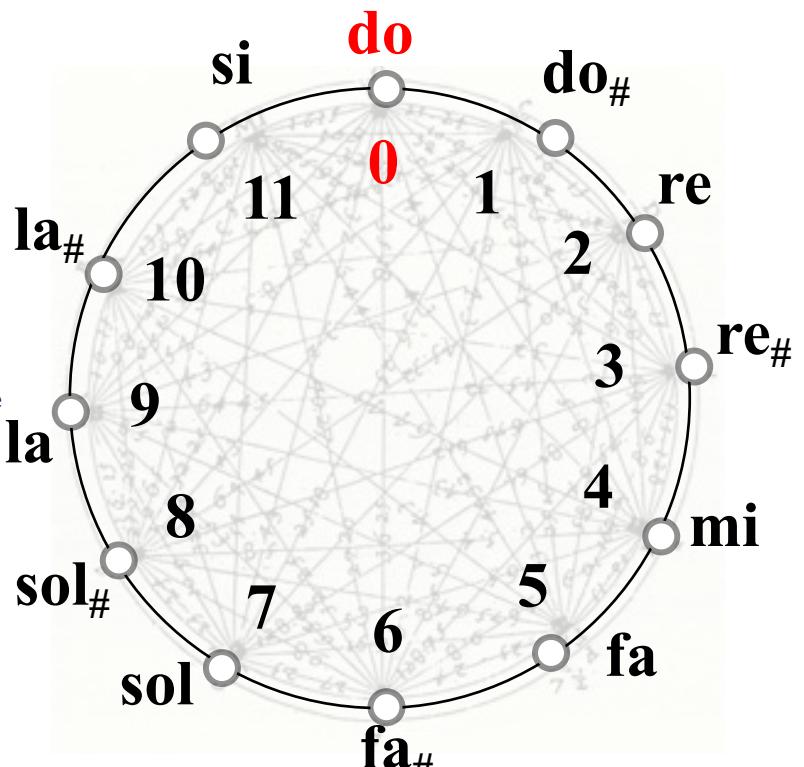
M. Andreatta, C. Agon,
« La musique mise en algèbre »,
Pour la Science, 2008



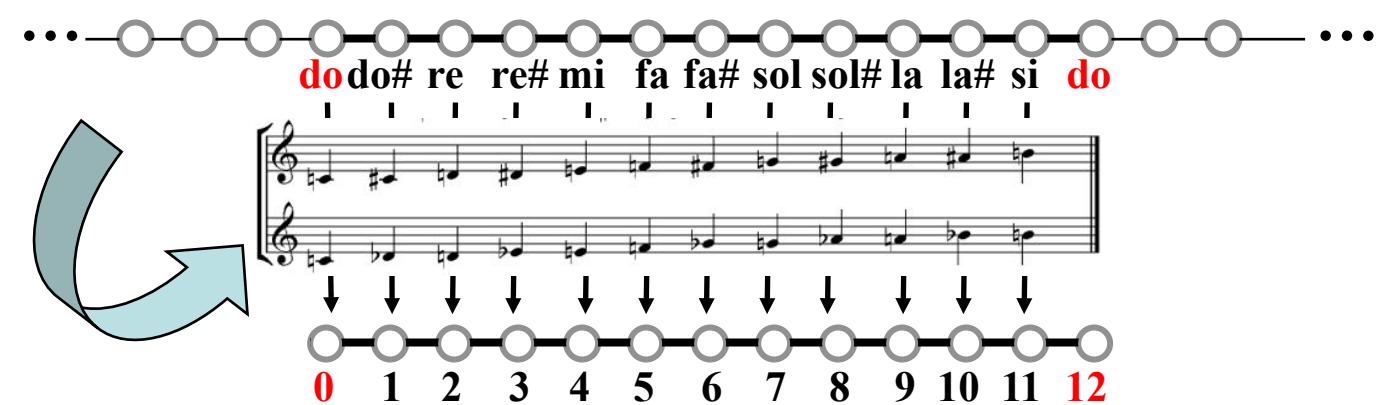
Music and the birth of combinatorics



Marin Mersenne



Harmonicorum Libri XII, 1648



*M. Andreatta, C. Agon,
«Algèbre et géométrie :
sont-elles inscrites dans le
cerveau ?»,
Pour la Science, 2018*



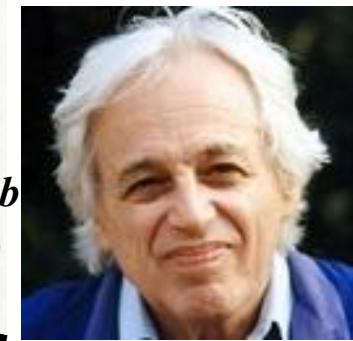
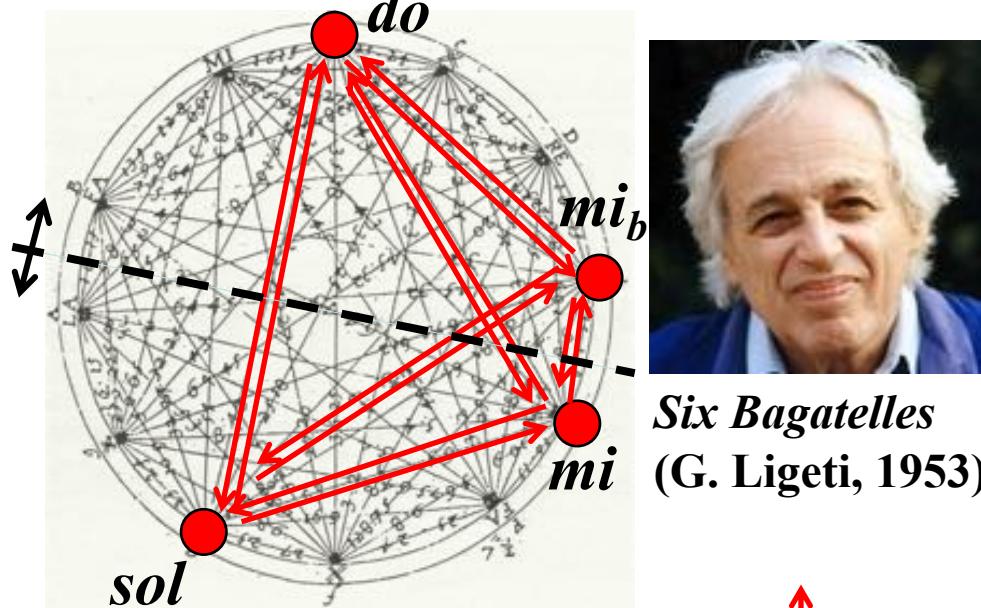
Permutational melodies in contemporary (art) music

II.4 Marin Mersenne, *Harmonicorum Libri XII*, 1648

LIBER SEPTIMVS DE CANTIBVS, SEV CANTILENIS, EARVMQ; NVMERO, PARTIBVS, ET SPECIEBVS.

Tableta Combinationis ab I ad XXI.

I	I
II	II
III	6
IV	24
V	120
VI	720
VII	5040
VIII	40320
IX	361800
X	3618000
XI	39916800
XII	479001600
XIII	6117010800
XIV	8717819100
XV	1107674568000
XVI	10922789888000
XVII	311687418296000
XVIII	6401173705718000
XIX	11164100040813000
XX	1433904008176640000
XXI	51090941171709440000
XXII.	1884000737777607680000



Six Bagatelles
(G. Ligeti, 1953)

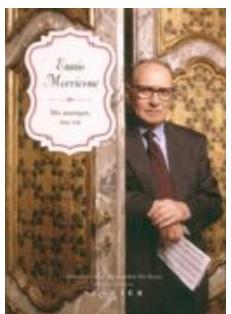
The musical score consists of 24 staves of music, each representing a different permutation of four notes. The staves are numbered 1 through 24. The music is written on a grid of five horizontal lines and five vertical bar lines, with note heads indicating pitch and duration. The title of the score is 'Varietas, seu Combinatio quatuor notarum.'

A permutteral hit of the 1960s

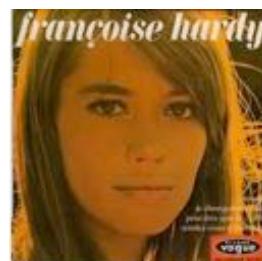
Se telefonando, 1966 (Maurizio Costanzo/Ennio Morricone) / Mina



(min. 0'53")

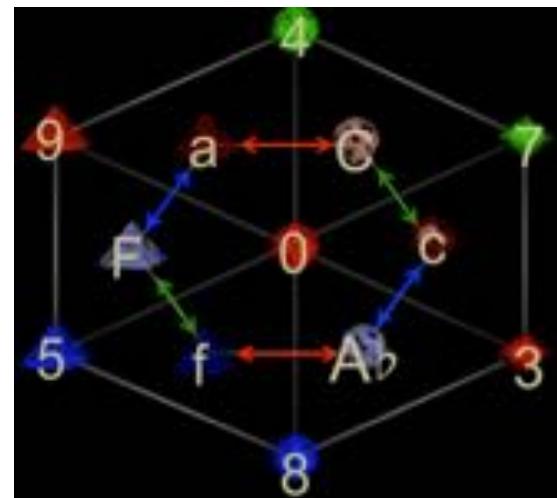


Ennio Morricone, Ma musique, ma vie.
Entretiens avec Alessandro De Rosa, éditions Seguier, 2018. Traduit de l'italien par Florence Rigollet (en collaboration avec M. Andreatta)



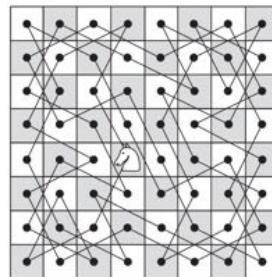
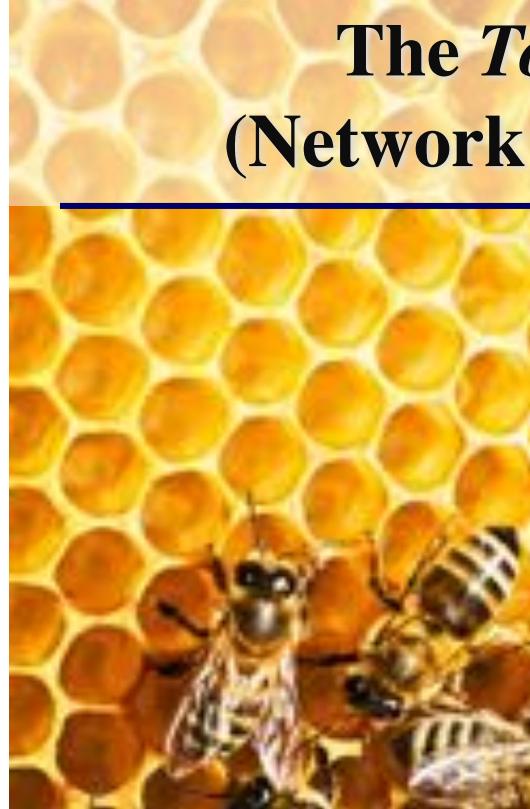
Je changerais d'avis,
(Françoise Hardy)

The harmonic space

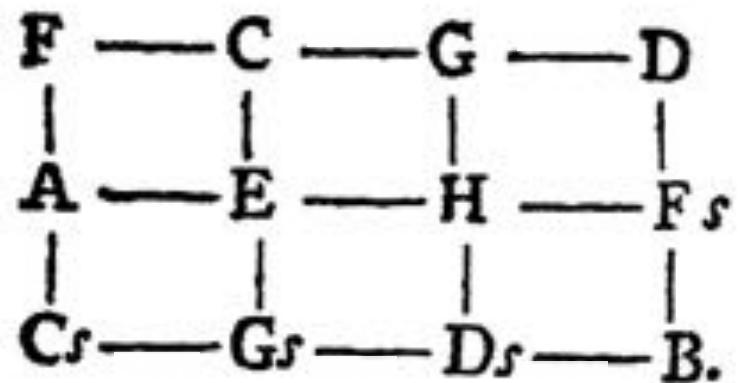


C	c	C_#	c _#	D	d
E _b	e_b	E	e	F	f
F _#	f _#	G	g	G _#	g _#
A	a	B_b	b_b	B	b
Chord enumeration					

The Tonnetz (Network of Tones)

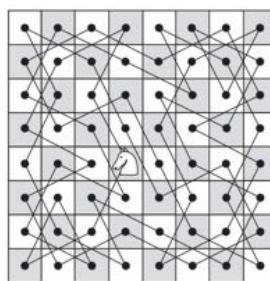
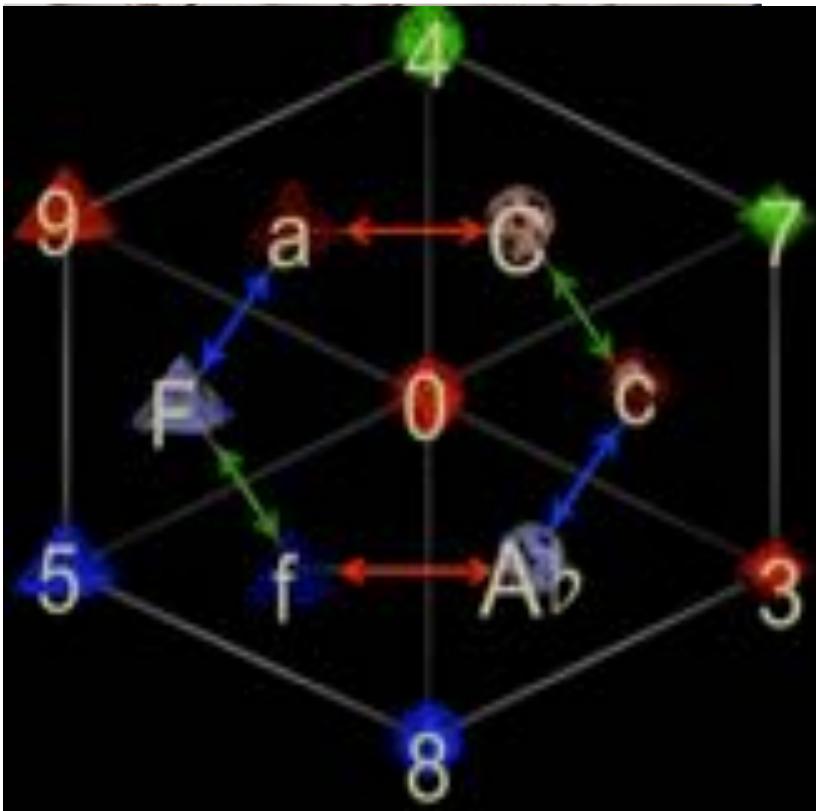


Leonhard Euler

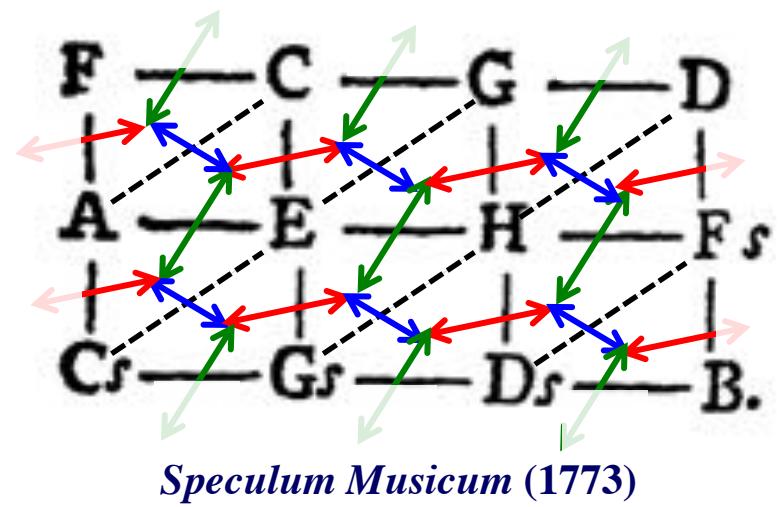


Speculum Musicum (1773)

The Tonnetz (Network of Tones)



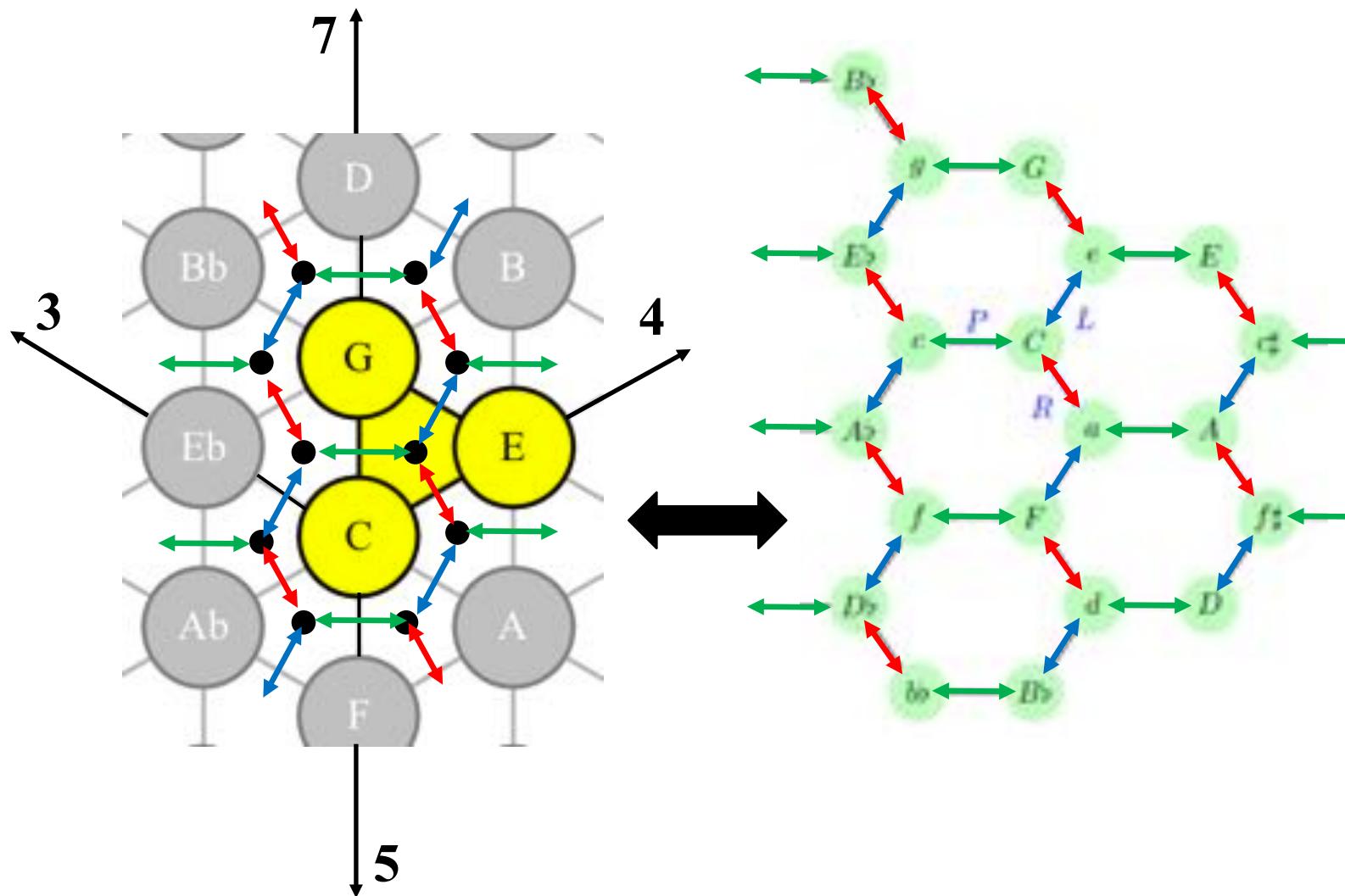
Leonhard Euler



Speculum Musicum (1773)

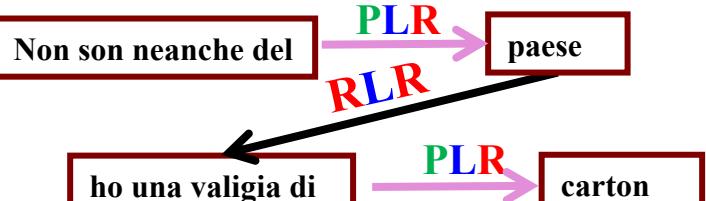
→ DEMO

From the Tonnetz to the dual one (and vice-versa)



Symmetric harmonic progressions in Paolo Conte's songs

IL REGNO DEL TANGO (Paolo Conte)



sono vestito, sì PLR in borghese,
RLR

ma dentro c'è PLR il bandoneon...

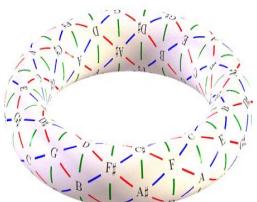
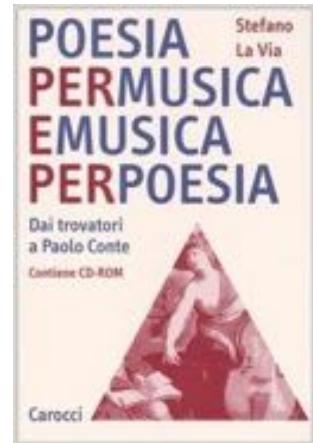
potrei sembrare PLR un ragioniere,

RLR anche un geometra PLR potrei,

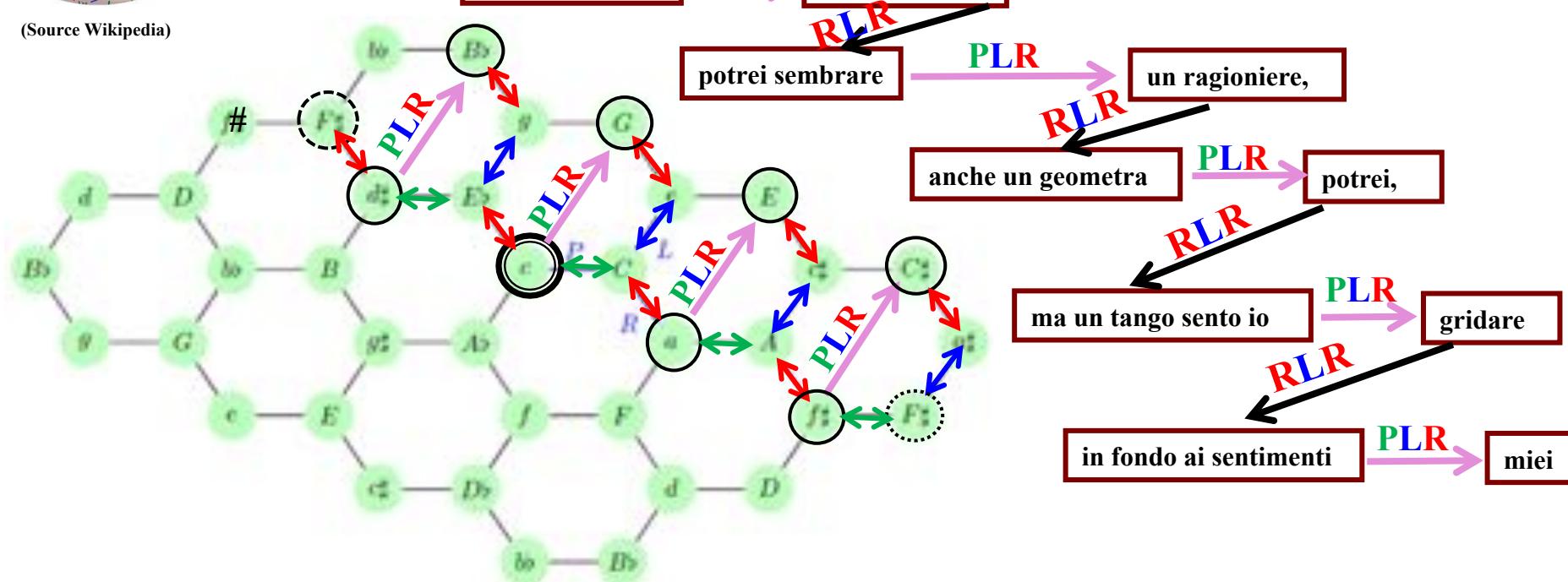
ma un tango sento io PLR gridare

RLR in fondo ai sentimenti PLR miei

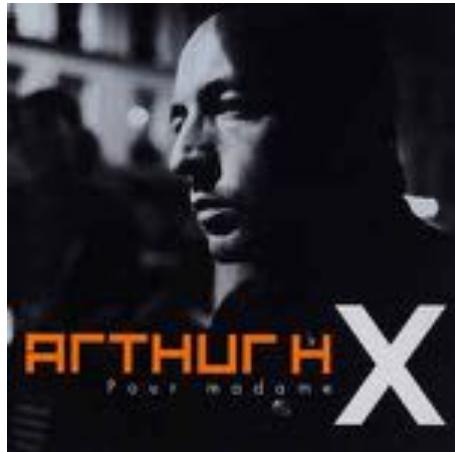
Stefano La
Via, *Poesia*
per musica e
musica per
poesia. Dai
trovatori a
Paolo Conte,
Carocci, 2006



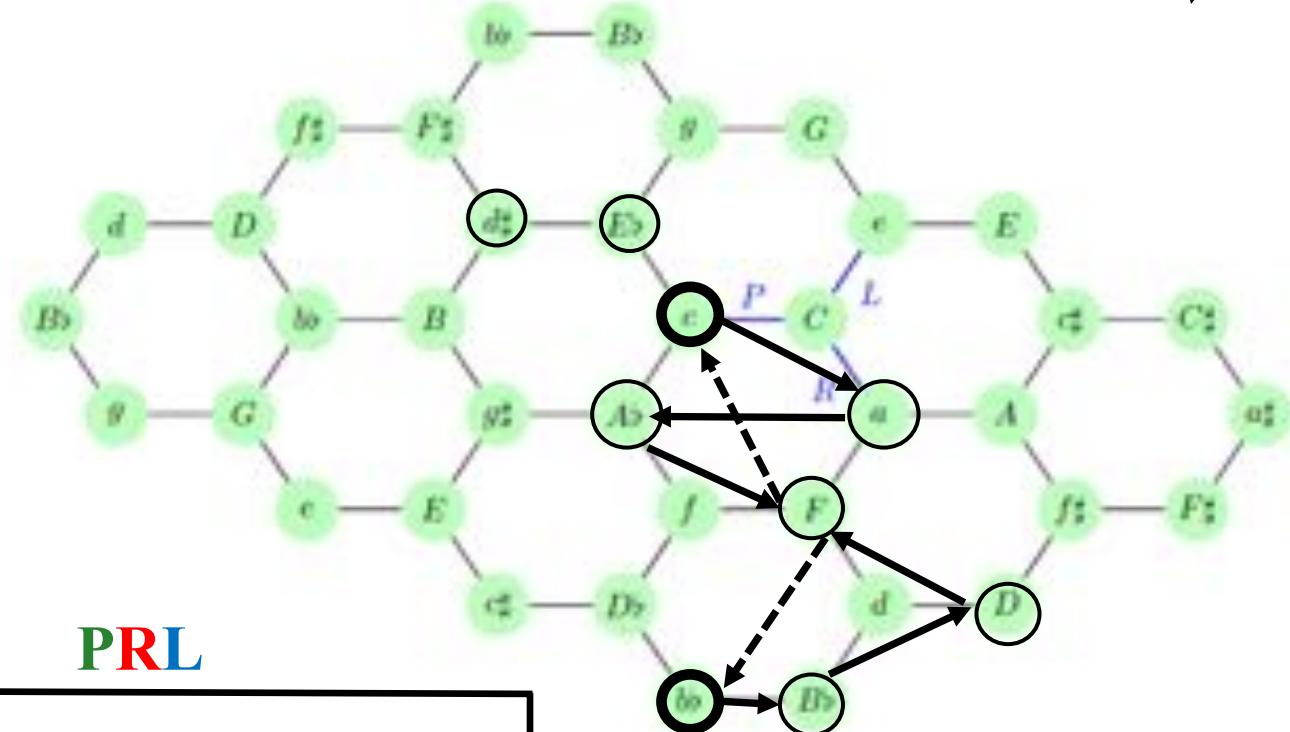
(Source Wikipedia)



Harmonic progressions in Arthur H's music

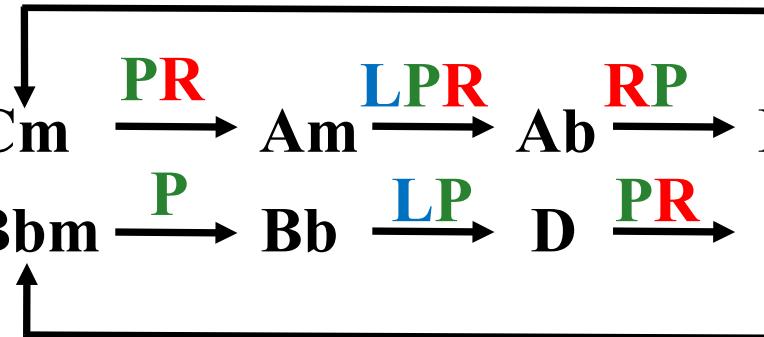


Les Parures Secrètes (album *Pour Madame X*, 2000)



Cycle 1 : Cm $\xrightarrow{\text{PR}}$ Am $\xrightarrow{\text{LPR}}$ Ab $\xrightarrow{\text{RP}}$ F

Cycle 1 : Bbm $\xrightarrow{\text{P}}$ Bb $\xrightarrow{\text{LP}}$ D $\xrightarrow{\text{PR}}$ F



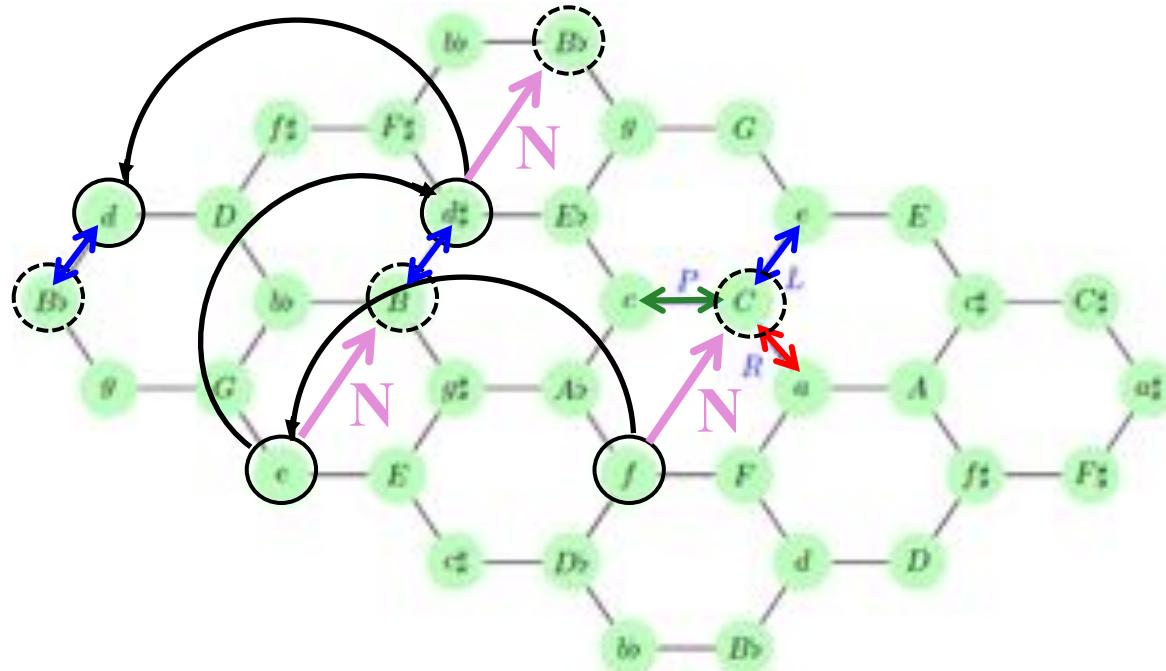
PLR=N



'Shortcuts' in the Tonnetz



Arrangement by Alberto D'Este
(CD in preparation)



FRANGIFLUtti (L. Mello / M. Andreatta)

Nel rifrangere i nostri cuori,
– gente nata che esige cura –
sono stato tra i meno bravi
nella tua favola insicura.

Ora è tardi lo so oramai
venti freddi come una fiaba
però tengo a cantare il canto
Eva sola che resta maga.

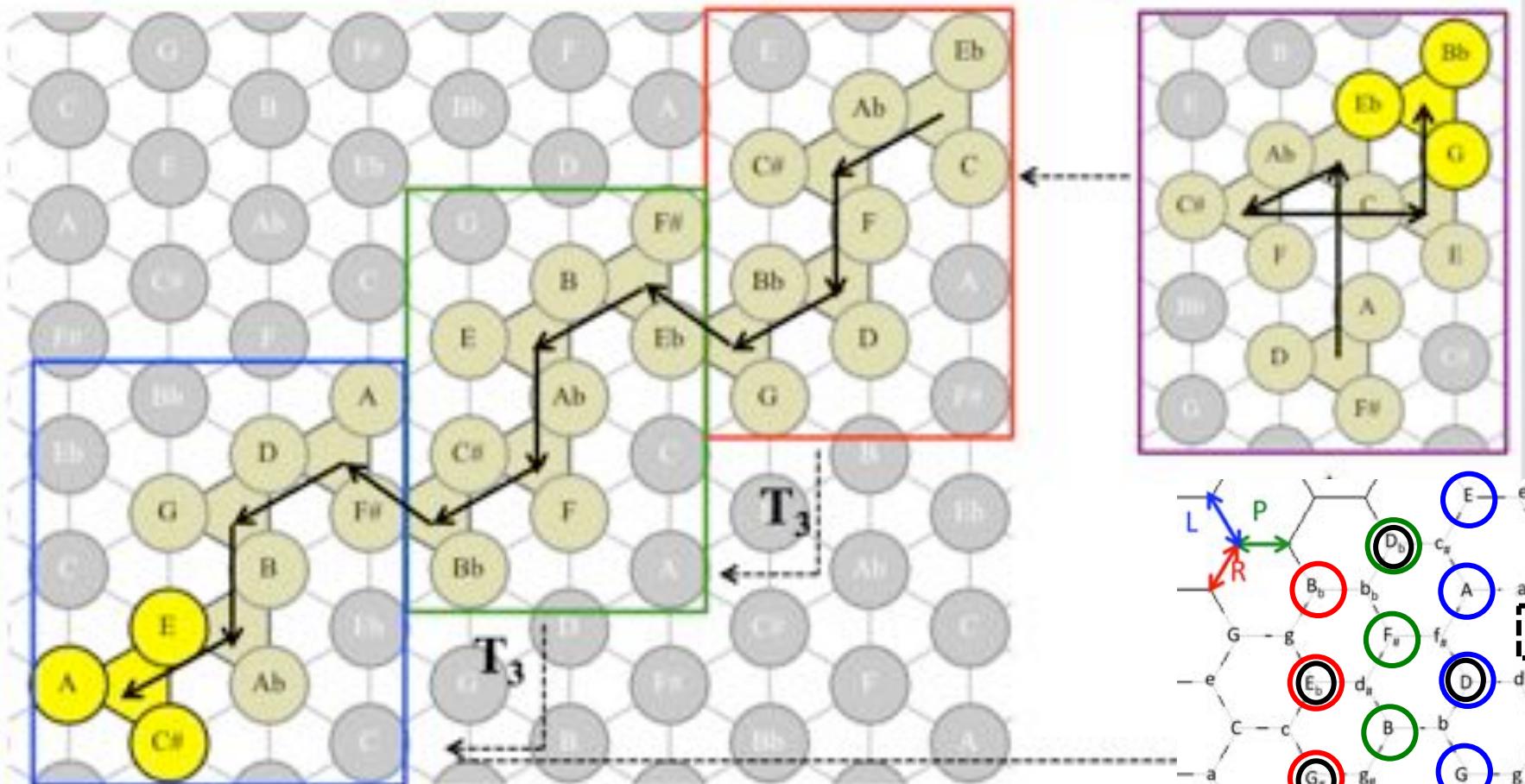
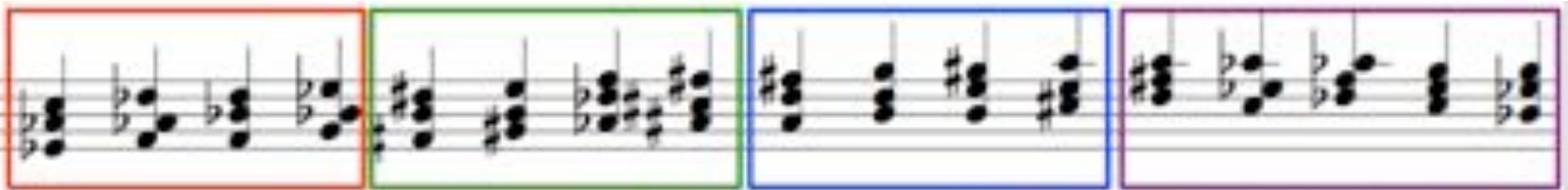
Eva cenno di ribellione
Eva fascio pronto all'addio
Eva donna che sa parlare
Al silenzio fatto d'oblio.

Sai parole da incatenare
sai sorridere per piacere
sai scappare senza tornare
sai ferire e sai far l'amore.

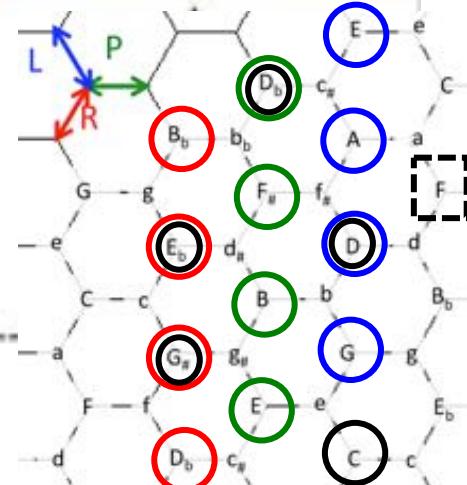
f
↓ N
C
↓ L
e
↓ N
B
↓ L
d#
↓ N
Bb
↓ L
d

Symmetries in Paolo Conte's *Madeleine*

La_b Re_b Si_b Mi_b Si Mi Re_b Fa_# Re Sol Mi La Re La_b Re_b Do Mi_b



Almost total covering of the major-chords space



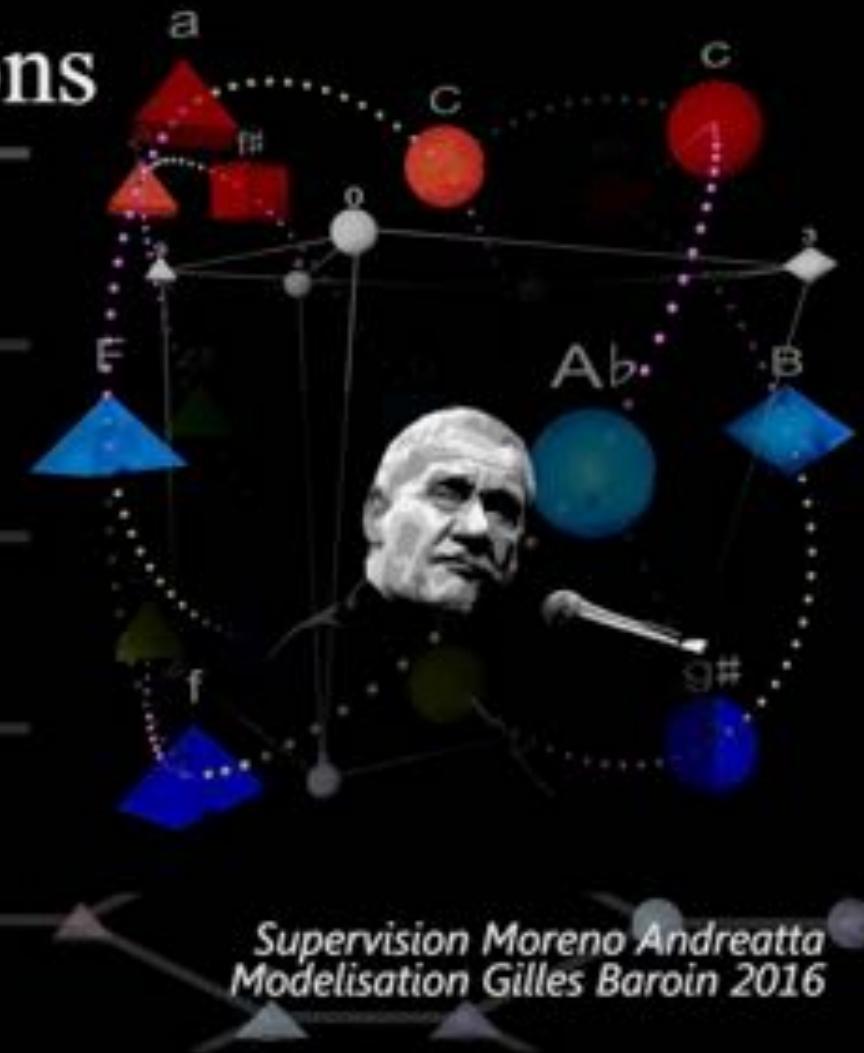
Harmonic Progressions

In Paolo Conte

Madeleine



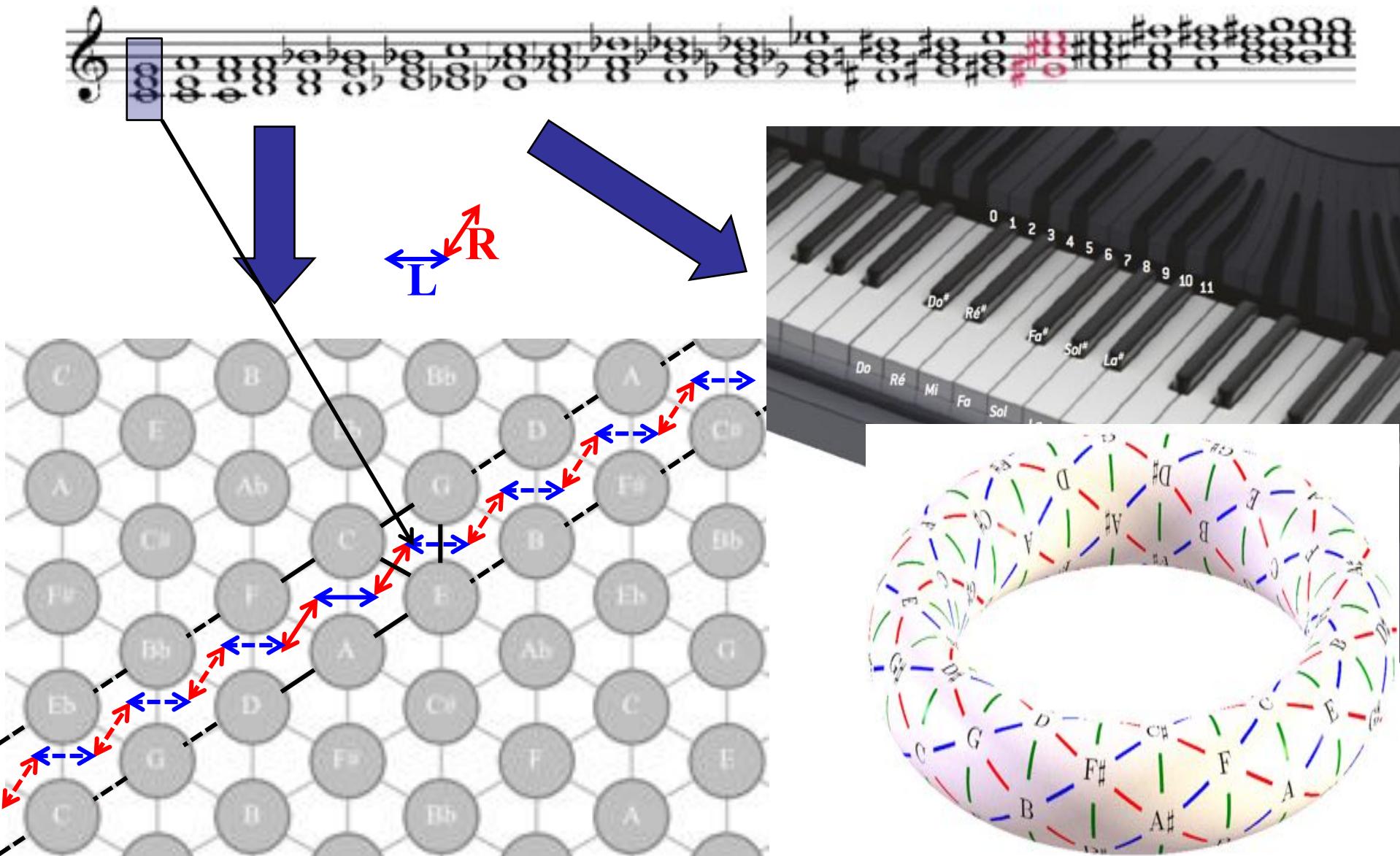
Gilles Baroin



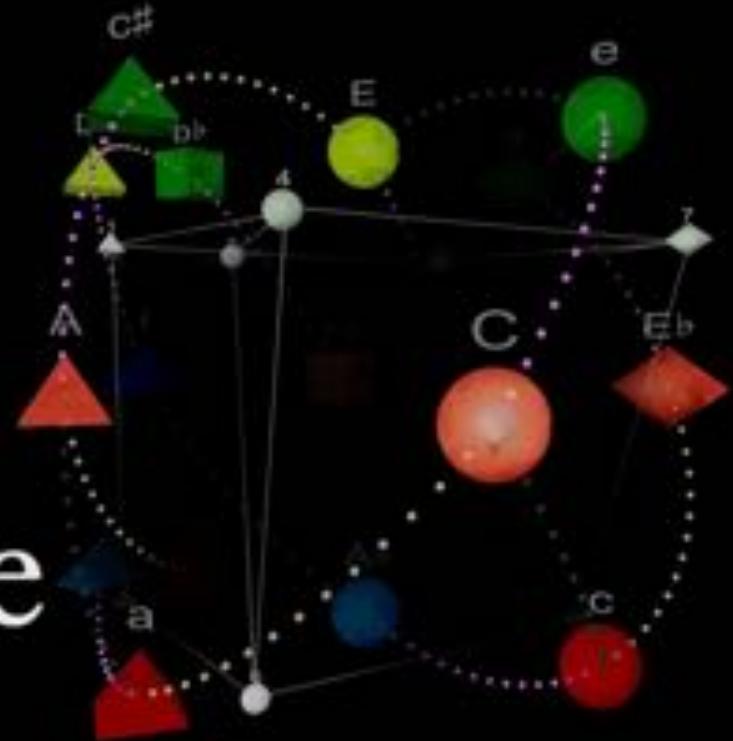
*Supervision Moreno Andreatta
Modélisation Gilles Baroin 2016*

→ www.mathemusic.net

The Zig-zag as a Hailtonian Path



Beethoven and the Hypersphere *(and the Tonnetz)*



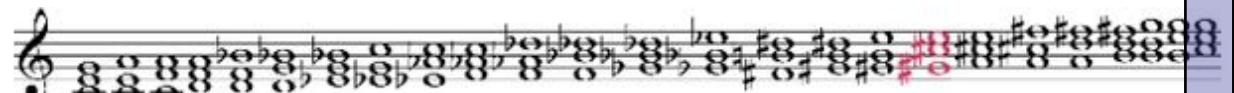
Gilles Baroin 2016
www.MatheMusic.net



Gilles Baroin

→ www.mathemusic.net

Reading Beethoven backwards

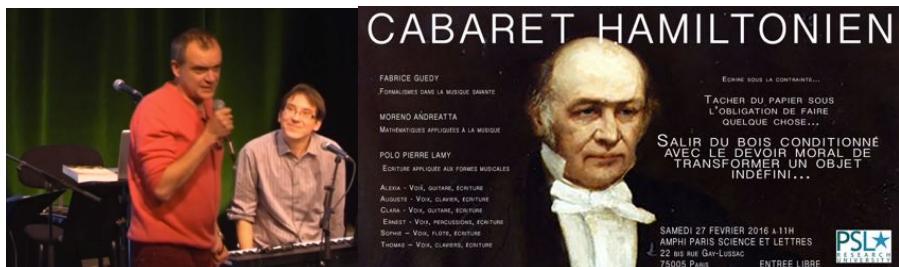
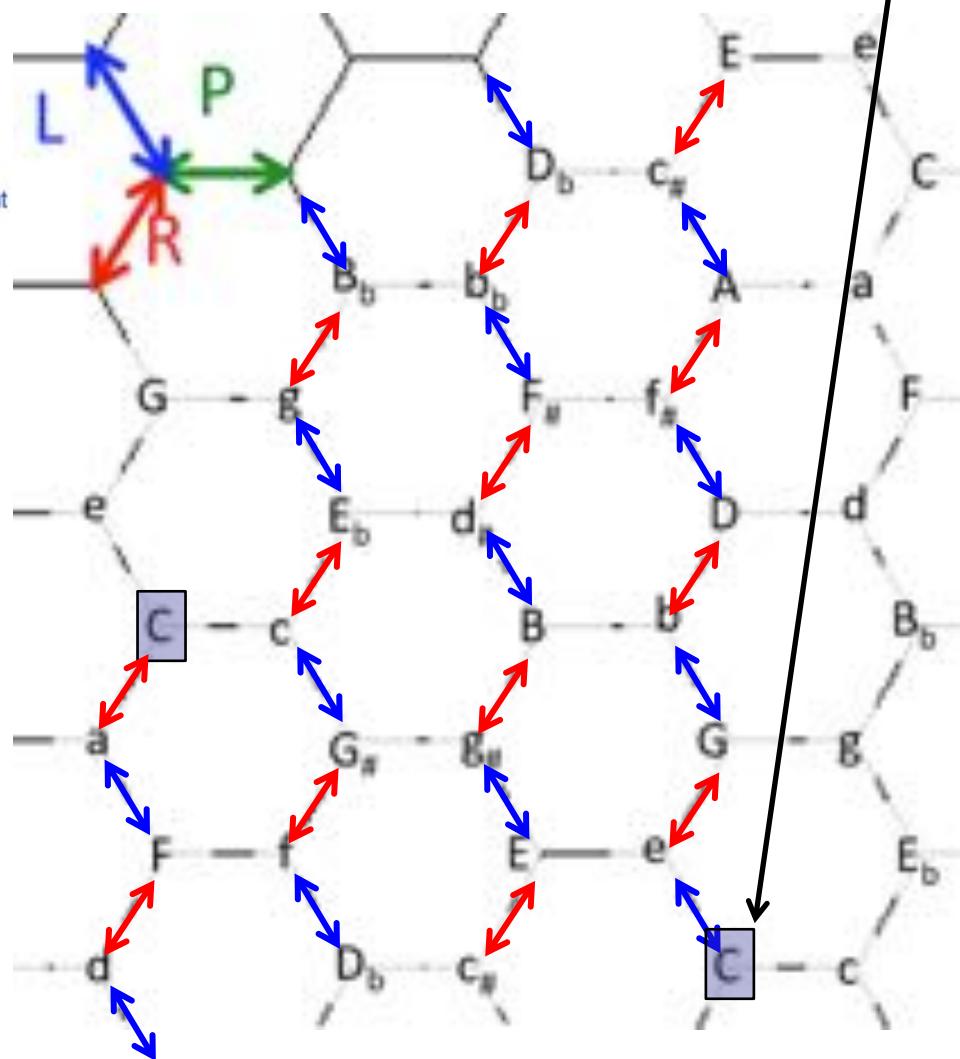


← time

Le Blé en Herbe

(Polo/Moreno/Dieu)

- | | |
|--|--|
| Plonger comme un enfant, cheveux au vent | Croiser matin dans l'herbe folle |
| Sous l'océan du blé en herbe | Deux tourterelles qui s'envolent |
| Marée d'épis couleur d'amande | Suivre les jeux des hirondelles |
| Qui tendent à caresser le ciel | Sur le paysage éternel |
| Algues tendres de mille plages | Nager comme un enfant, cheveux au vent |
| Frôlant le ventre des nuages | Sous l'océan |
| Cheveux de pluie, dos de poissons | Du blé en herbe |
| Qui frissonnent à l'unisson | Marée de fruits au goût amer |
| Suivre le bord des continents | Acide et salée comme la mer |
| Dans l'océan du blé en herbe | Vers l'îlot d'un petit village |
| Pêcher le corail du pavot | Vers un château d'eau sur la plage |
| Dans le sang des coquelicots | Quand tout s'éteint avant l'orage |
| | Quand se lève le vent du large |
| | Sur le blé vert |

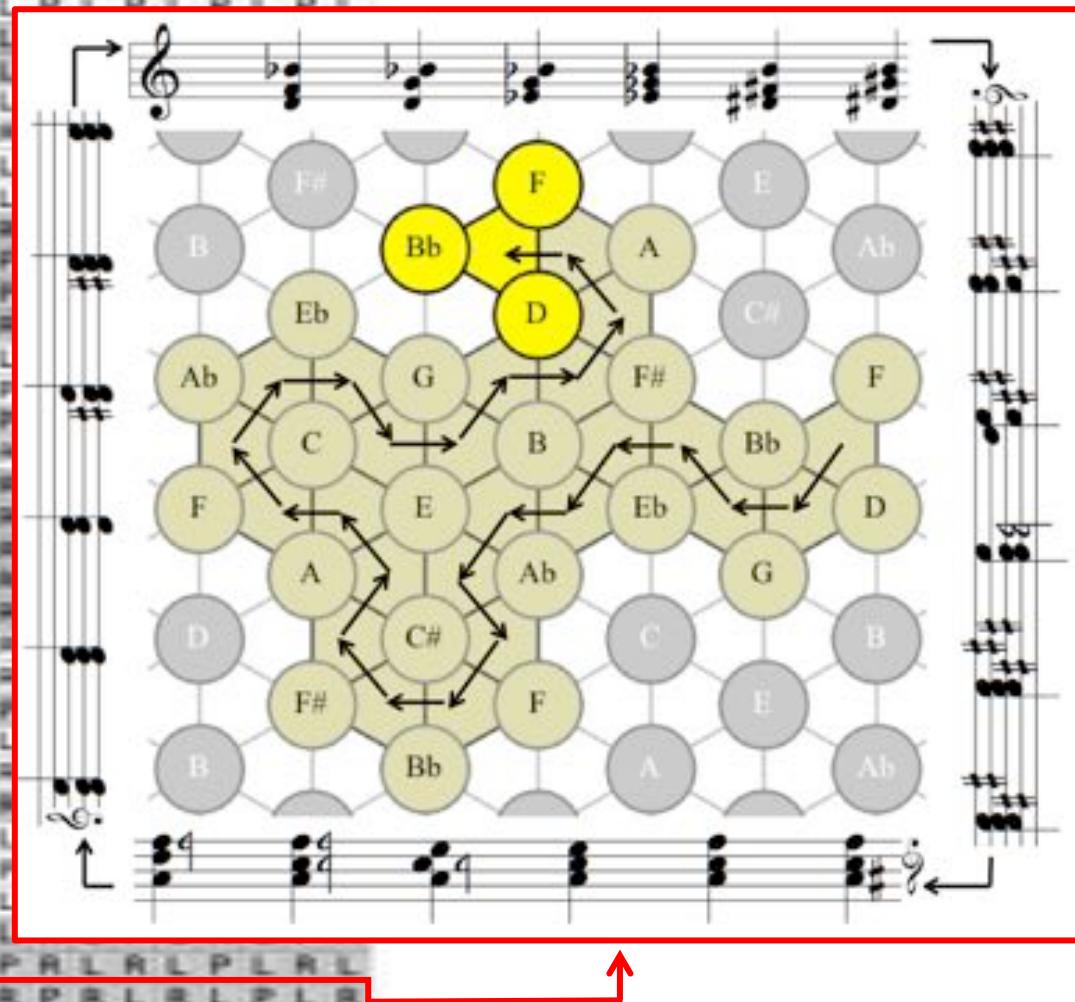
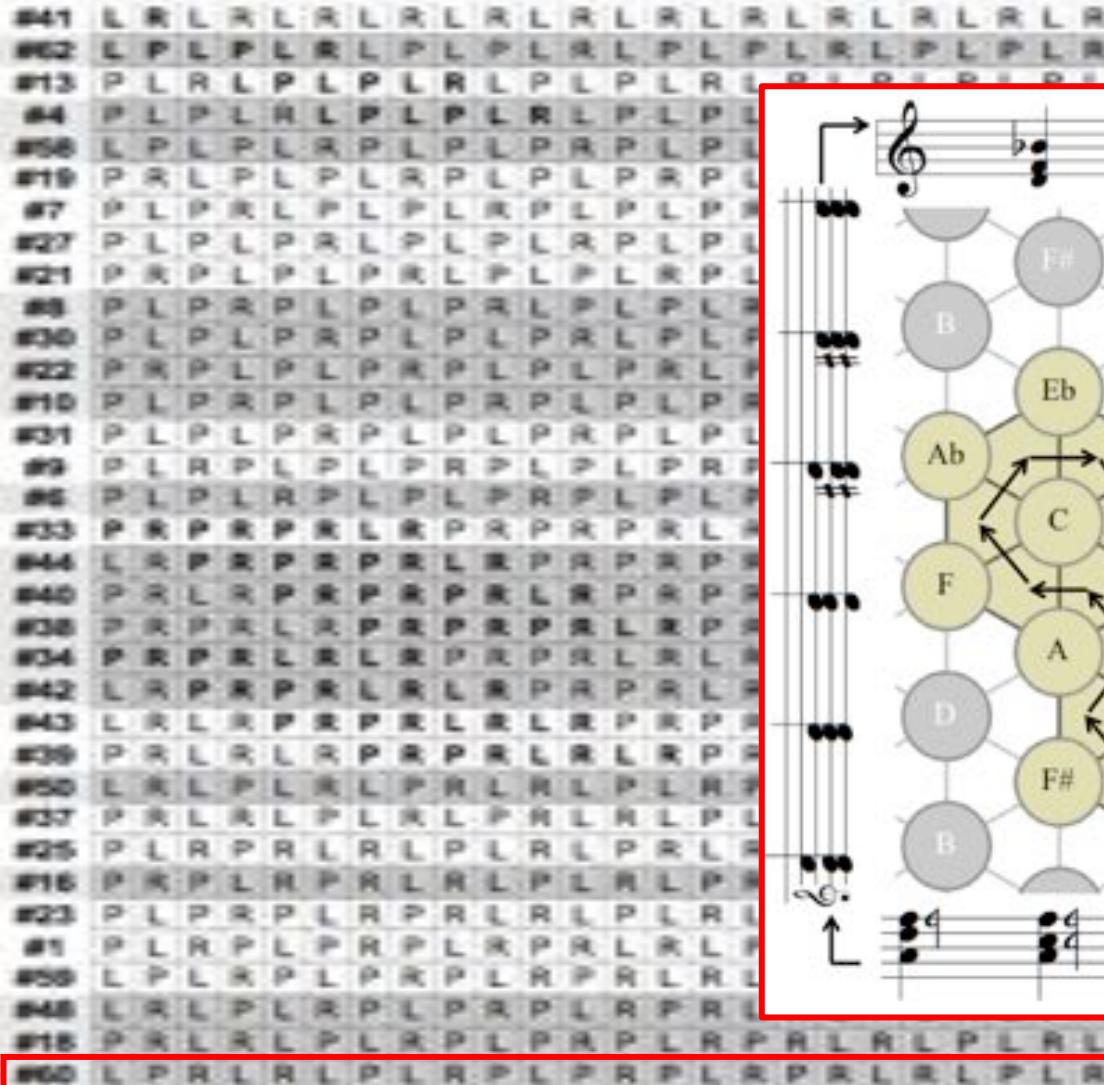
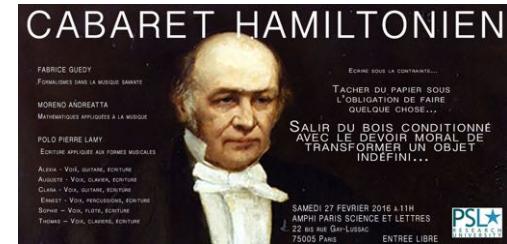


The collection of 124 Hamiltonian Cycles

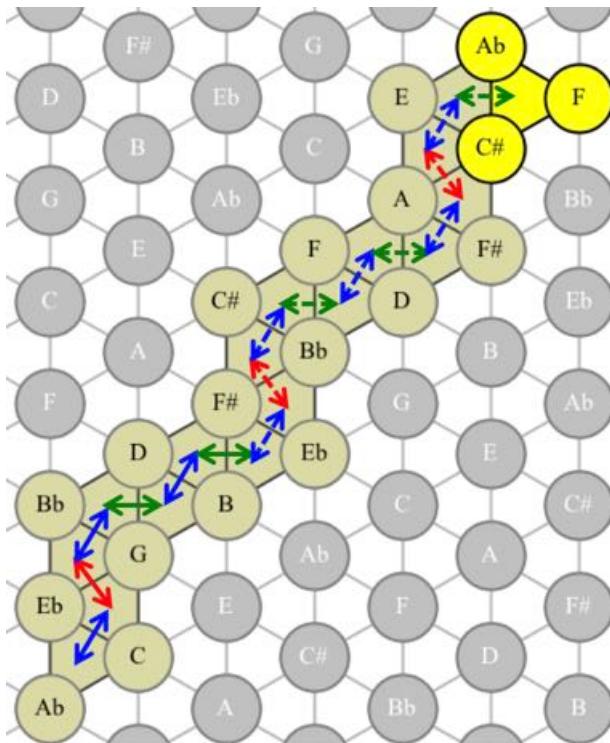
ACTIONS

Math'n'pop

Aprile (d'après Gabriele D'Annunzio)



La sera non è più la tua canzone (after Mario Luzi)

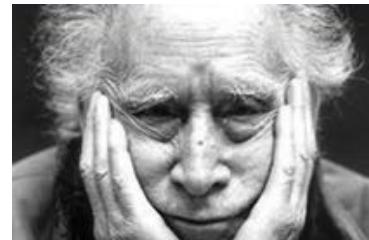


**La sera non è più la tua canzone,
è questa roccia d'ombra traforata
dai lumi e dalle voci senza fine,
la quiete d'una cosa già pensata.**

**Ah questa luce viva e chiara viene
solo da te, sei tu così vicina
al vero d'una cosa conosciuta,
per nome hai una parola ch'è passata
nell'intimo del cuore e s'è perduta.**

**Caduto è più che un segno della vita,
riposi, dal viaggio sei tornata
dentro di te, sei scesa in questa pura
sostanza così tua, così romita
nel silenzio dell'essere, (compiuta).**

**L'aria tace ed il tempo dietro a te
si leva come un'arida montagna
dove vaga il tuo spirito e si perde,
un vento raro scivola e ristagna.**



M. Luzi (1914-2005)

*Le soir n'est plus ta chanson,
c'est ce rocher d'ombre transpercé
par les lumières et les voix sans fin,
la paix d'une chose déjà pensée.*

*Ah, cette lumière vive et claire vient
uniquement de toi, tu es si proche
du vrai d'une chose connue,
tu as pour nom une parole qui est passée
dans l'intimité du cœur où elle s'est
perdue .*

*Tombé est plus qu'un signe de la vie,
tu te reposes, du voyage tu es revenue
à l'intérieur de toi même, tu es
descendue dans cette
pure substance qui est si tienne,
si éloignée
dans le silence de l'être, achevée.*

*L'air se tait et le temps derrière toi
se lève tel une montagne aride
où plane ton esprit et se perd,
un vent rare glisse et stagne.*

(tr. Antonia Soulez, philosophe et poète)

Music: M. Andreatta
Arrangement and mix: M. Bergomi & S. Geravini
(Perfect Music Production)
Mastering: A. Cutolo (Massive Arts Studio, Milan)

Luzi



Hamiltonian Song
on
SpinnenTonnetz
2014

Lyrics by Mario Luzi

Music and Vocals by Moreno Andreatta

Graphics and Animation by Gilles Baroin

SpinnenTonnetz by Gilles Baroin, Hugò Seress

Original "Chicken Wire" graph by J.Douthett, P.Steinbach



Gilles Baroin

→ www.mathemusic.net



From poetry to song writing:

hamiltonian compositional strategies

A part (Andrée Chedid, poème tiré du recueil *Rhymes Collection Poésie/Gallimard* (n. 527), Gallimard, 2018)

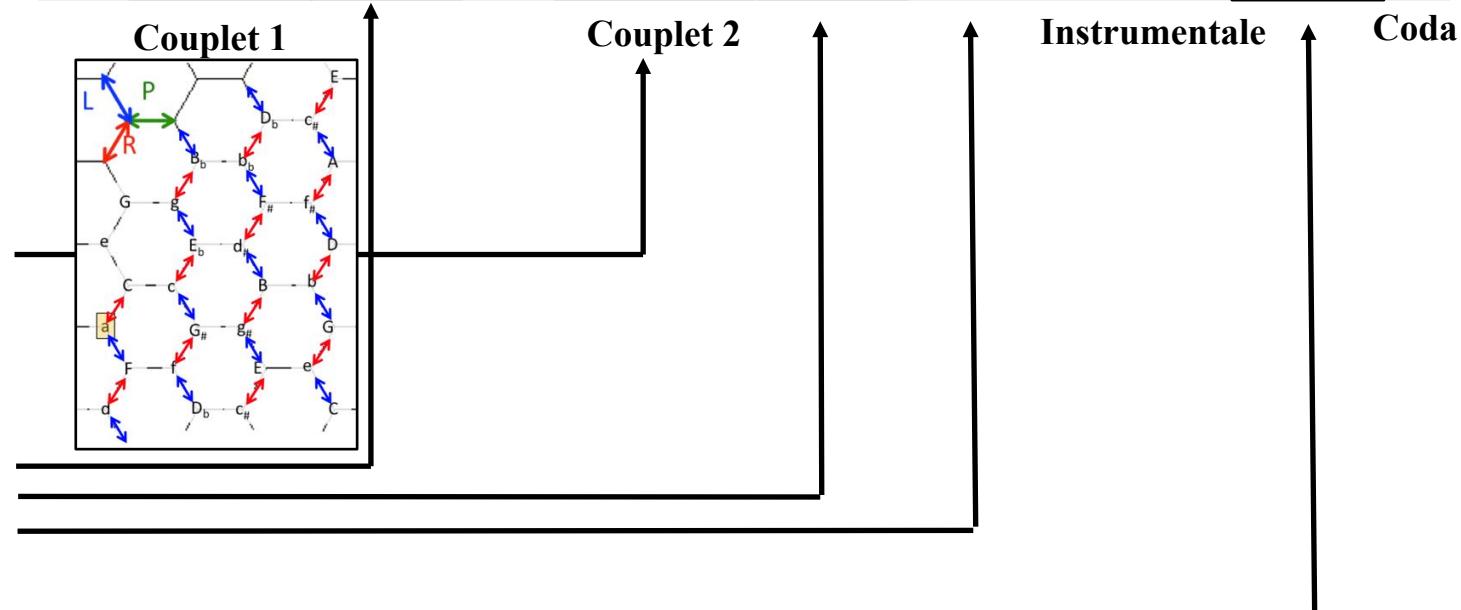
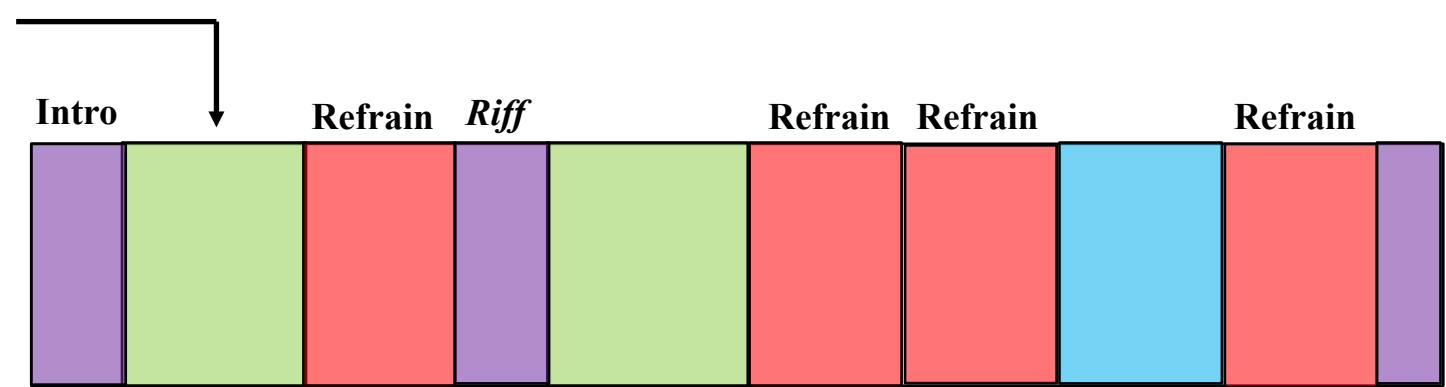


À part le temps
Et ses rouages
À part la terre
En éruptions
À part le ciel
Pétrisseur de nuages
À part l'ennemi
Qui génère l'ennemi

À part le désamour
Qui ronge l'illusion
À part la durée
Qui moisit nos visages

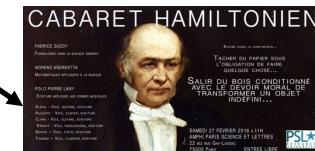
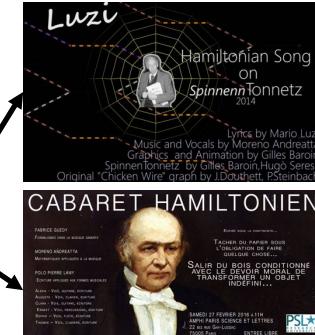
À part les fléaux
À part la tyrannie
À part l'ombre et le crime
Nos batailles nos outrages

Je te célèbre ô Vie
Entre cavités et songes
Intervalle convoité
Entre le vide et le rien



The collection of 28 ‘redundant’ Hamiltonian Cycles

1. C-Cm-Ab-Abm-E-C#m-A-Am-F-Fm-C#-Bbm-F#-F#m-D-Dm-Bb-Gm-Eb-Ebm-B-Bm-G-Em--PLPLRL
2. C-Cm-Ab-Fm-C#-C#m-A-Am-F-Dm-Bb-Bbm-F#-F#m-D-Bm-G-Gm-Eb-Ebm-B-Abm-E-Em--PLRLPL
3. C-Cm-Eb-Ebm-F#-F#m-A-C#m-E-Em-G-Gm-Bb-Bbm-C#-Fm-Ab-Abm-B-Bm-D-Dm-F-Am--PRPRPRLR
4. C-Cm-Eb-Ebm-F#-Bbm-C#-C#m-E-Em-G-Gm-Bb-Dm-F-Fm-Ab-Abm-B-Bm-D-F#m-A-Am--PRPRLRPR
5. C-Cm-Eb-Ebm-F#-Bbm-C#-Fm-Ab-Abm-B-Bm-D-F#m-A-C#m-E-Em-G-Gm-Bb-Dm-F-Am--PRPRLRLR
6. C-Cm-Eb-Gm-Bb-Bbm-C#-C#m-E-Em-G-Bm-D-Dm-F-Fm-Ab-Abm-B-Ebm-F#-F#m-A-Am--PRLRPRPR
7. C-Cm-Eb-Gm-Bb-Bbm-C#-Fm-Ab-Abm-B-Ebm-F#-F#m-A-C#m-E-Em-G-Bm-D-Dm-F-Am--PRLRLR
8. C-Cm-Eb-Gm-Bb-Dm-F-Fm-Ab-Abm-B-Ebm-F#-Bbm-C#-C#m-E-Em-G-Bm-D-F#m-A-Am--PRLRLRPR
9. C-Em-E-Abm-Ab-Cm-Eb-Gm-G-Bm-B-Ebm-F#-Bbm-Bb-Dm-D-F#m-A-C#m-C#-Fm-F-Am--LPLPLR
10. C-Em-E-Abm-B-Ebm-Eb-Gm-G-Bm-D-F#m-F#-Bbm-Bb-Dm-F-Am-A-C#m-C#-Fm-Ab-Cm--LPLRLP
11. C-Em-G-Gm-Bb-Bbm-C#-C#m-E-Abm-B-Bm-D-Dm-F-Fm-Ab-Cm-Eb-Ebm-F#-F#m-A-Am--LRPRPRPR
12. C-Em-G-Gm-Bb-Bbm-C#-Fm-Ab-Cm-Eb-Ebm-F#-F#m-A-C#m-E-Abm-B-Bm-D-Dm-F-Am--LRPRPRLR
13. C-Em-G-Gm-Bb-Dm-F-Fm-Ab-Cm-Eb-Ebm-F#-Bbm-C#-C#m-E-Abm-B-Bm-D-F#m-A-Am--LRPR
14. C-Em-G-Bm-B-Ebm-Eb-Gm-Bb-Dm-D-F#m-F#-Bbm-C#-Fm-F-Am-A-C#m-E-Abm-Ab-Cm--LRLPLP
15. C-Em-G-Bm-D-Dm-F-Fm-Ab-Cm-Eb-Gm-Bb-Bbm-C#-C#m-E-Abm-B-Ebm-F#-F#m-A-Am--LRLRPRPR
16. C-Em-G-Bm-D-F#m-A-C#m-E-Abm-B-Ebm-F#-Bbm-C#-Fm-Ab-Cm-Eb-Gm-Bb-Dm-F-Am--LR
17. C-Am-A-F#m-F#-Ebm-Eb-Cm-Ab-Fm-F-Dm-D-Bm-B-Abm-E-C#m-C#-Bbm-Bb-Gm-G-Em--RPRPRPRL
18. C-Am-A-F#m-F#-Ebm-B-Abm-Ab-Fm-F-Dm-D-Bm-G-Em-E-C#m-C#-Bbm-Bb-Gm-Eb-Cm--RPRPLRP
19. C-Am-A-F#m-F#-Ebm-B-Abm-E-C#m-C#-Bbm-Bb-Gm-Eb-Cm-Ab-Fm-F-Dm-D-Bm-G-Em--RPRPRLRL
20. C-Am-A-F#m-D-Bm-B-Abm-Ab-Fm-F-Dm-Bb-Gm-G-Em-E-C#m-C#-Bbm-F#-Ebm-Eb-Cm--RPRLRPRP
21. C-Am-A-F#m-D-Bm-B-Abm-E-C#m-C#-Bbm-F#-Ebm-Eb-Cm-Ab-Fm-F-Dm-Bb-Gm-G-Em--RPRPL
22. C-Am-A-F#m-D-Bm-G-Em-E-C#m-C#-Bbm-F#-Ebm-B-Abm-Ab-Fm-F-Dm-Bb-Gm-Eb-Cm--RPRRLRLP
23. C-Am-F-Fm-C#-C#m-A-F#m-D-Dm-Bb-Bbm-F#-Ebm-B-Bm-G-Gm-Eb-Cm-Ab-Abm-E-Em--RLPLPL
24. C-Am-F-Dm-D-Bm-B-Abm-Ab-Fm-C#-Bbm-Bb-Gm-G-Em-E-C#m-A-F#m-F#-Ebm-Eb-Cm--RLRPRPRP
25. C-Am-F-Dm-D-Bm-B-Abm-E-C#m-A-F#m-F#-Ebm-Eb-Cm-Ab-Fm-C#-Bbm-Bb-Gm-G-Em--RLRPRPRL
26. C-Am-F-Dm-D-Bm-G-Em-E-C#m-A-F#m-F#-Ebm-B-Abm-Ab-Fm-C#-Bbm-Bb-Gm-Eb-Cm--RLRP
27. C-Am-F-Dm-Bb-Gm-G-Em-E-C#m-A-F#m-D-Bm-B-Abm-Ab-Fm-C#-Bbm-F#-Ebm-Eb-Cm--RLRLRPRP
28. C-Am-F-Dm-Bb-Gm-Eb-Cm-Ab-Fm-C#-Bbm-F#-Ebm-B-Abm-E-C#m-A-F#m-D-Bm-G-Em--RL



Le Blé en Herbe



ANDRÉ CHEDID
Rythmes

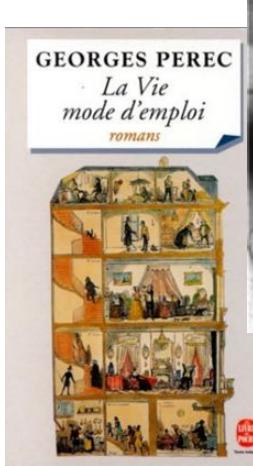
Photo: André Chedid

ef
éditions du Seuil

The use of constraints in arts



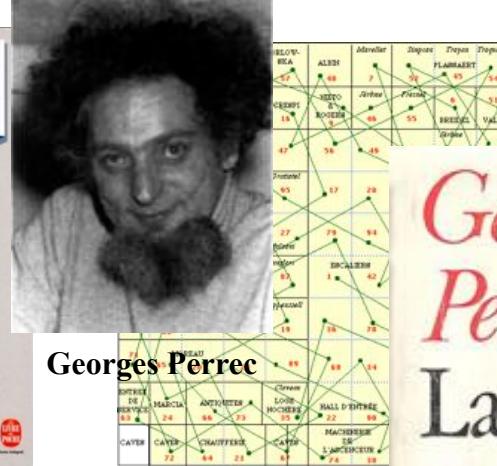
Cent mille milliards de poèmes, 1961



La vie mode d'emploi,



Georges Perec



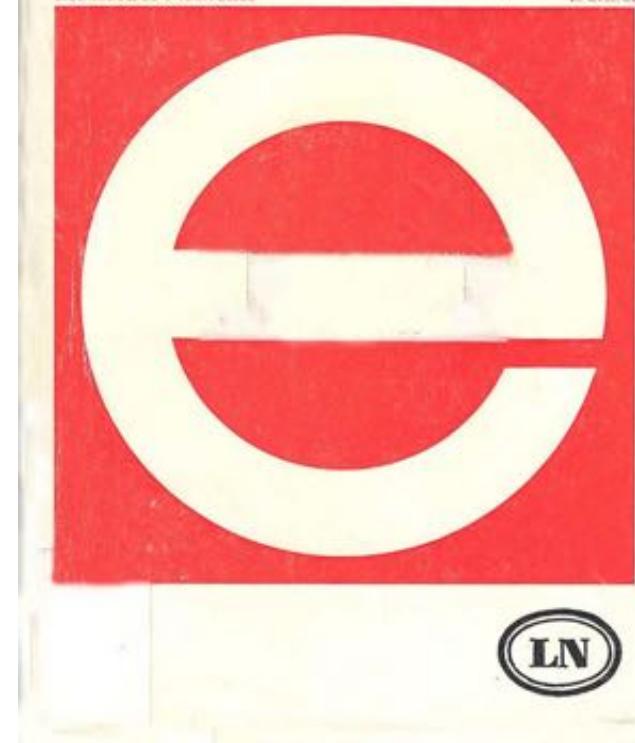
*Georges
Perec*

Roman

La disparition

Les Lettres Nouvelles

Denoël



Raymond Queneau



Italo Calvino

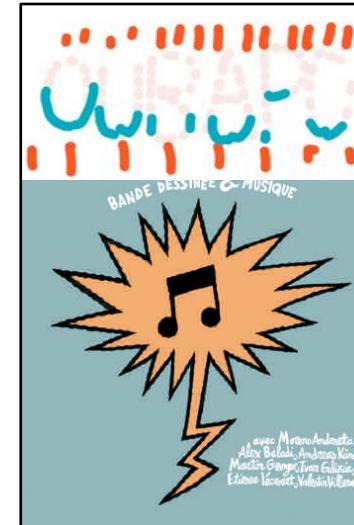
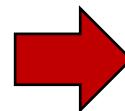
*Il castello dei destini
incrociati*, 1969

LN

From the OuLiPo to the OuMuPo (ouvroir de musique potentielle)



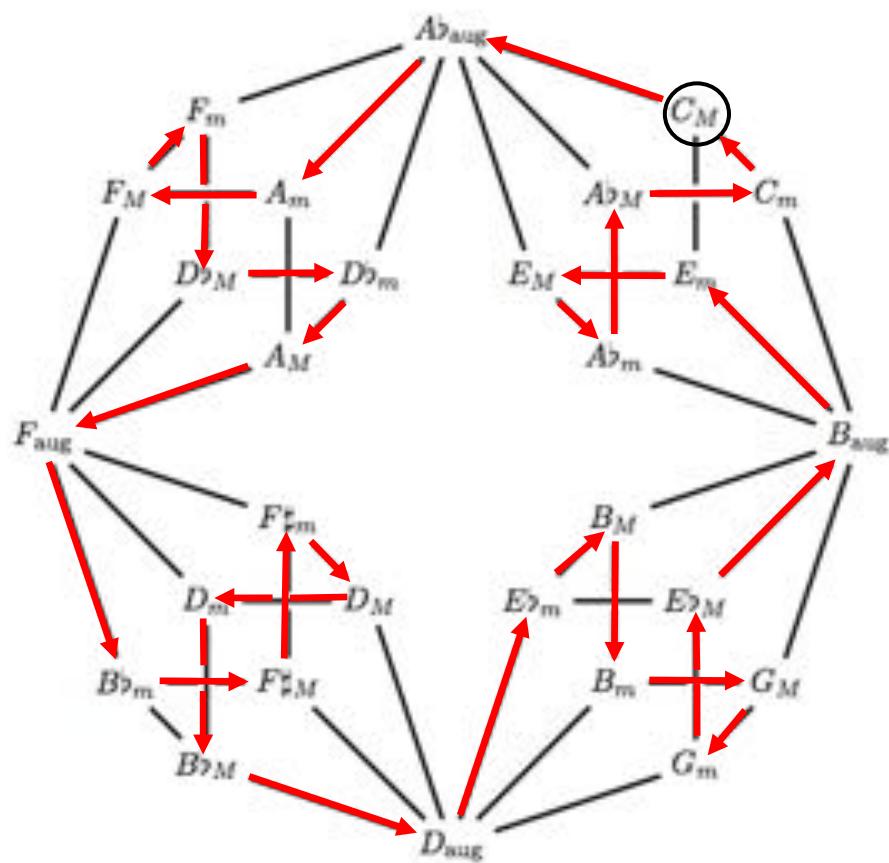
<http://oumupo.org/>



M. Andreatta et al., « Music, mathematics and language: chronicles from the Oumupo sandbox », in Kapoula, Z., Volle, E., Renault, J., Andreatta, M. (Eds.), *Exploring Transdisciplinarity in Art and Sciences*, Springer, 2018



The Gunner's Hamiltonian Dream (an *oumouopian* experiment on a song by Pink-Floyd)



The three main hamiltonian cycles ($C_M = C$, $C_m = Cm$, $C_{aug} = C+$)

$C \rightarrow C+ \rightarrow Am \rightarrow F \rightarrow Fm \rightarrow C\#m \rightarrow C\# \rightarrow A \rightarrow F+ \rightarrow Bbm \rightarrow F\# \rightarrow F\#m \rightarrow D \rightarrow Dm \rightarrow Bb \rightarrow D+ \rightarrow Ebm \rightarrow B \rightarrow Bm \rightarrow G \rightarrow Gm \rightarrow Eb \rightarrow G+ \rightarrow Em \rightarrow E \rightarrow G\#m \rightarrow G\# \rightarrow Cm \rightarrow C$

$C \rightarrow C+ \rightarrow Am \rightarrow F \rightarrow Fm \rightarrow C\#m \rightarrow C\# \rightarrow A \rightarrow F+ \rightarrow F\#m \rightarrow F\# \rightarrow Bbm \rightarrow Bb \rightarrow Dm \rightarrow D \rightarrow D+ \rightarrow Ebm \rightarrow B \rightarrow Bm \rightarrow G \rightarrow Gm \rightarrow Eb \rightarrow G+ \rightarrow Em \rightarrow E \rightarrow G\#m \rightarrow G\# \rightarrow Cm \rightarrow C$

$C \rightarrow C+ \rightarrow Am \rightarrow F \rightarrow Fm \rightarrow C\#m \rightarrow C\# \rightarrow A \rightarrow F+ \rightarrow F\#m \rightarrow D \rightarrow Dm \rightarrow Bb \rightarrow Bbm \rightarrow F\# \rightarrow D+ \rightarrow Ebm \rightarrow B \rightarrow Bm \rightarrow G \rightarrow Gm \rightarrow Eb \rightarrow G+ \rightarrow Cm \rightarrow G\# \rightarrow G\#m \rightarrow E \rightarrow Em \rightarrow C$

The Gunner's dream (R. Waters, 1983 / M. Andreatta, 2018)

(C)

C+
Floating down through the clouds

Am

F

Memories come rushing up to meet me now.

Fm

In the space between the heavens

C#

and in the corner of some foreign field

A

F+

Bbm

I had a dream.

C#m

F#

F#m

D

Dm

I had a dream.

Bb

Good-bye Max.

D+

Good-bye Ma.

Ebm

B

After the service when you're walking slowly to the car

Bm

G

And the silver in her hair shines in the cold November air

Gm

You hear the tolling bell

Eb

And touch the silk in your lapel

G+

And as the tear drops rise to meet the comfort of the band

G#

Cm

You take her frail hand

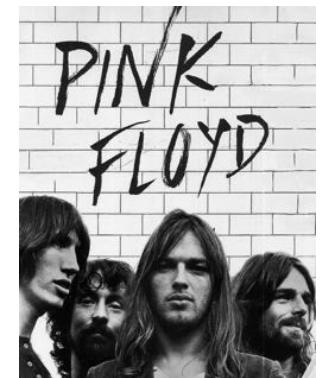
Em

E

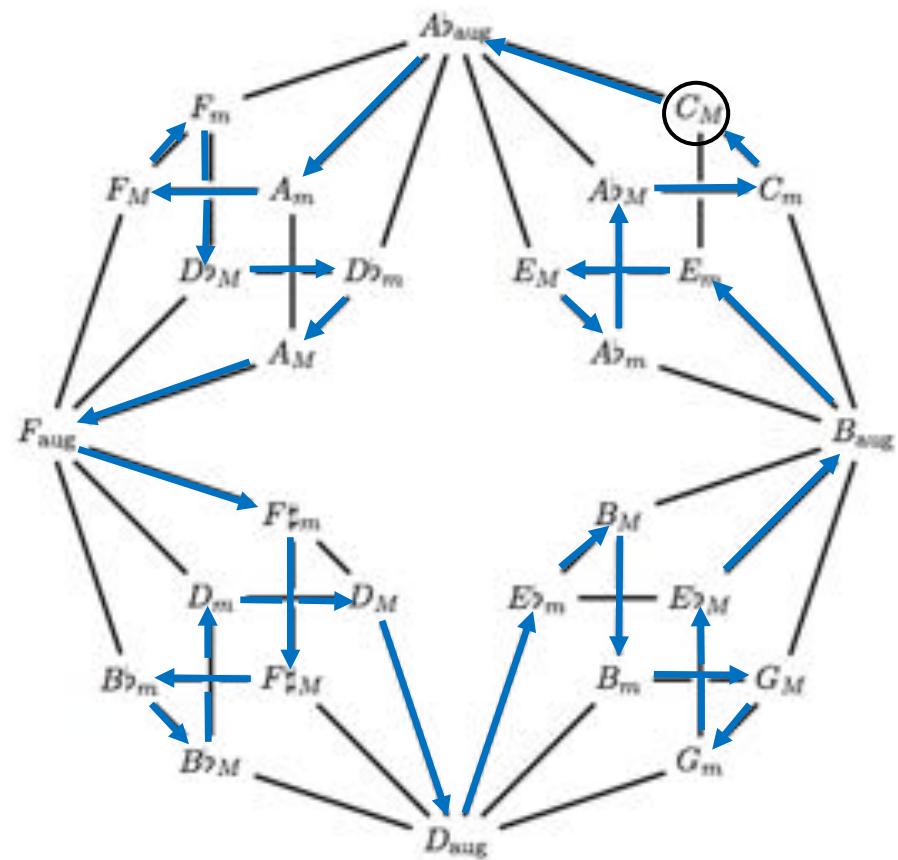
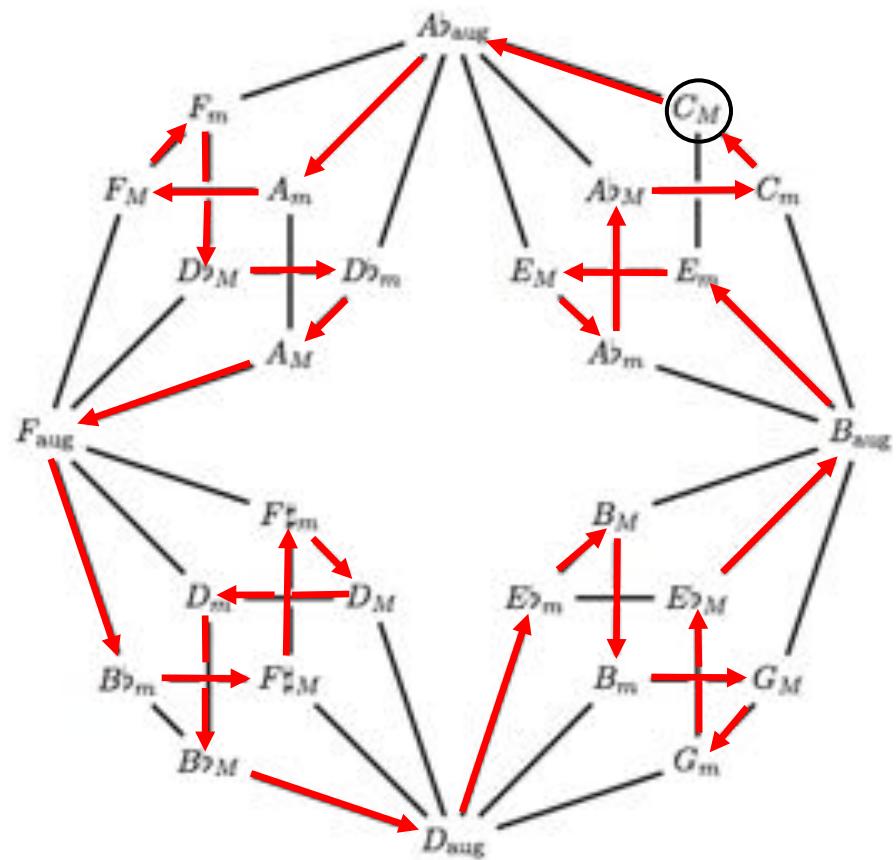
G#m

C

And hold on to the dream.



The Gunner's Hamiltonian Dream (an *oumouopian* experiment on a song by Pink-Floyd)

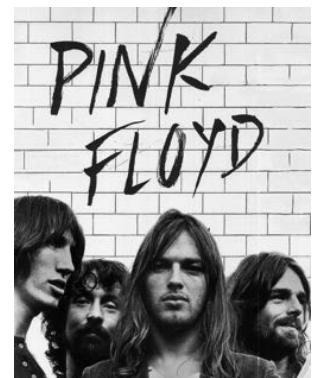


The three main hamiltonian cycles ($C_M = C$, $C_m = Cm$, $C_{aug} = C+$)

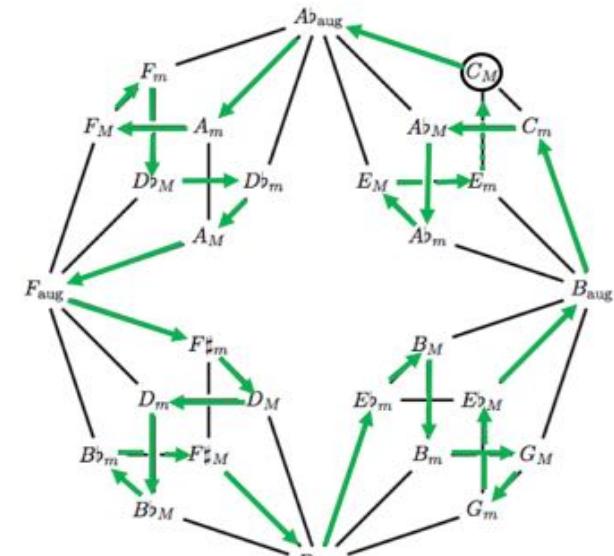
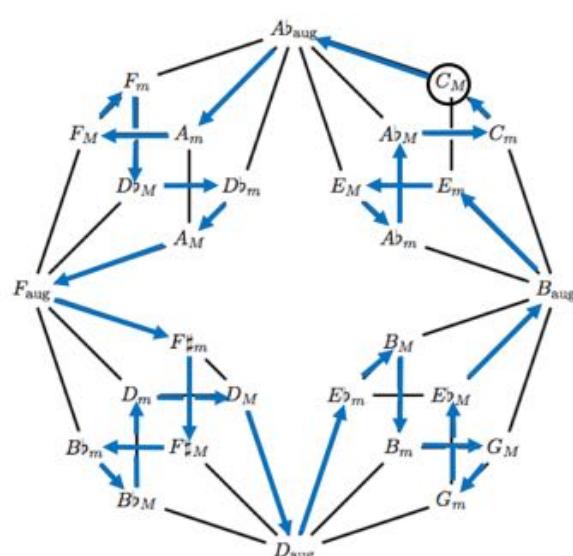
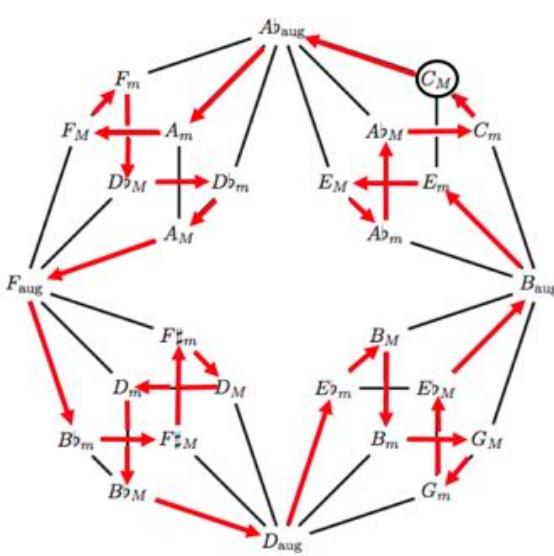
$C \rightarrow C+ \rightarrow Am \rightarrow F \rightarrow Fm \rightarrow C\# \rightarrow C\#m \rightarrow A \rightarrow F+ \rightarrow Bbm \rightarrow F\# \rightarrow F\#m \rightarrow D \rightarrow Dm \rightarrow Bb \rightarrow D+ \rightarrow Ebm \rightarrow B \rightarrow Bm \rightarrow G \rightarrow Gm \rightarrow Eb \rightarrow G+ \rightarrow Em \rightarrow E \rightarrow G\#m \rightarrow G\# \rightarrow Cm \rightarrow C$

$C \rightarrow C+ \rightarrow Am \rightarrow F \rightarrow Fm \rightarrow C\# \rightarrow C\#m \rightarrow A \rightarrow F+ \rightarrow F\#m \rightarrow F\# \rightarrow Bbm \rightarrow Bb \rightarrow Dm \rightarrow D \rightarrow D+ \rightarrow Ebm \rightarrow B \rightarrow Bm \rightarrow G \rightarrow Gm \rightarrow Eb \rightarrow G+ \rightarrow Em \rightarrow E \rightarrow G\#m \rightarrow G\# \rightarrow Cm \rightarrow C$

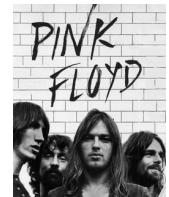
$C \rightarrow C+ \rightarrow Am \rightarrow F \rightarrow Fm \rightarrow C\# \rightarrow C\#m \rightarrow A \rightarrow F+ \rightarrow F\#m \rightarrow D \rightarrow Dm \rightarrow Bb \rightarrow Bbm \rightarrow F\# \rightarrow D+ \rightarrow Ebm \rightarrow B \rightarrow Bm \rightarrow G \rightarrow Gm \rightarrow Eb \rightarrow G+ \rightarrow Cm \rightarrow G\# \rightarrow G\#m \rightarrow E \rightarrow Em \rightarrow C$



The Gunner's Hamiltonian Dream (an *oumouopian* experiment on a song by Pink-Floyd)



The three main hamiltonian cycles ($C_M = C$, $C_m = Cm$, $C_{aug} = C+$)

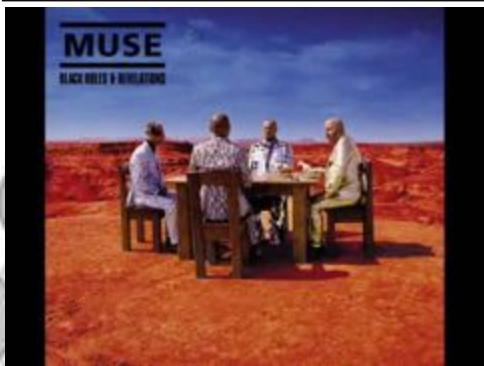


C-->C+-->Am-->F-->Fm-->C#m-->A-->F+->Bbm-->F#-->F#m-->D-->Dm-->Bb-->D+->Ebm-->B-->Bm-->
-->G-->Gm-->Eb-->G+->Em-->E-->G#m-->G#-->Cm-->C

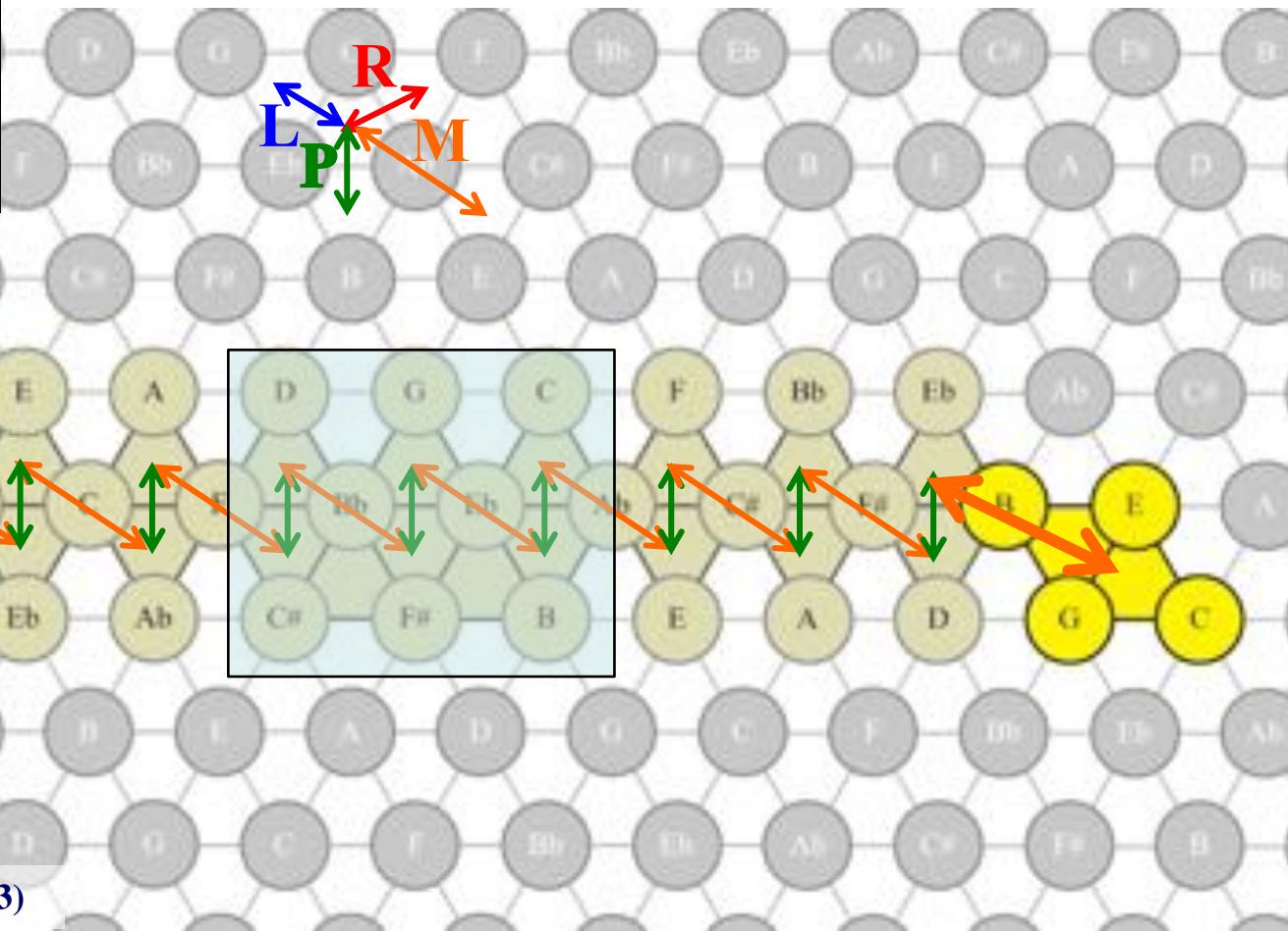
C->C+->Am-->F-->Fm-->C#m-->A-->F+->F#m-->F#-->Bbm-->Bb-->Dm-->D-->D+->Ebm-->B-->Bm-->-->G-->Gm-->Eb-->G+->Em-->E-->G#m-->G#-->Cm-->C

C->C+->Am-->F-->Fm-->C#-->C#m-->A-->F+->F#m-->D-->Dm-->Bb-->Bbm-->F#-->D+->Ebm-->B-->Bm-->G-->Gm-->Eb-->G+->Cm-->G#-->G#m-->E-->Em-->C

Symmetries and algorithmic processes in *Muse*



“Take a bow” (*Black Holes and Revelations*, 2006)



Hexachord (Louis Bigo, 2013)

Temporal axis

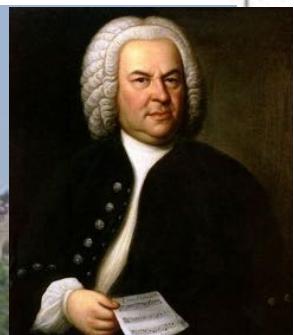
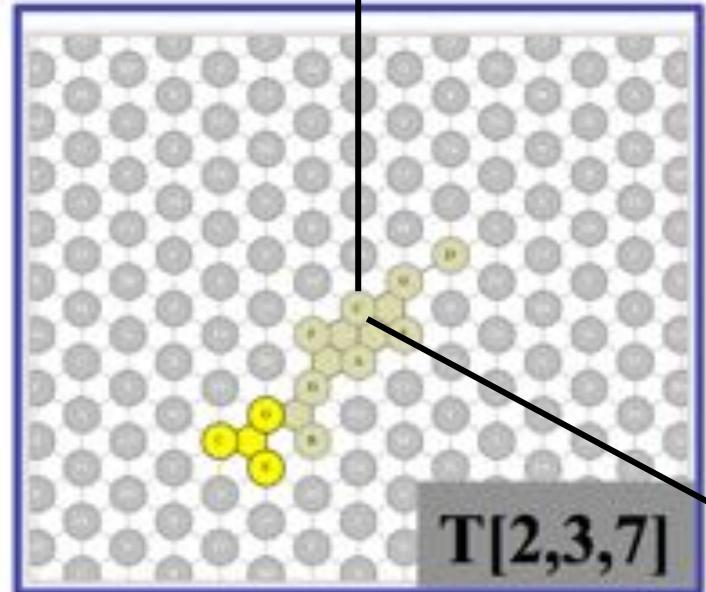
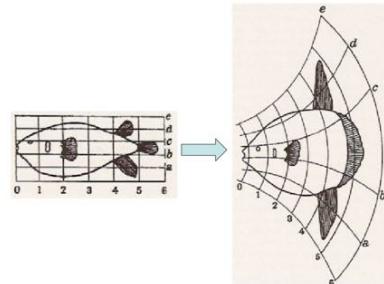
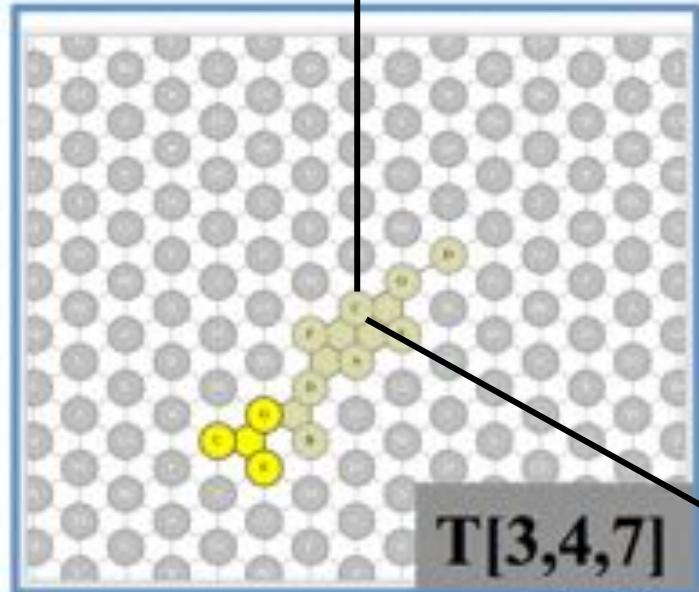
A Panoply of Tonnetze in the *Hexachord* environment

The screenshot displays the Hexachord software interface, which integrates several graphical and analytical tools for musical analysis:

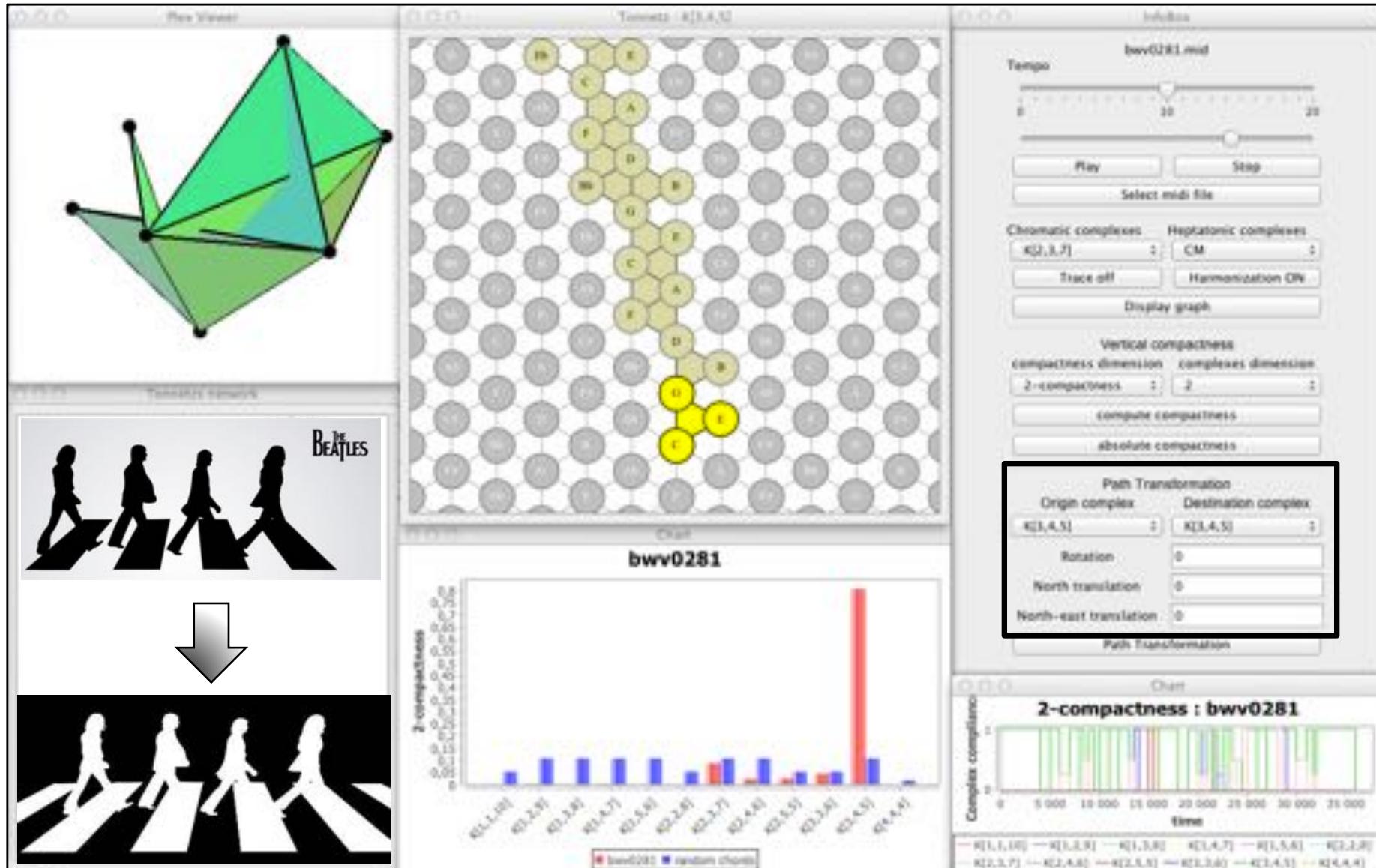
- Tonnetze View:** A 3D geometric representation of a hexachord's tonnetze, showing vertices and edges.
- Tonnetze (A3,3,4,2):** A hexagonal grid visualization where hexagons are labeled with letters (A through H) and numbers (1 through 4).
- InfoBox:** A control panel for audio playback and analysis settings, including:
 - Tempo slider (set to 30).
 - Play and Stop buttons.
 - Select midi file input.
 - Chromatic complexes dropdown (set to K(1,1,7)).
 - Heptatonic complexes dropdown (set to CM).
 - Trace off button.
 - Harmonization DN button.
 - Display graph button.
 - Vertical compactness section with compactness dimension (2), 2-compactness, compute compactness, and absolute compactness buttons.
 - Path Transformation section with origin complex (K(3,4,5)) and destination complex (K(3,4,5)), rotation (0), North translation (0), and North-east translation (0).
 - Chart section titled "2-compactness : bwv0281" showing a bar chart of compactness values over time.
- Computer Music Journal Article:** A thumbnail image of an article from the Computer Music Journal, Volume 35, Number 1, March 2011, featuring a geometric diagram and a hexachordal grid.
- Chart:** A bar chart titled "2-compactness : bwv0281" showing the distribution of 2-compactness values across 12 time steps. The x-axis is labeled with time steps: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11. The y-axis ranges from 0.00 to 0.20. The legend indicates two series: "bwv0281" (red bars) and "random choice" (blue bars). The "bwv0281" series shows a sharp peak at time step 10.

→ <http://www.lacl.fr/~lbigo/hexachord>

The musical style...is the space!

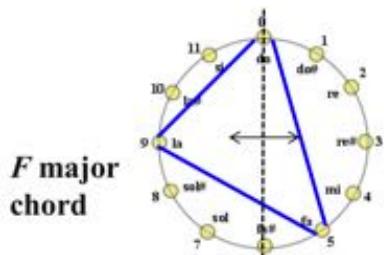
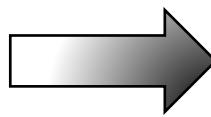


Keeping the space...but changing the trajectory!

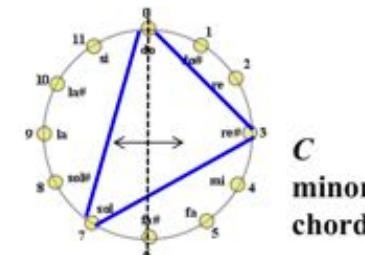


→ <http://www.lacl.fr/~lbigo/hexachord>

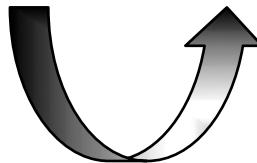
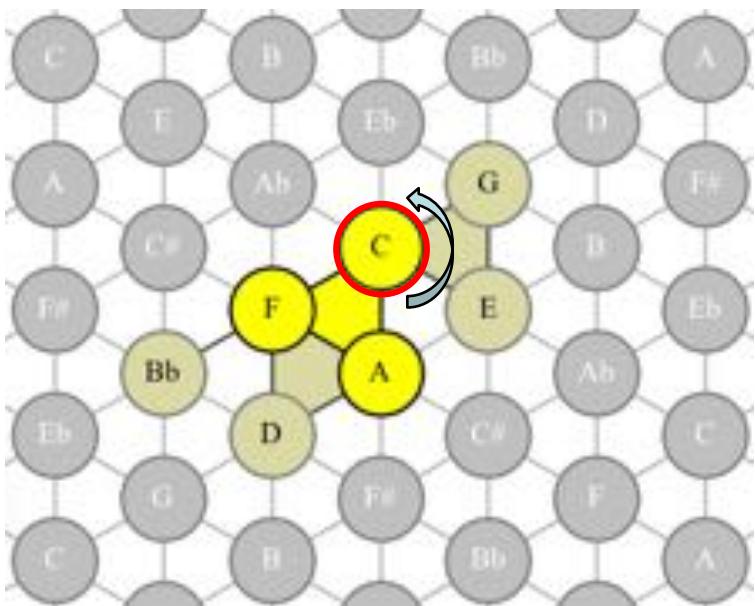
Keeping the space...but changing the trajectory!



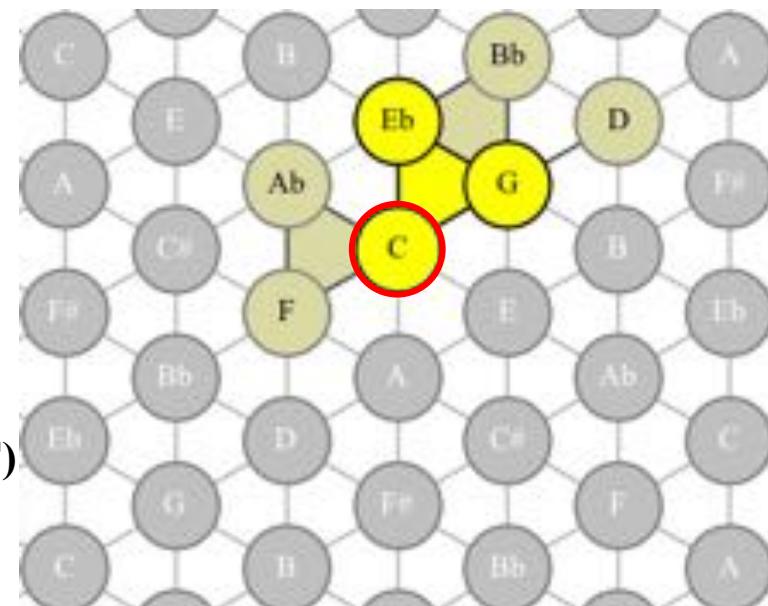
inversion



C
minor
chord



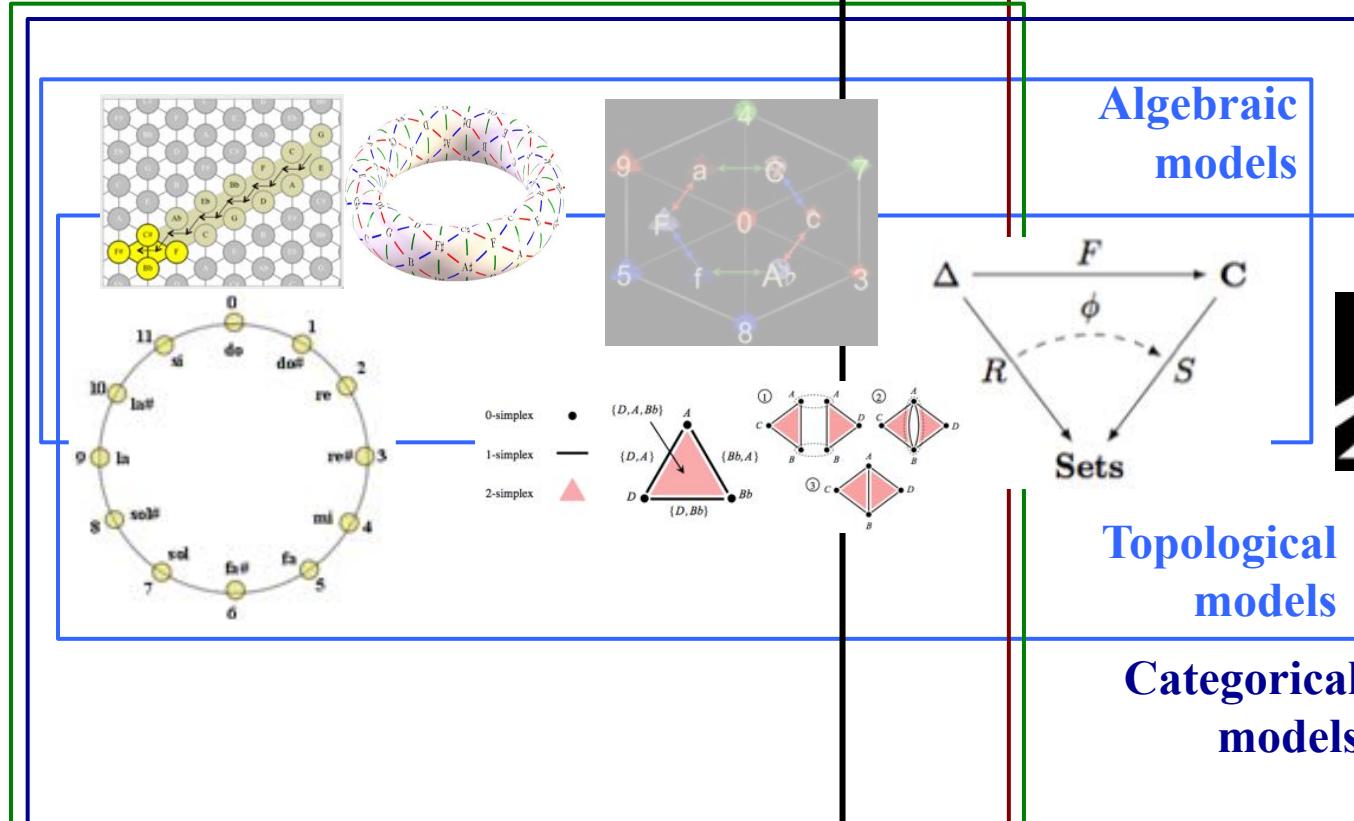
Rotation
(around the C)



Beatles, *Hey Jude* (orig. version)

Beatles, *Hey Jude* (transformed version)

The SMIR Project: Structural Music Information Research

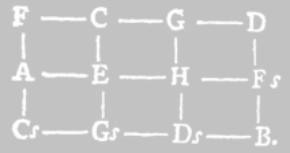


Computational models

Cognitive models

Structural Symbolic Music
Information Research

<http://repmus.ircam.fr/moreno/smir>



THANK YOU FOR YOUR ATTENTION