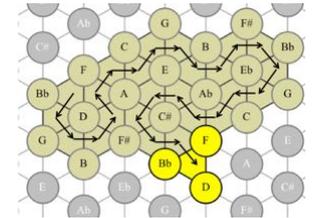
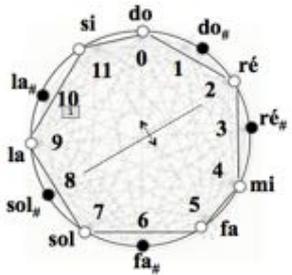


Modèles mathématiques et computationnels dans la chanson

Analyse de la musique et des répertoire III :
Musiques actuelles
(partie IV: espaces généralisés)



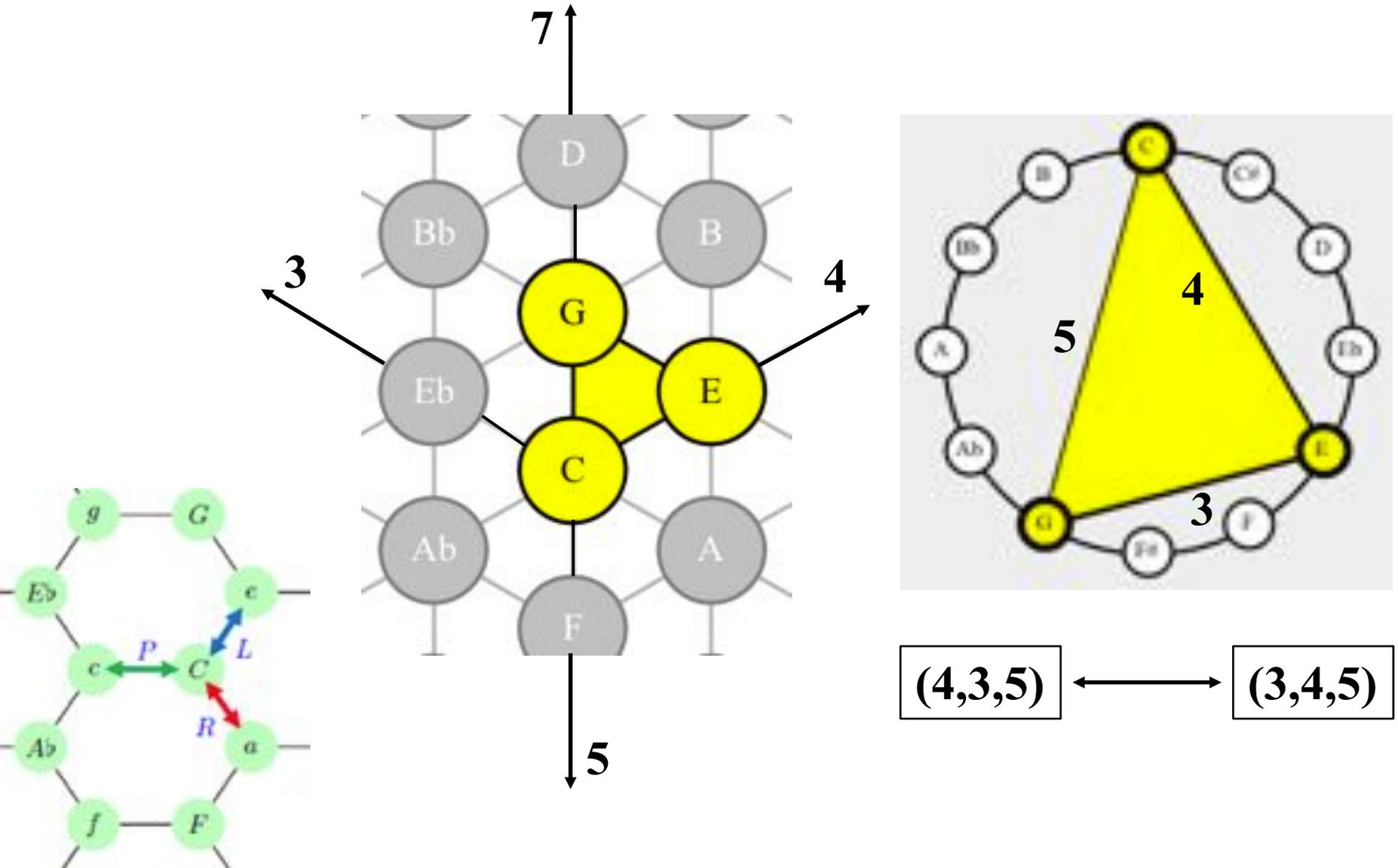
Moreno Andreatta

Equipe Représentations Musicales

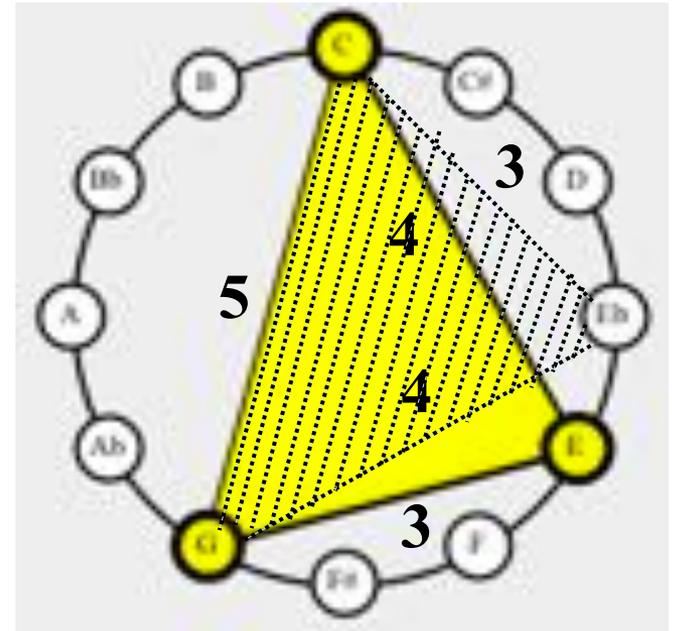
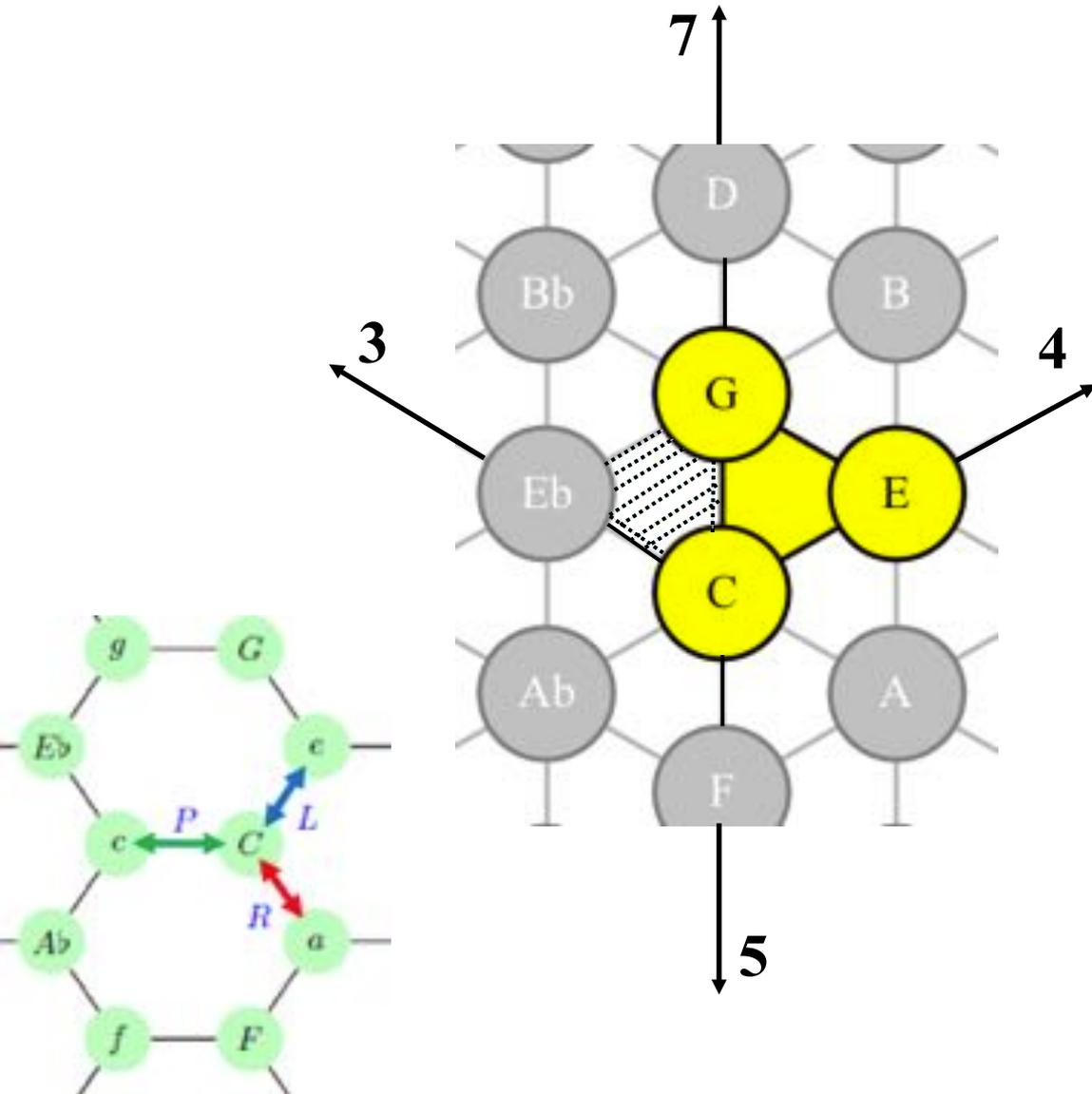
IRCAM / CNRS UMR 9912 / Sorbonne Université

IRMA & GREAM, Université de Strasbourg

Du Tonnetz aux Tonnetze

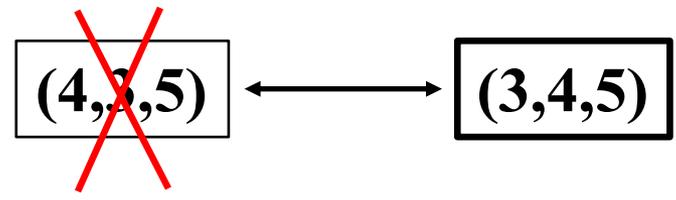
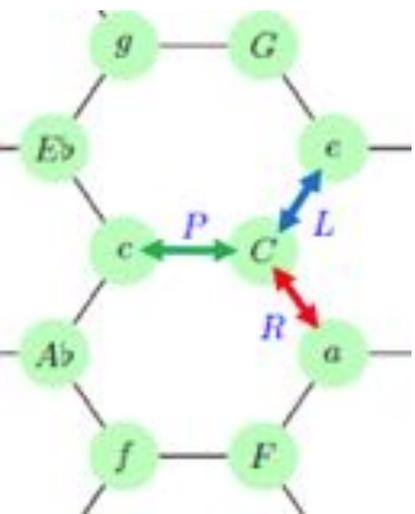
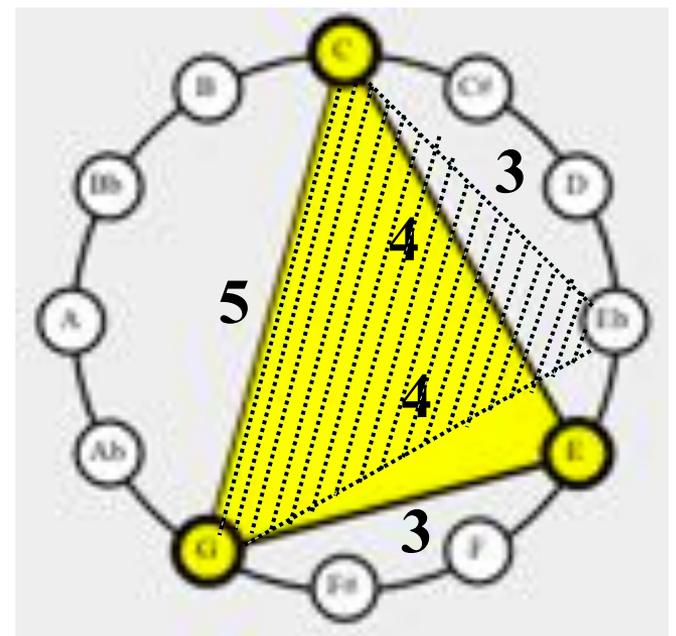
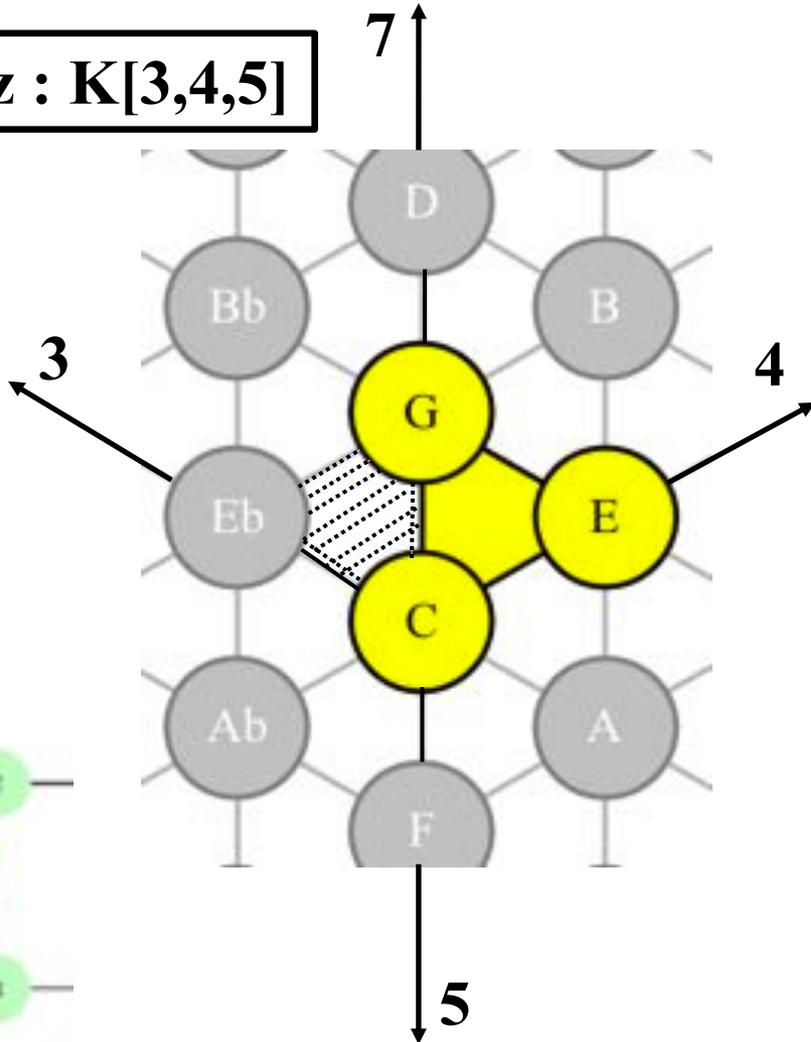


Du *Tonnetz* aux *Tonnetze*



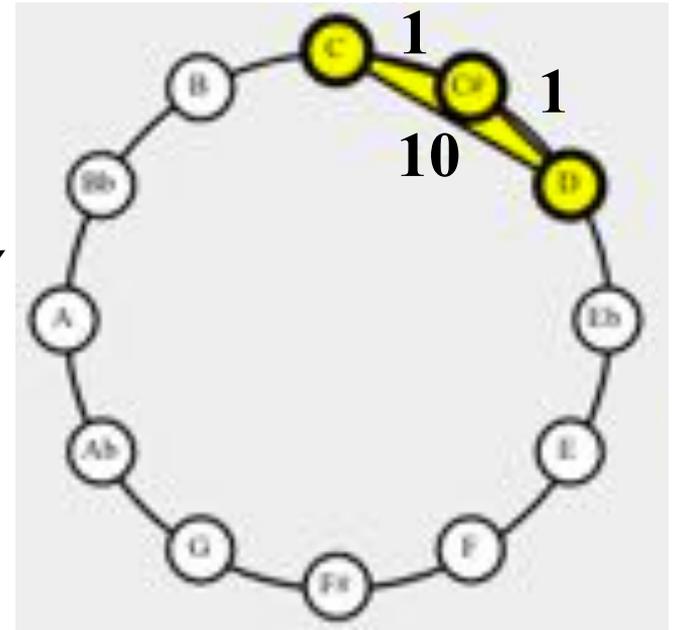
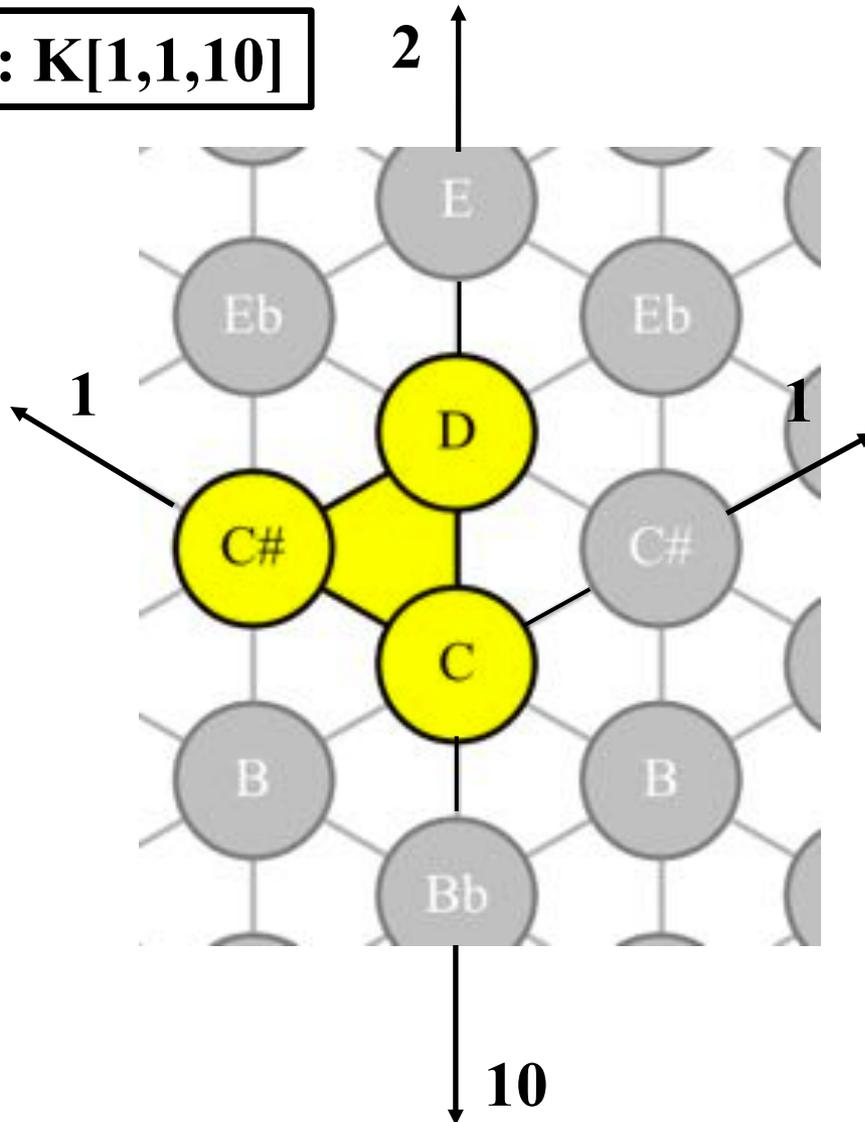
Du *Tonnetz* aux *Tonnetze*

Tonnetz : $K[3,4,5]$



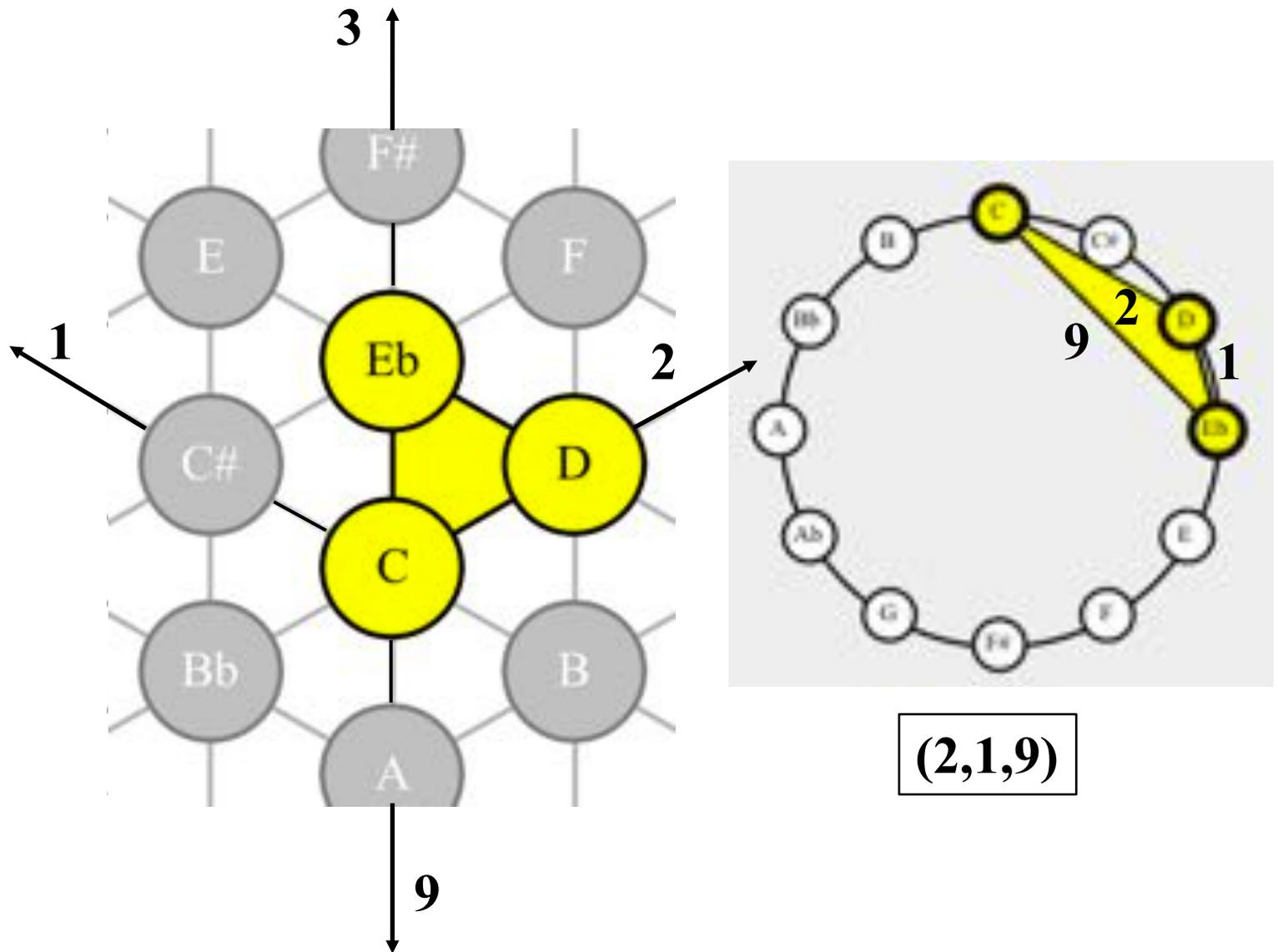
Du *Tonnetz* aux *Tonnetze*

Tonnetz : $K[1,1,10]$

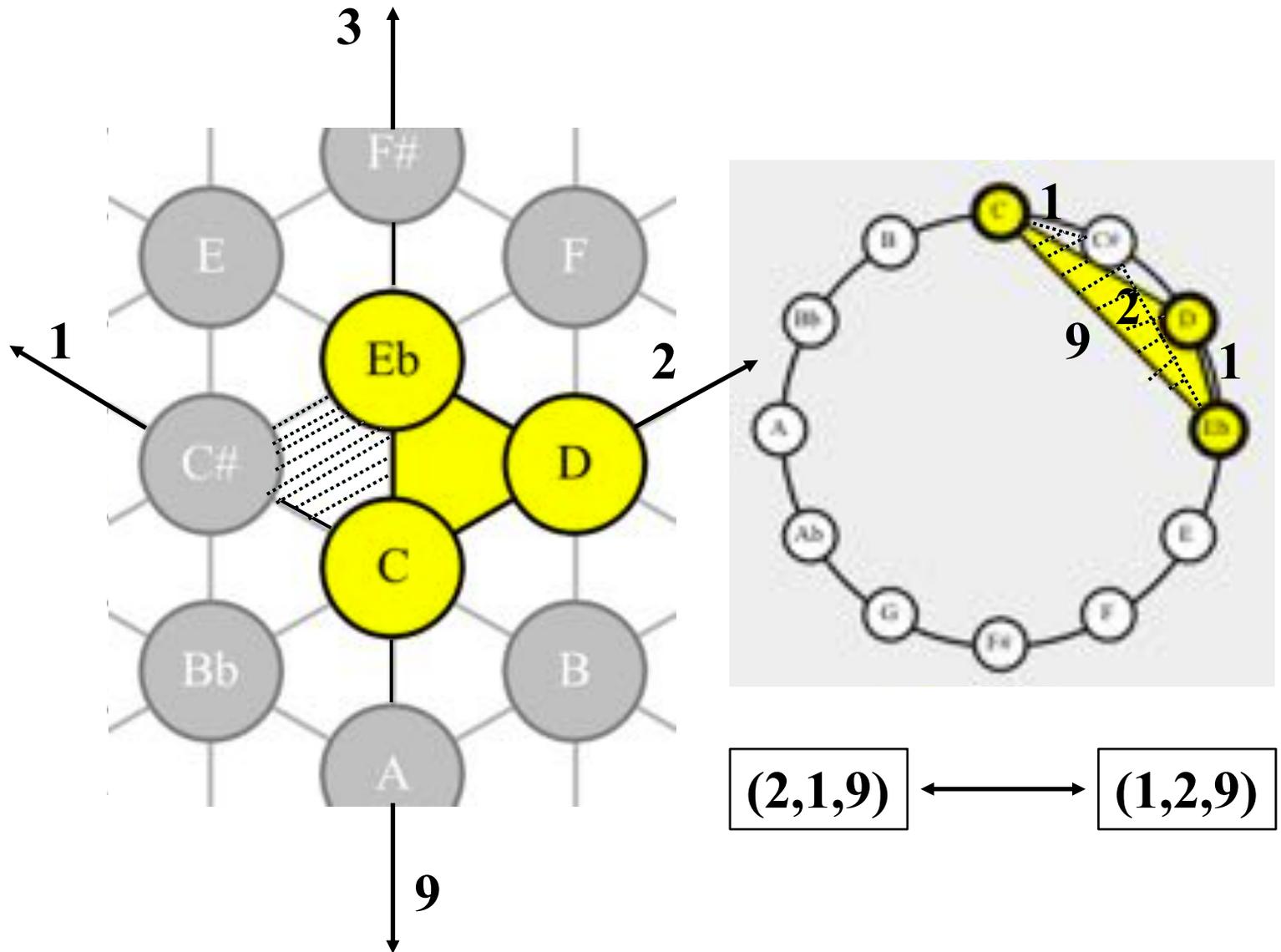


$(1,1,10)$

Du Tonnetz aux Tonnetze

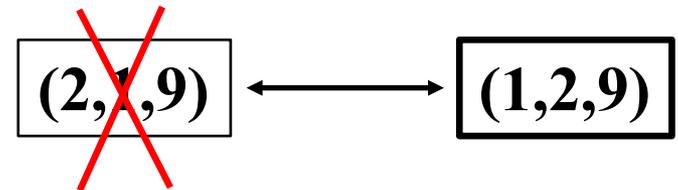
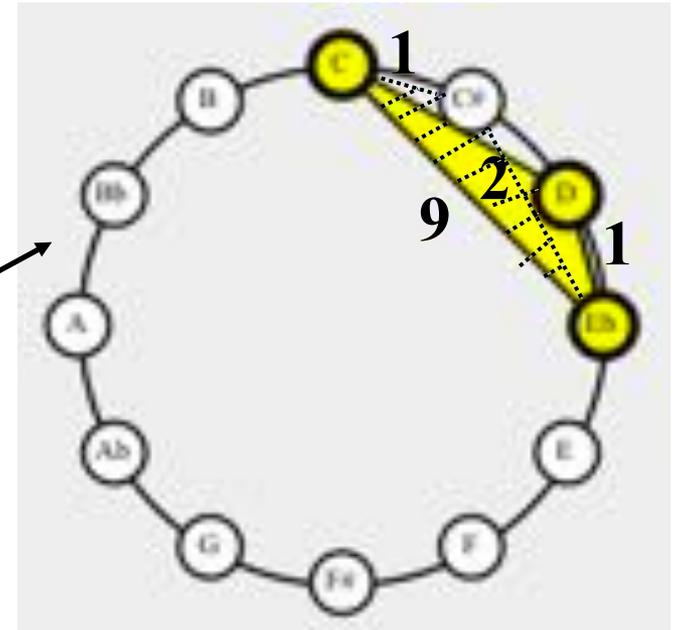
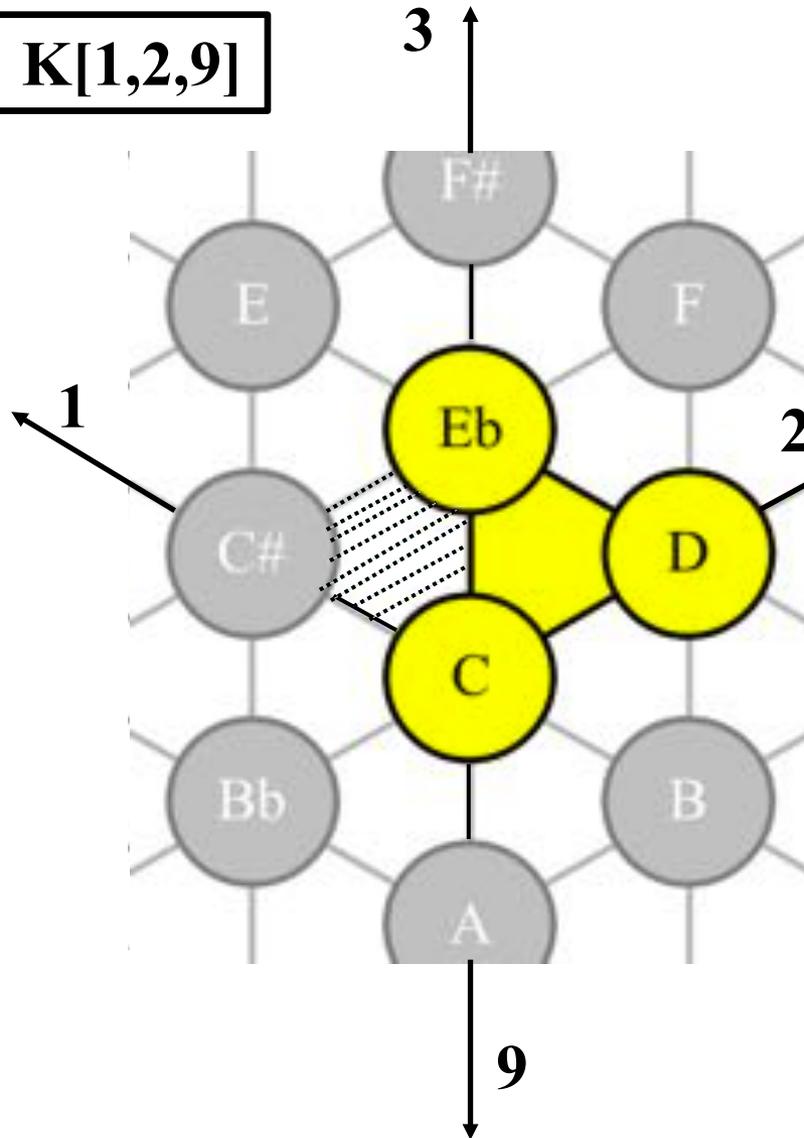


Du Tonnetz aux Tonnetze



Du Tonnetz aux Tonnetze

Tonnetz : $K[1,2,9]$



Choix de l'espace de représentation dans *Hexachord*

The screenshot displays the Hexachord software interface, which is used for analyzing musical structures. It is divided into several panels:

- File Viewer:** Shows a 3D visualization of a complex polyhedron, likely representing a chord space.
- Timbrez (K[3,4,5]):** A grid of circles representing notes, with a path of yellow circles highlighting a specific sequence of notes.
- Controls:** Includes a tempo slider (set to 20), Play/Stop buttons, and a 'Select midi file' button. A box highlights the 'Chromatic complexes' section, showing 'K[2,3,7]' selected.
- Vertical compactness:** A section with sliders for 'compactness dimension' (set to 2) and 'complexes dimension' (set to 2), and buttons for 'compute compactness' and 'absolute compactness'.
- Path Transformation:** A section with input fields for 'Origin complex' (K[3,4,5]) and 'Destination complex' (K[3,4,5]), and sliders for 'Rotation', 'North translation', and 'North-east translation'.
- Chart:** A bar chart titled 'bww0281' showing '2-compactness' for various complexes. The y-axis ranges from 0 to 10. The x-axis lists complexes: K[1,1,0], K[1,2,0], K[1,3,0], K[1,4,7], K[1,5,0], K[2,2,0], K[2,3,7], K[2,4,0], K[2,5,0], K[3,3,0], K[3,4,5], and K[4,4,0]. The K[3,4,5] complex has the highest value, around 10.
- Chart:** A bar chart titled '2-compactness : bww0281' showing 'Complex compactness' over 'Time' (0 to 25,000). The y-axis ranges from 0 to 1. The chart shows multiple colored bars representing different complexes over time.

A small inset image shows a man, Louis Bigo, sitting at a desk with a laptop.

Louis Bigo

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

Hexachord et le problème de la classification stylistique

The collage illustrates the concept of hexachord classification through multiple visualizations and a software interface. The top-left shows a 3D geometric model of a hexachord. The top-middle displays a hexachord diagram on a circle of fifths grid. The top-right is a software interface for 'bww0281.mid' with various controls, including a 'compute compactness' button highlighted with a red box. The bottom-left shows the cover of 'Computer Music Journal'. The bottom-middle is a bar chart titled 'bww0281' comparing '2-compactness' for different hexachords. The bottom-right is a smaller bar chart titled '2-compactness : bww0281' showing 'Complex compactness' over time.

Computer Music Journal

bww0281

2-compactness

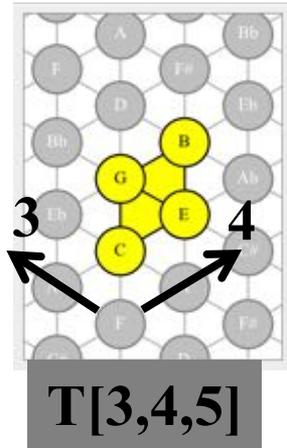
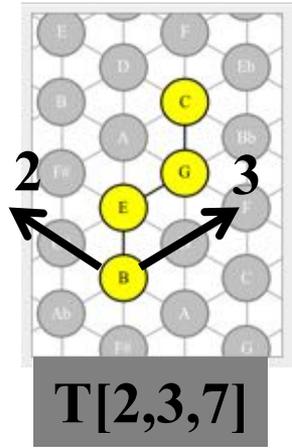
Complex compactness

Time

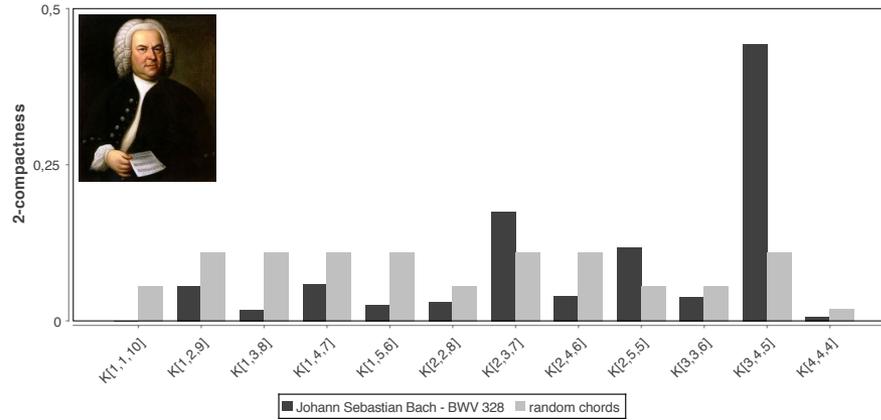
Louis Bigo

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

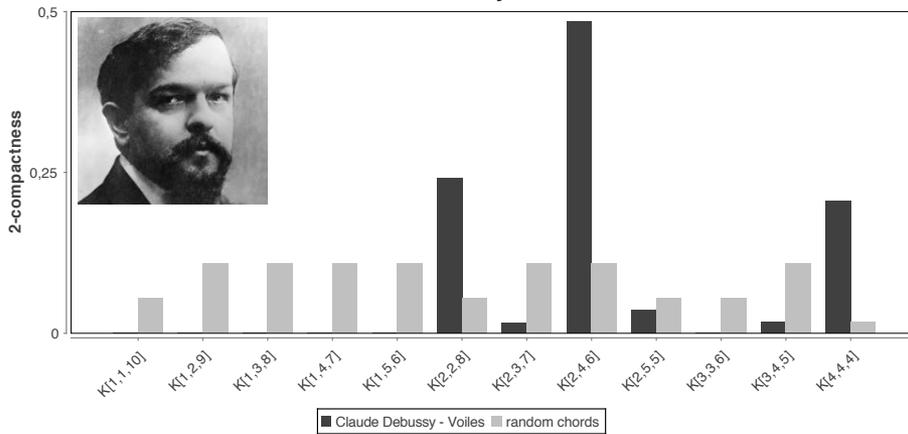
Le caractère spatial du « style musical »



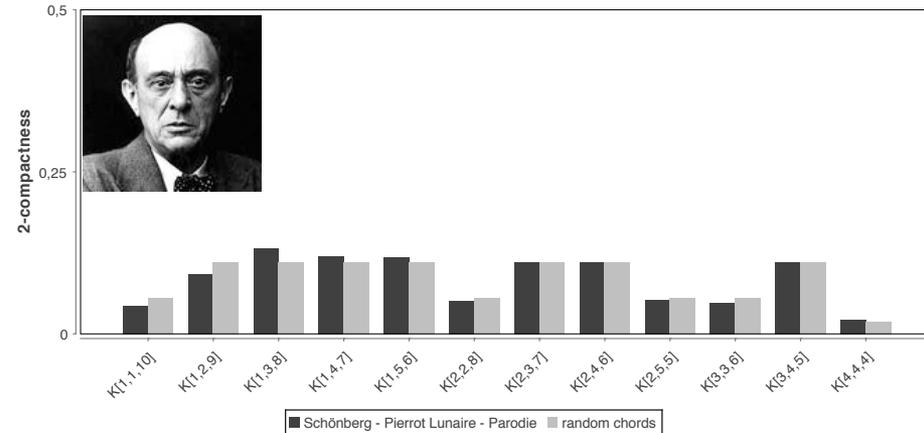
Johann Sebastian Bach - BWV 328



Claude Debussy - Voiles



Schönberg - Pierrot Lunaire - Parodie



« Embeddings » musicaux dans *Hexachord*

The screenshot displays the Hexachord software interface, which is used for analyzing musical structures. The interface is divided into several panels:

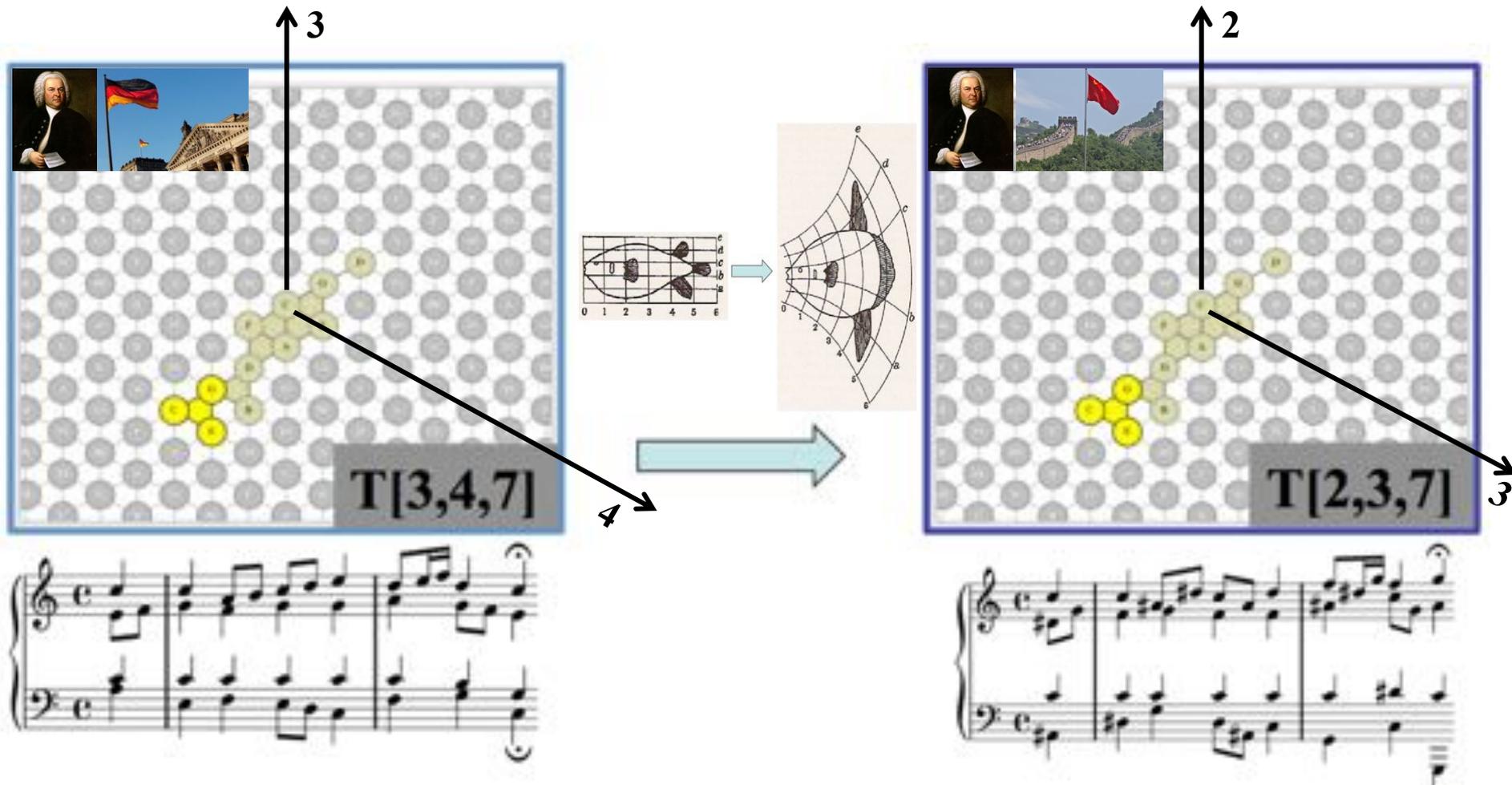
- File Viewer:** Shows a 3D geometric model of a hexachord, represented as a polyhedron with green and blue faces.
- Tomsetti: K[3,4,5]:** Displays a hexachord lattice (a grid of circles) with a path of yellow circles highlighted, representing a specific musical structure.
- Player:** A MIDI player interface for the file *bwv0281.mid*, including a tempo slider (set to 30), Play and Stop buttons, and a Select midi file button.
- Complexes:** A control panel for complex analysis, including Chromatic complexes (K[2,3,7]), Heptatonic complexes (CM), Trace off, Harmonization ON, Display graph, Vertical compactness (compactness dimension: 2, complexes dimension: 2), compute compactness, and absolute compactness.
- Path Transformation:** A section for path transformation, with Origin complex K[3,4,5] and Destination complex K[3,4,5] highlighted in a black box. It also includes Rotation, North translation, North-east translation, and a Path Transformation button.
- Computer Music Journal:** A thumbnail of the journal cover, featuring the title "Computer Music Journal" and a small diagram.
- Chart:** A bar chart titled *bwv0281* showing the 2-compactness of various complexes. The x-axis lists complexes like K[1,1,0], K[1,2,0], K[1,3,0], K[1,4,7], K[1,5,0], K[2,2,0], K[2,3,7], K[2,4,0], K[2,5,0], K[3,3,0], K[3,4,5], and K[4,4,0]. The y-axis is labeled "2-compactness". A prominent red bar is visible for K[3,4,5].
- Chart:** A bar chart titled *2-compactness : bwv0281* showing the complex compactness over time (0 to 25,000). The y-axis is labeled "Complex compactness". The chart shows multiple colored bars representing different complexes over time.



Louis Bigo

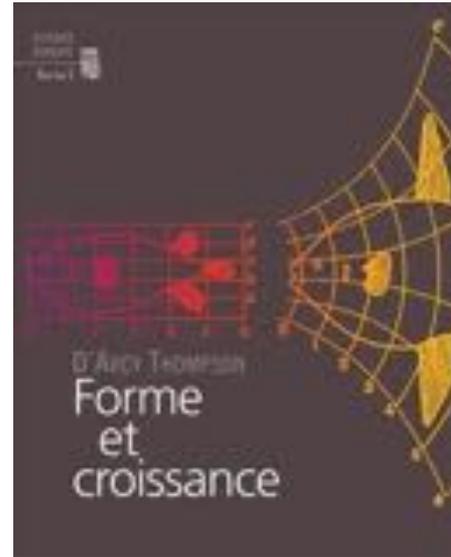
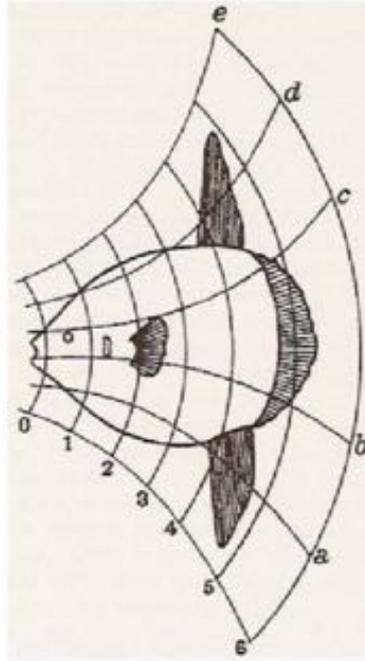
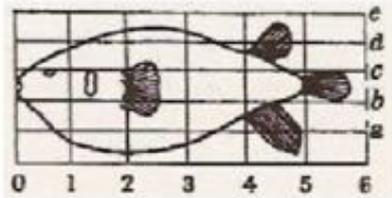
➔ <http://www.lacl.fr/~lbigo/hexachord>

Transformations géométriques et transformations musicales



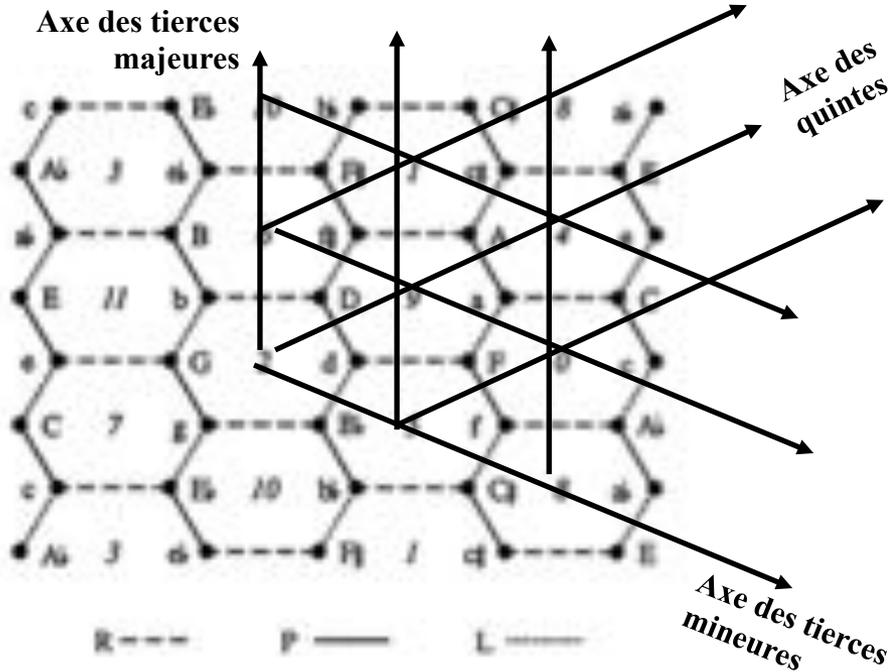
« Il me semble que le **style** est l'un des outils opératoire majeurs dont nous disposons pour essayer de comprendre la corrélation entre la nature et la culture... Dans le domaine de la musique [...] il ne fait aucun doute, dans mon esprit, qu'il est possible de passer d'une mélodie classique à une mélodie moderne par une **transformation purement mathématique** dont les compositeurs sont, bien entendu, totalement ignorants. Mais le fait saillant à propos du style, c'est que l'esprit humain travaille inconsciemment dans une direction comparable à celle de la nature » (Lévi-Strauss, 1953 / tr. J.-J. Nattiez 1973).

Transformations géométriques et transformations musicales



« [La notion de **transformation**] me vient d'un ouvrage qui a joué pour moi un rôle décisif et que j'ai lu pendant la guerre aux États Unis: *On Growth and Form*, en deux volumes, de D'Arcy Wentworth Thompson, paru pour la première fois en 1917. L'auteur, naturaliste écossais, (...) interprétait comme des transformations les différences visibles entre les espèces ou organes animaux ou végétaux au sein d'un même genre. Ce fut une illumination, d'autant que j'allais vite m'apercevoir que cette façon de voir s'inscrivait dans une longue tradition: derrière Thompson, il y avait la botanique de Goethe, et derrière Goethe, Albert Dürer avec son *Traité de la proportion du corps humain* » (Lévi-Strauss et Eribon, 1988).

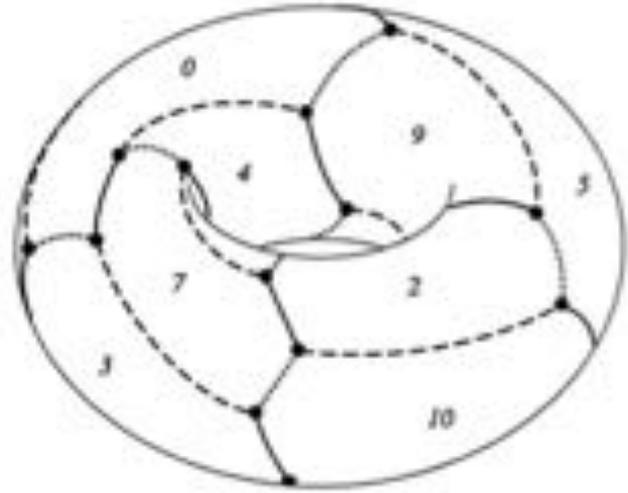
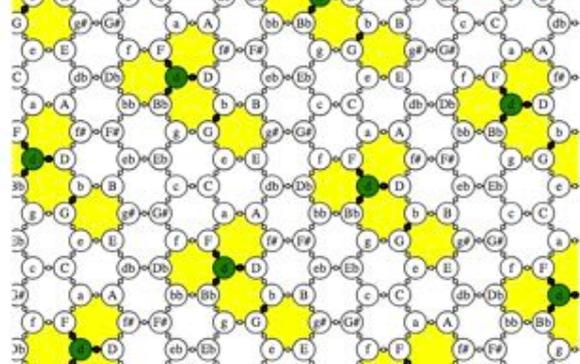
Autres espaces de représentations pour les progressions harmoniques



The Tonnetz

One key — Many Representations

[[1,1,10]] [[1,2,9]] [[1,3,8]] [[1,4,7]] [[1,5,6]] [[2,2,8]] [[2,3,7]] [[2,4,6]] [[2,5,5]] [[3,4,5]] [[3,3,6]] [[4,4,4]]
 [[1,1,10]] [[1,2,9]] [[1,3,8]] [[1,4,7]] [[1,5,6]] [[2,2,8]] [[2,3,7]] [[2,4,6]] [[2,5,5]] **[[3,4,5]]** [[3,3,6]] [[4,4,4]]

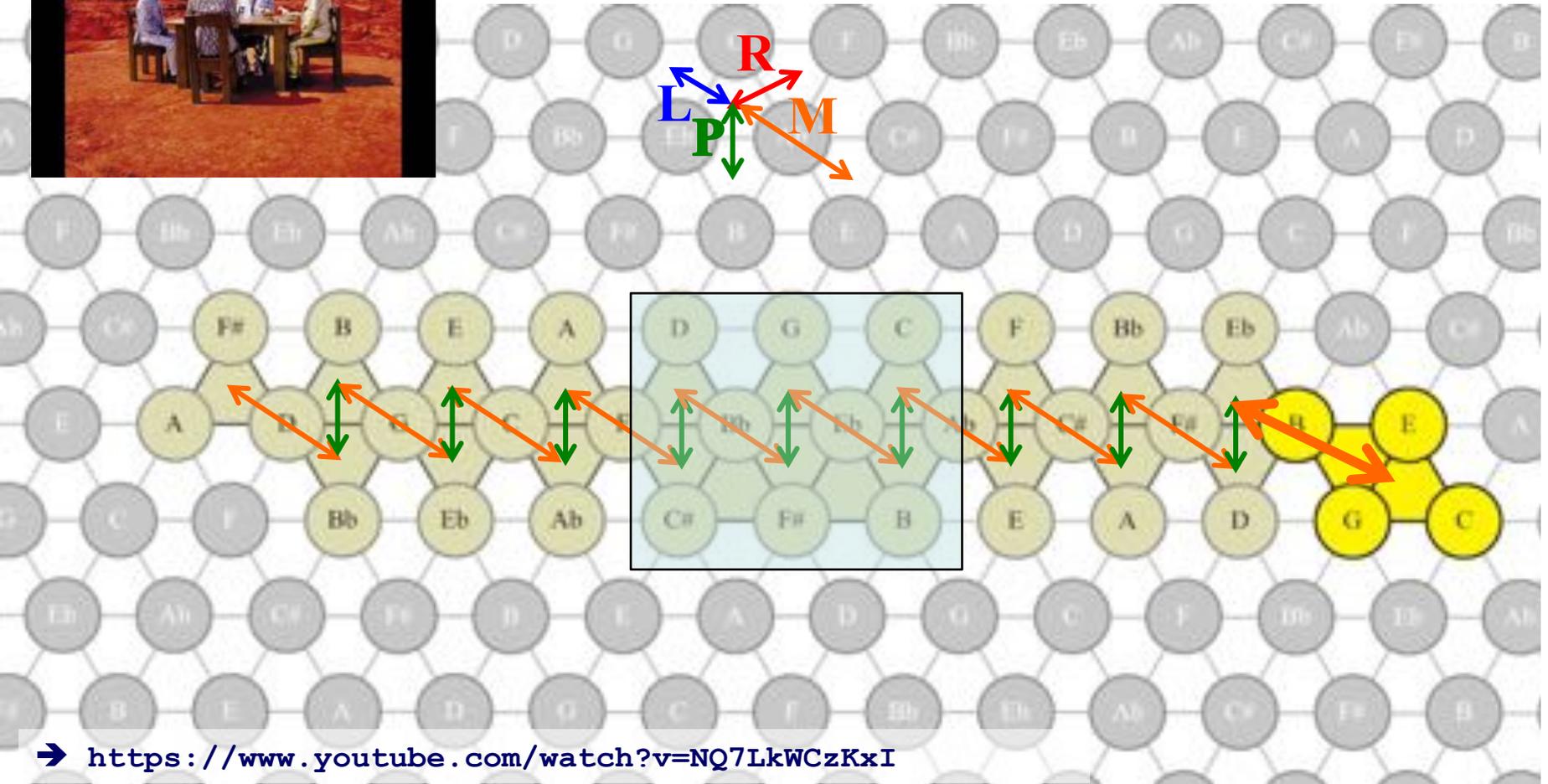


J. Douthett, P. Steinbach, Parsimonious Graphs: A Study in Parsimony, Contextual Transformation, and Modes of Limited Transposition, *Journal of Music Theory*, 42/2, 1998.

Symétries et procédés algorithmiques chez *Muse*



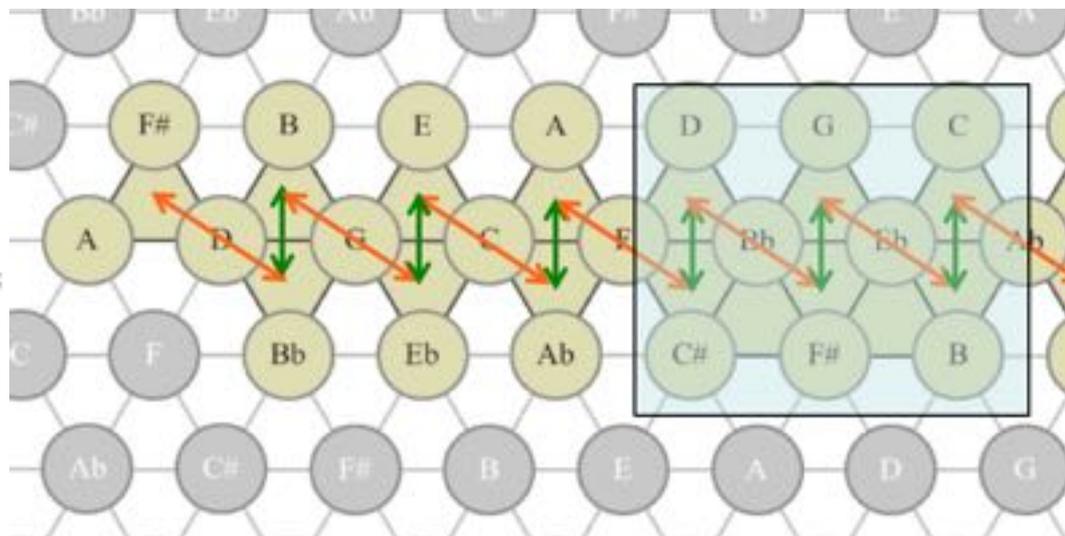
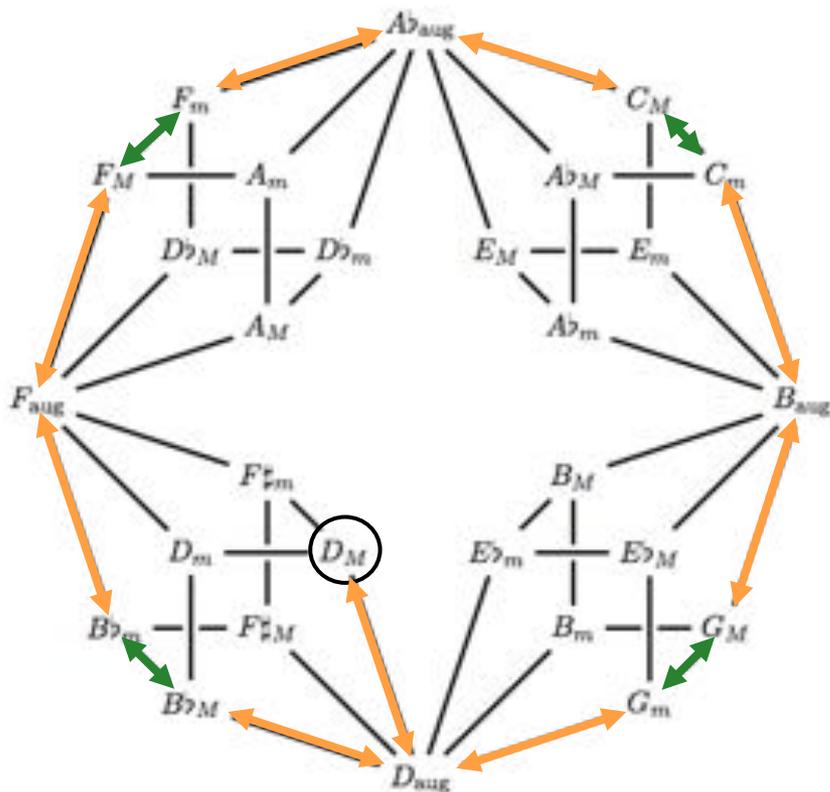
“Take a bow” (*Black Holes and Revelations*, 2006)



➔ <https://www.youtube.com/watch?v=NQ7LkWCzKxI>

axe temporel →

Autres espaces de représentations pour les progressions harmoniques

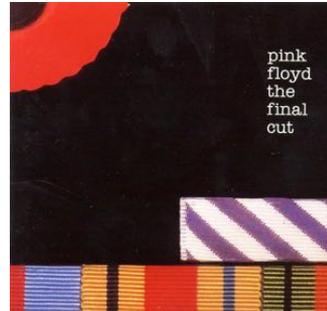


J. Douthett, P. Steinbach, Parsimonious Graphs: A Study in Parsimony, Contextual Transformation, and Modes of Limited Transposition, *Journal of Music Theory*, 42/2, 1998.

The Gunner's (Ham) Dream (une expérience *oumupienne* autour de Pink-Floyd)

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# C#m
and in the corner of some foreign field
A F+ Bbm
I had a dream.
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+ Em E G#m
And as the tear drops rise to meet the comfort of the band
G# Cm
You take her frail hand
C
And hold on to the dream.



Le rêve du canonnier

Flottant parmi les nuages

Des souvenirs se ruent à ma rencontre.

Dans l'espace entre les cieux

Et dans un recoin d'un lointain champ de bataille

J'ai fait un rêve,

J'ai fait un rêve.

Au revoir Max

Au revoir maman

Après le service, quand tu marches lentement vers la voiture

Et l'argent dans ses cheveux luit dans l'air froid de novembre

Tu entends sonner le glas

Et touche la soie sur ton revers

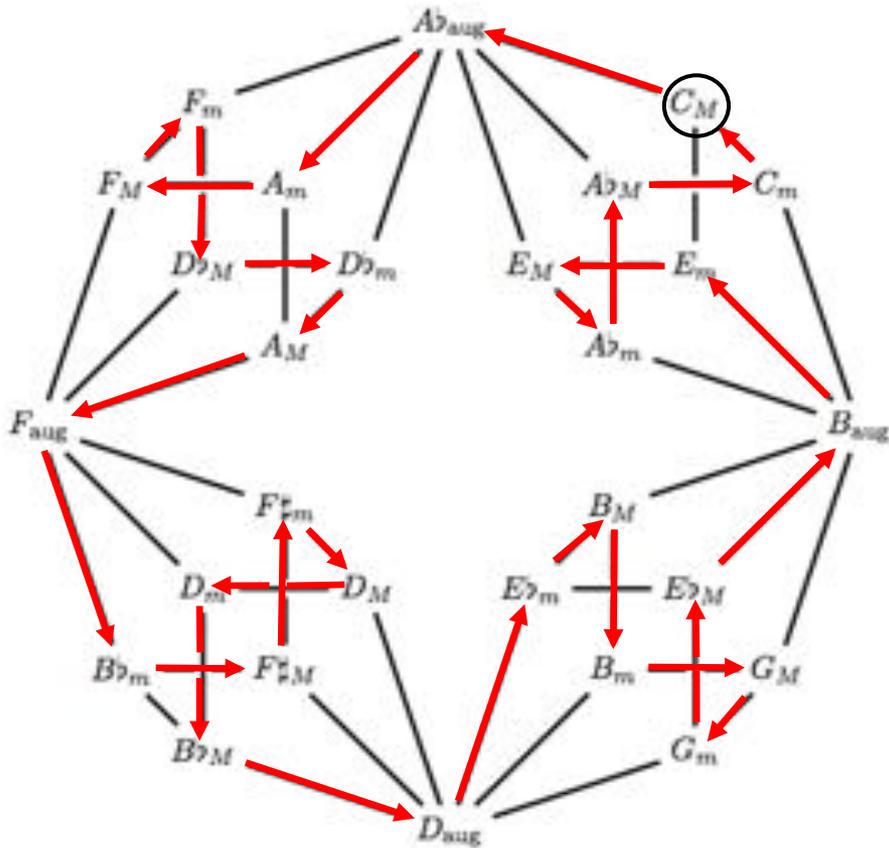
Et tandis que les larmes versées s'élèvent pour se fondre dans le confort du groupe

Tu prends sa frêle main

Et tu t'accroches au rêve.



The Gunner's Hamiltonian Dream (une expérience *oumupienne* autour de Pink-Floyd)



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# C#m
 and in the corner of some foreign field
 A F+ Bbm
 I had a dream.
 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+ Em E G#m
 And as the tear drops rise to meet the comfort of the band
 G# Cm
 You take her frail hand
C
 And hold on to the dream.

Les trois cycles hamiltoniens (C_M = C, C_m = Cm, C_{aug} = C+)

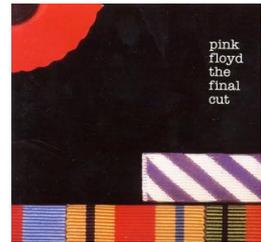
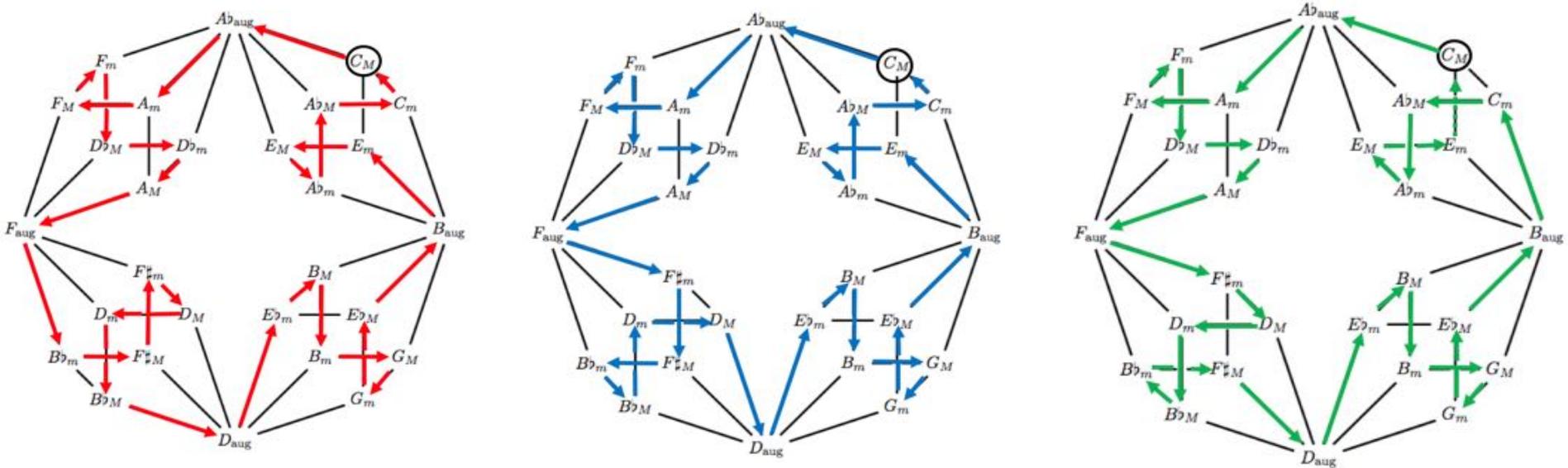
C-->C+-->Am-->F-->Fm-->C#-->C#m-->A-->F+-->Bbm-->F#-->F#m-->D-->Dm-->Bb-->D+-->Ebm-->B-->Bm-->
 -->G-->Gm-->Eb-->G+-->Em-->E-->G#m-->G#-->Cm-->C

C-->C+-->Am-->F-->Fm-->C#-->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



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



pink
floyd
the
final
cut

Les trois cycles hamiltoniens ($C_M = C$, $C_m = Cm$, $C_{aug} = C+$)

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

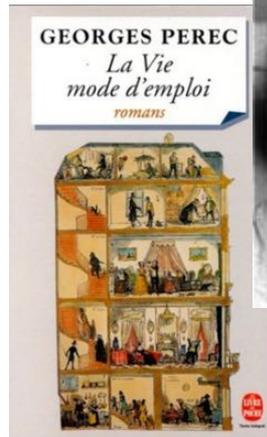
$C \rightarrow C+ \rightarrow Am \rightarrow F \rightarrow Fm \rightarrow C\# \rightarrow C\#m \rightarrow A \rightarrow F+ \rightarrow F\#m \rightarrow F\# \rightarrow Bbm \rightarrow Bb \rightarrow Dm \rightarrow D \rightarrow D+ \rightarrow Ebm \rightarrow B \rightarrow Bm \rightarrow G \rightarrow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

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

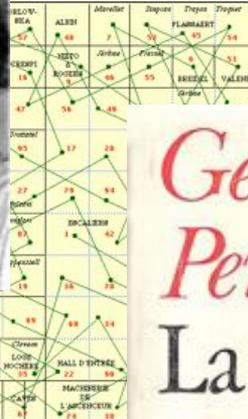
Les contraintes dans l'art : l'OuLiPo (Ouvroir de Littérature Potentielle)



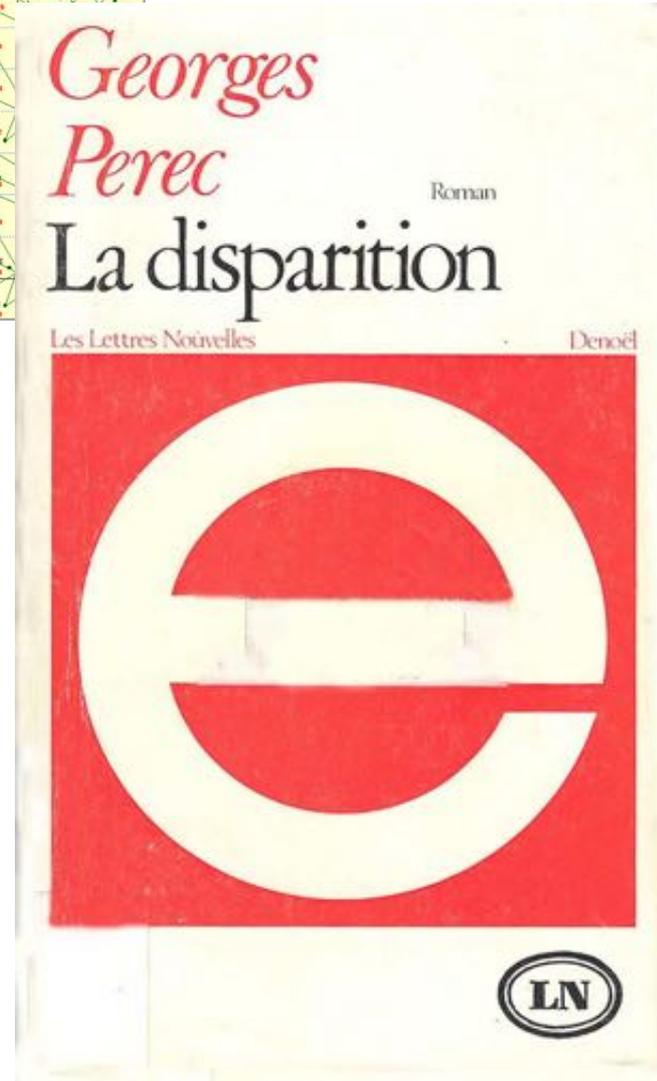
Cent mille milliards de poèmes, 1961



Georges Perec



La vie mode d'emploi,



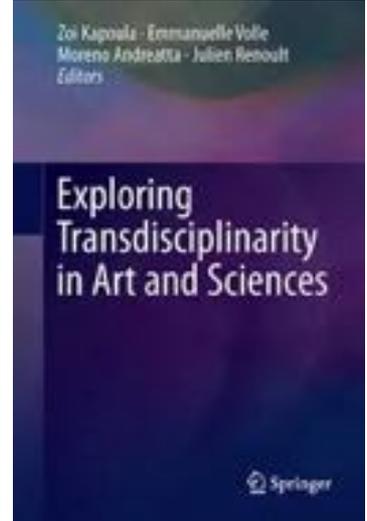
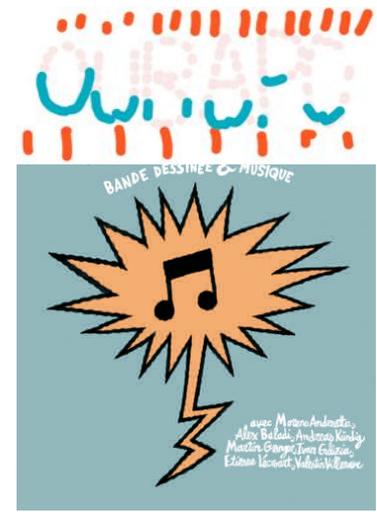
Raymond Queneau



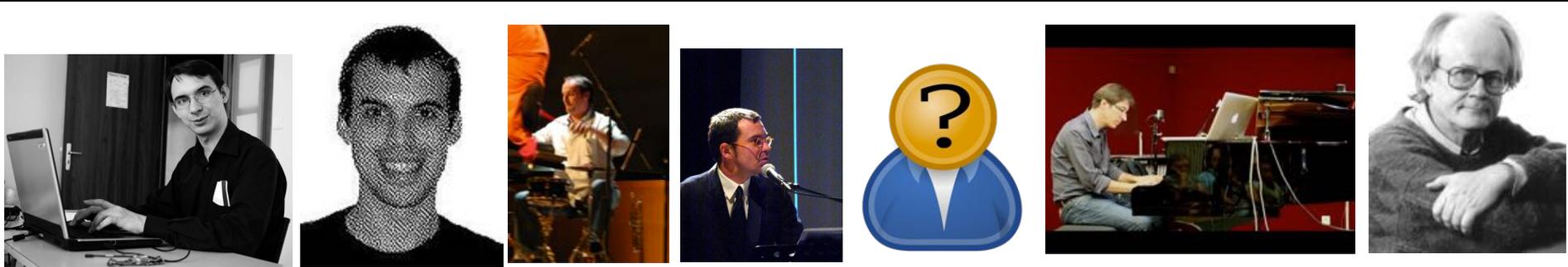
Italo Calvino

Le Château des destins croisés, 1969

De l'OuLiPo à l'OuMuPo (ouvroir de musique potentielle)



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



Valentin Villenave

Mike Solomon

Jean-François Piette

Martin Granger

Joseph Boisseau

Moreno Andreatta

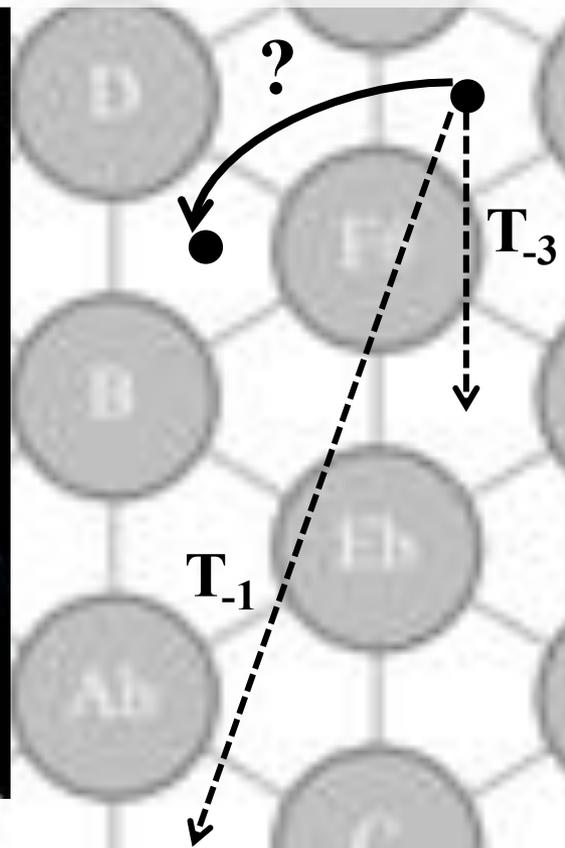
Tom Johnson

A la recherche du bon espace de représentation

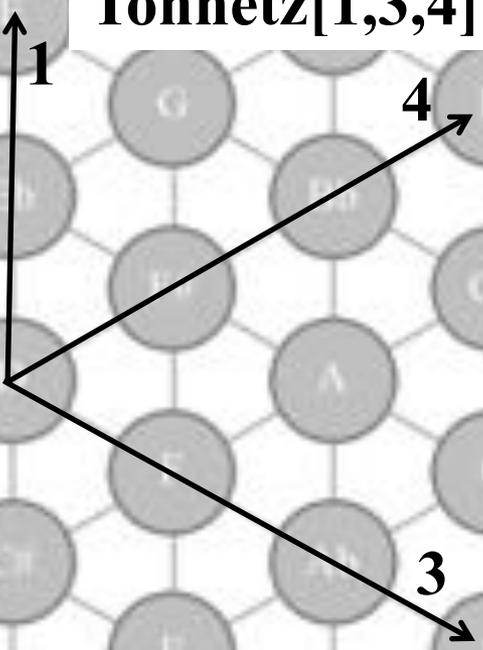


???

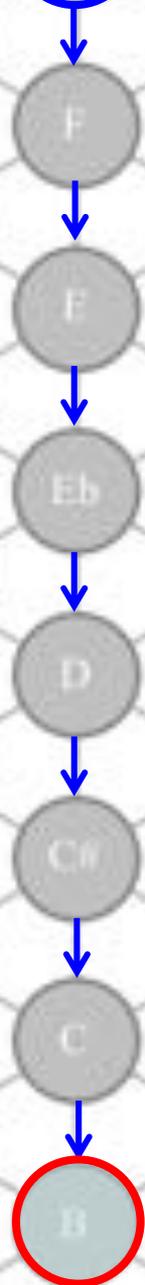
Find all Hamiltonian Mathemusical Paths that modulate through all minor triads from f# min to b min, using only -1 or -3



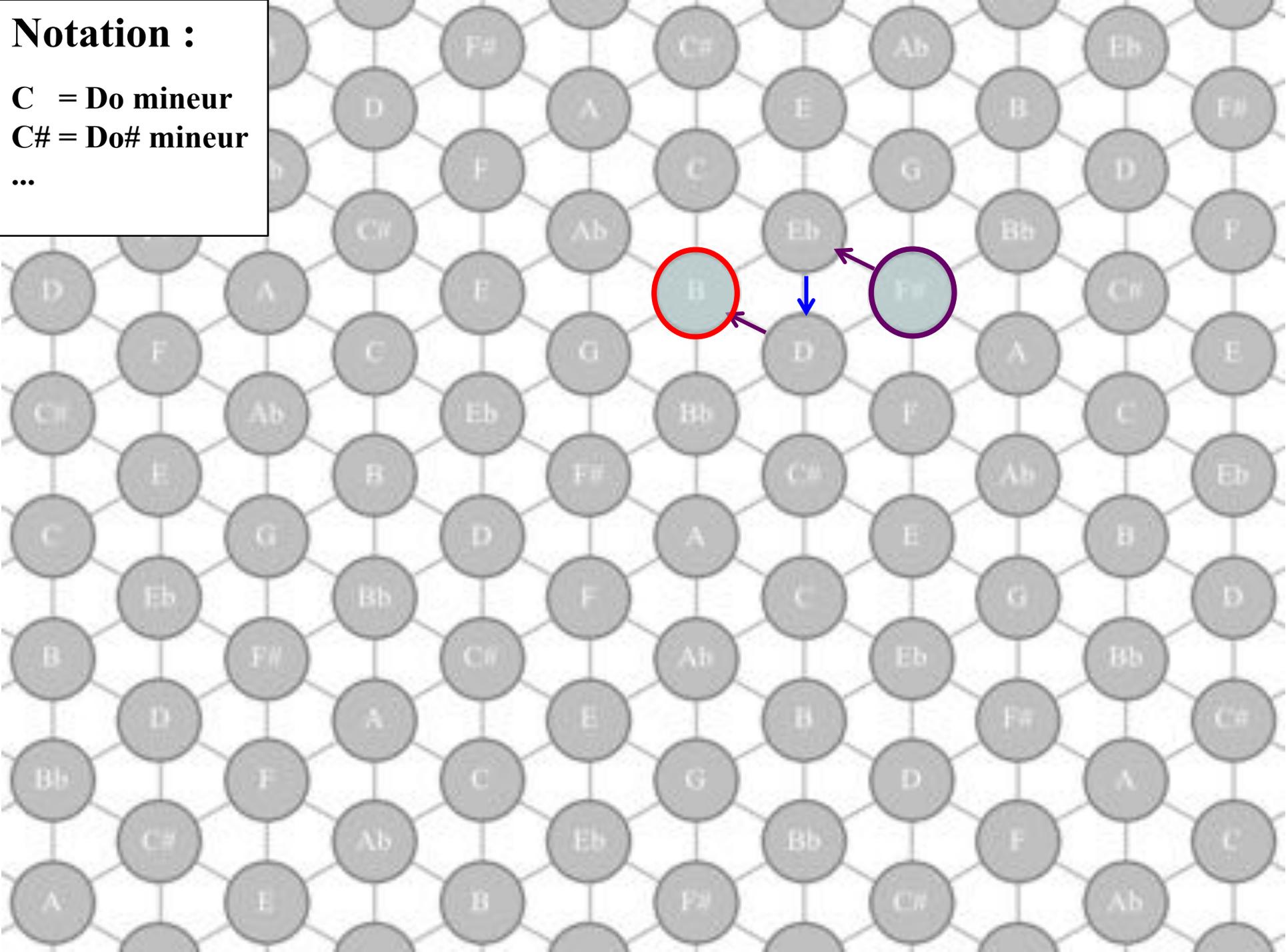
Tonnetz[1,3,4]



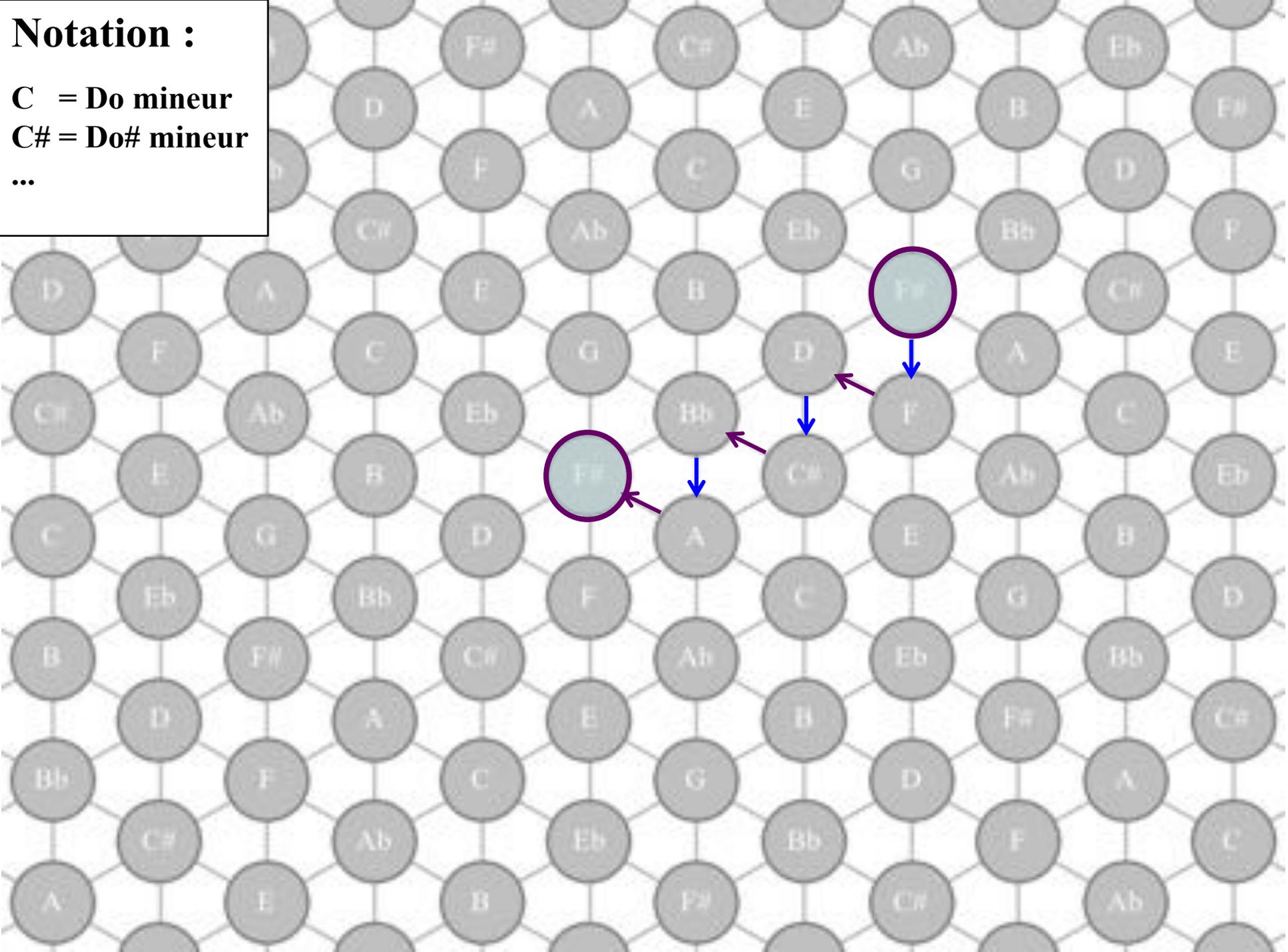
Notation :
C = Do mineur
C# = Do# mineur
.
.
.
B = Si mineur



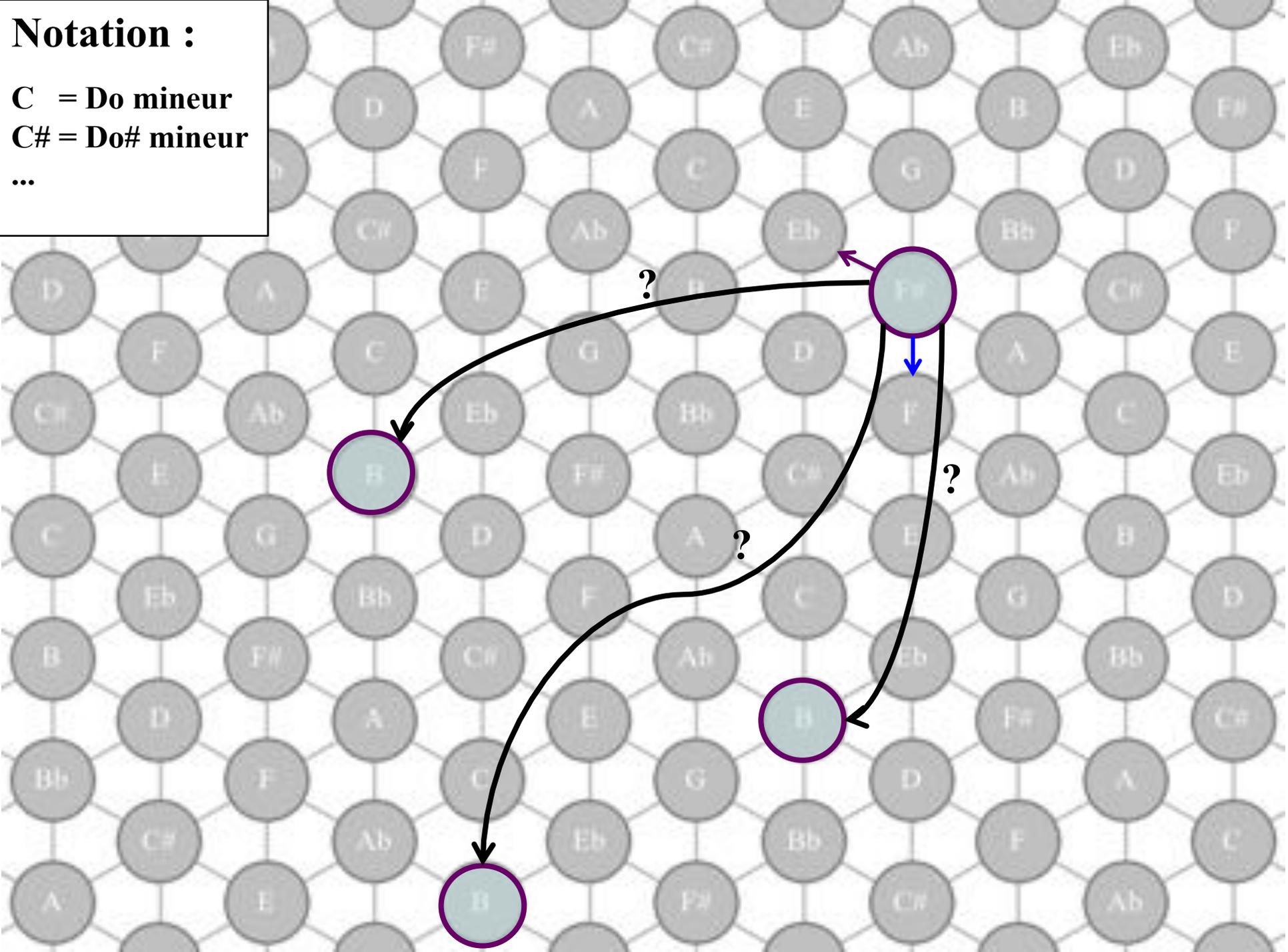
Notation :
C = Do mineur
C# = Do# mineur
...



Notation :
C = Do mineur
C# = Do# mineur
...



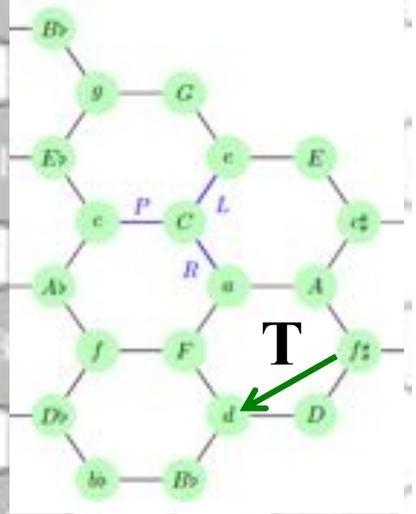
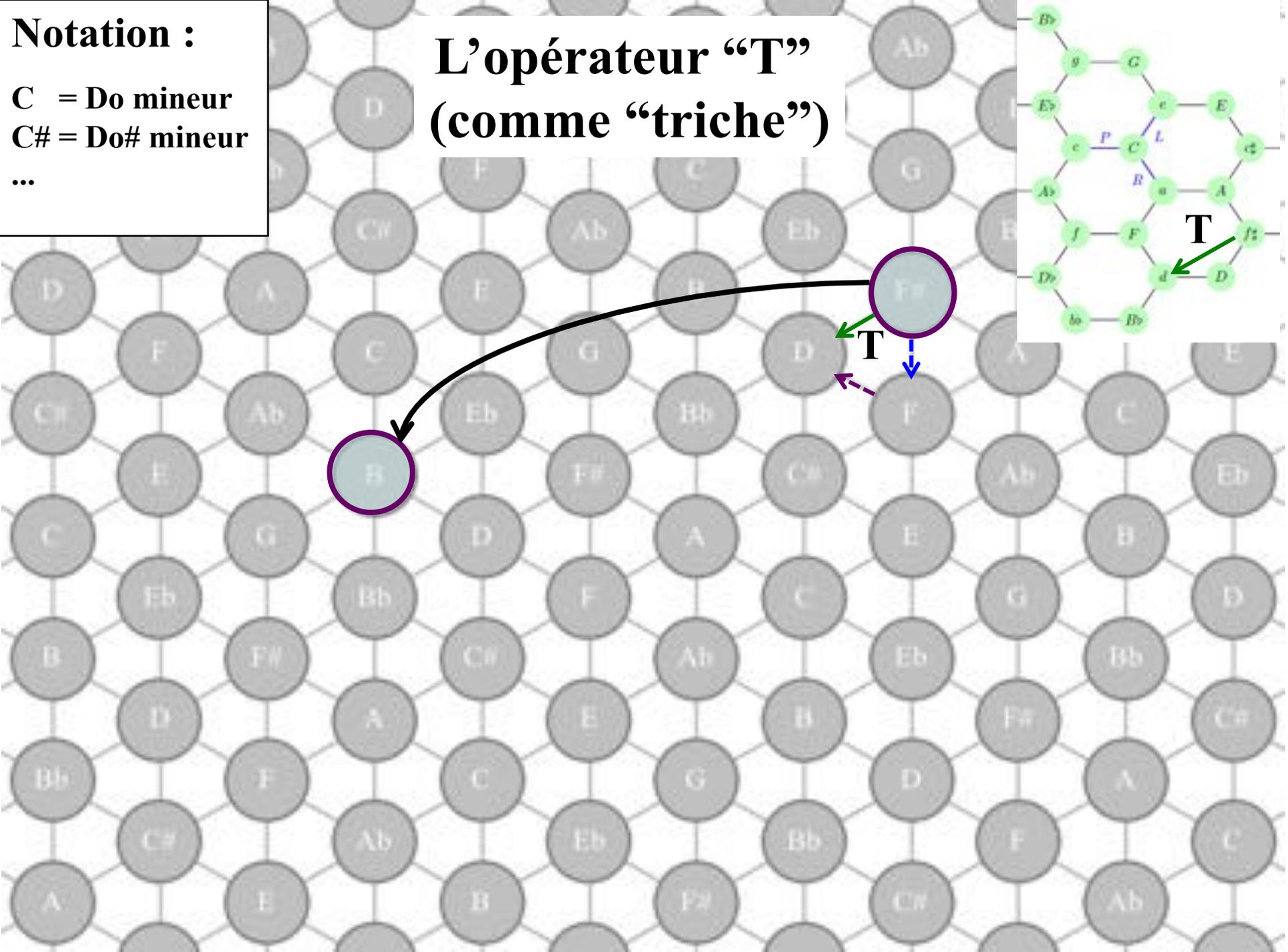
Notation :
C = Do mineur
C# = Do# mineur
...



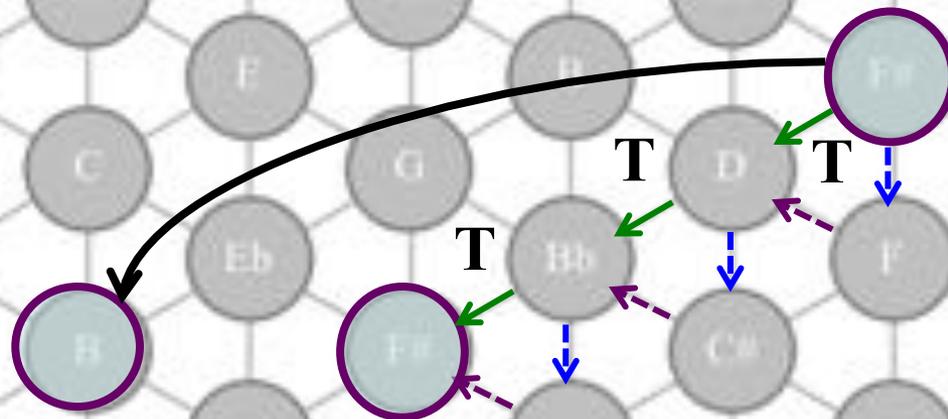
Notation :

- C = Do mineur
- C# = Do# mineur
- ...

L'opérateur "T" (comme "triche")



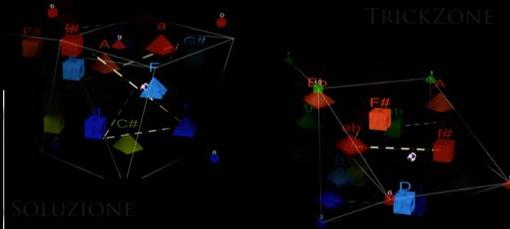
L'opérateur "T" (comme "triche")



Notation :

C = Do minor
C# = Do# minor
...

DOMENEDIO



<http://www.mathemusic.net>

Find all Hamiltonian Mathematical Paths
that modulate through all minor triads
from f# min to b min, using only -1 or -3

TRICKZONE

<http://www.mathemusic.net>

Notation :

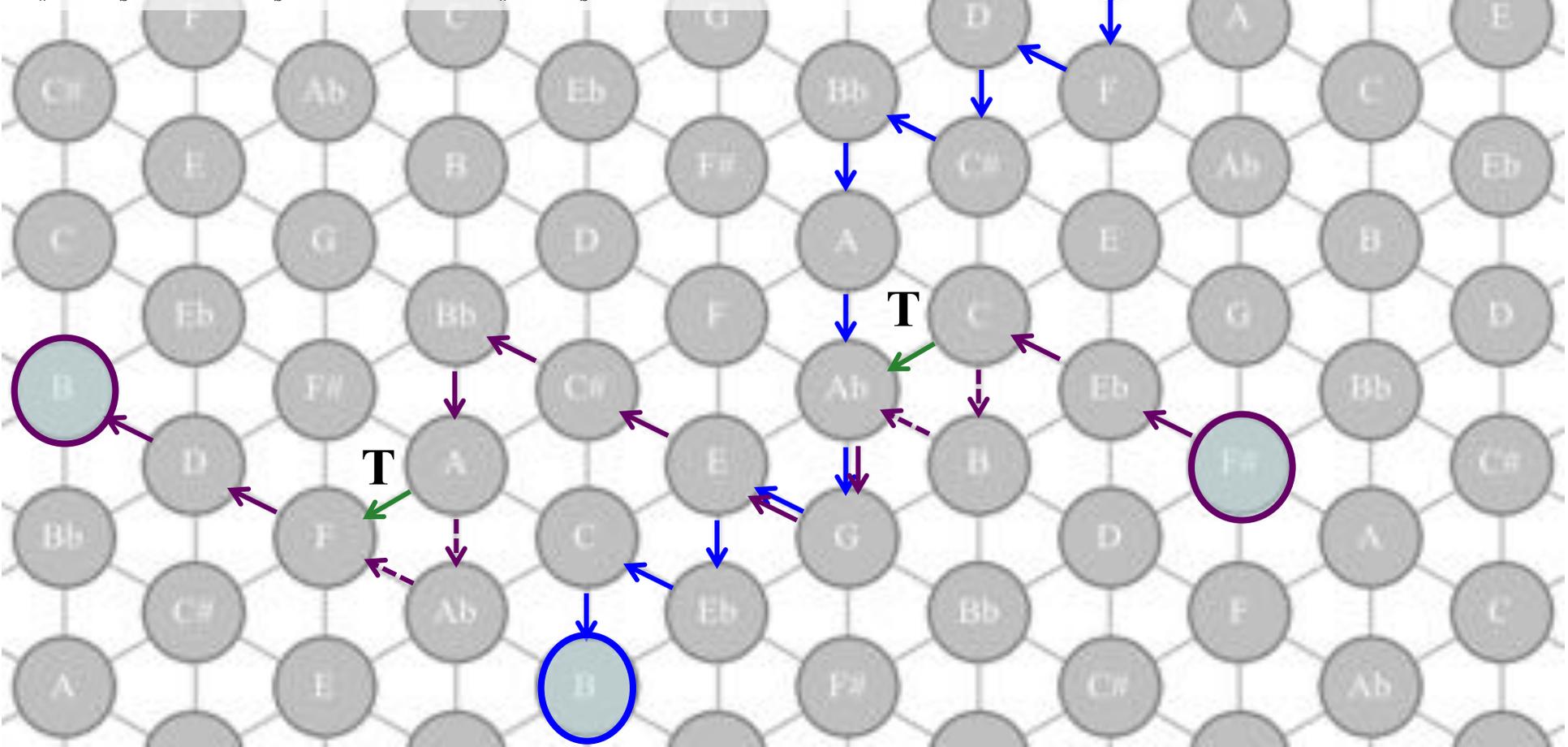
C = Do minor

C# = Do# minor

...

$F\#m \rightarrow Fm \rightarrow Dm \rightarrow C\#m \rightarrow B_bm \rightarrow Am \rightarrow A_bm \rightarrow Gm \rightarrow Em \rightarrow E_bm \rightarrow Cm \rightarrow Bm$

$F\#m \rightarrow E_bm \rightarrow Cm \rightarrow A_bm \rightarrow Gm \rightarrow Em \rightarrow C\#m \rightarrow B_bm \rightarrow Am \rightarrow Fm \rightarrow Dm \rightarrow Bm$

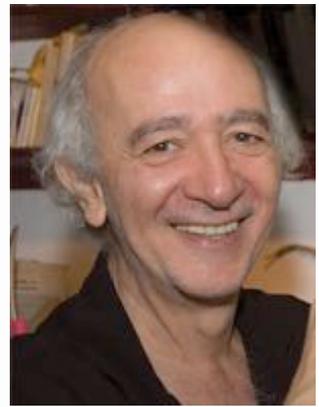
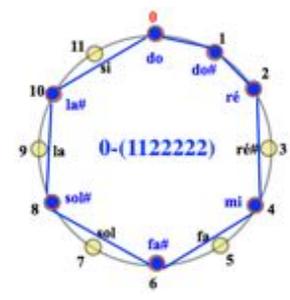


Le permutohédre d'Estrada comme espace combinatoire

Julio Estrada, *Théorie de la composition : discontinuum – continuum*, université de Strasbourg II, 1994

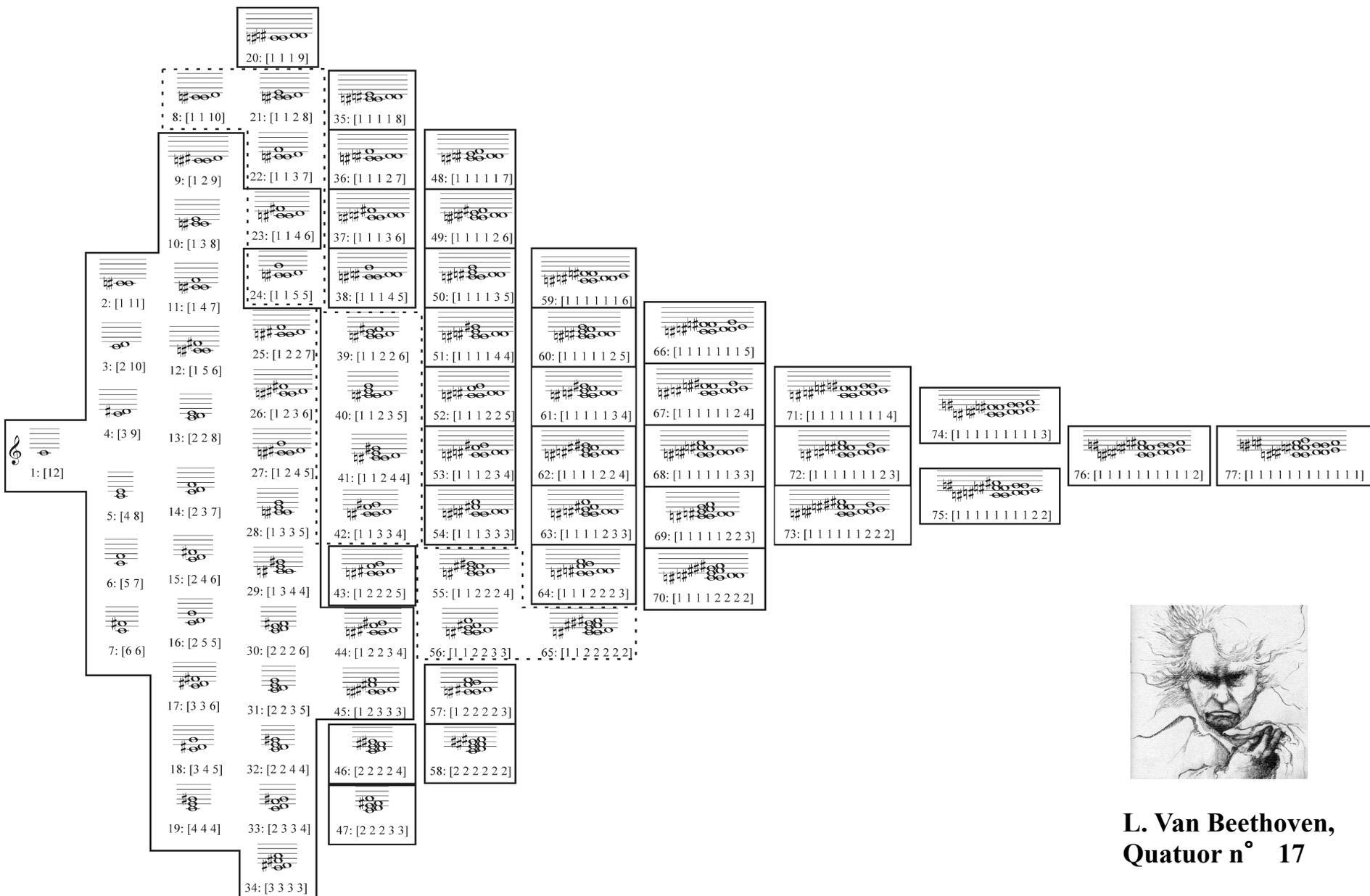
ILLUSTRATION III. REPRESENTATION EN NOTATION MUSICALE DE L'ENSEMBLE DE PARTITIONS DE L'ECHELE DE HAUTEURS D12 : 12 NIVEAUX DE DENSITE, 77 IDENTITES.

$$DIA_E = (1,1,2,2,2,2,2)$$



J. Estrada

Le permutohèdre d'Estrada comme espace *conceptuel*



L. Van Beethoven,
Quatuor n° 17

Le permutohédre d'Estrada comme espace conceptuel

B. Bartok, Quartet n° 4 (3^d mouvement)



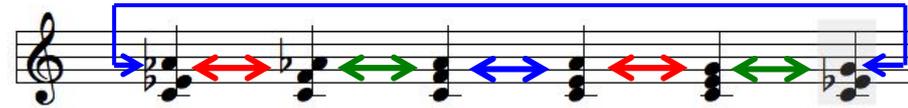
A. Schoenberg, *Six pieces* op. 19



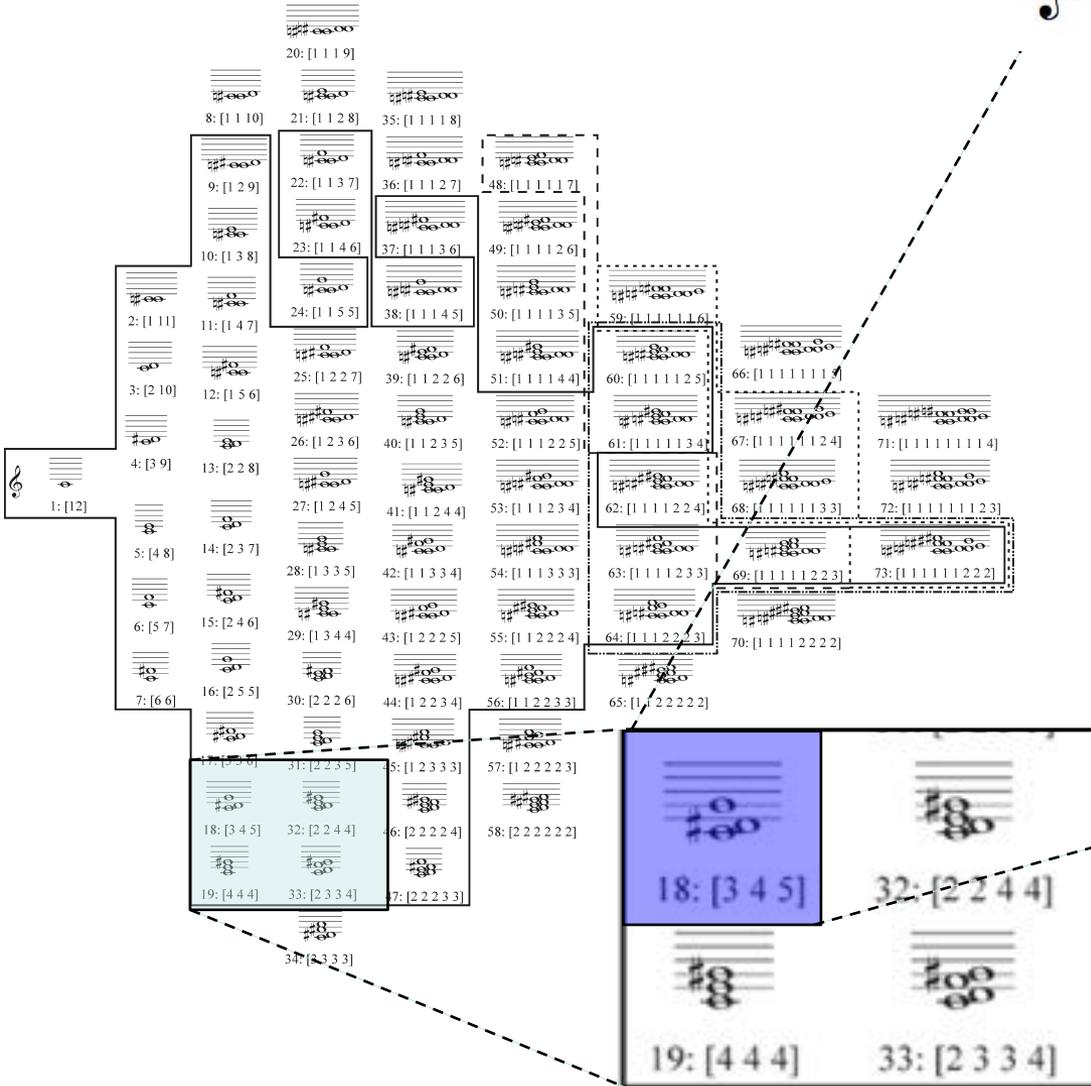
Musical score for B. Bartok, Quartet n° 4 (3^d mouvement). The score is presented as a grid of measures, with each measure containing a musical staff and a corresponding permutation label. The measures are numbered 1 through 70. The permutation labels are: 1: [12], 2: [111], 3: [210], 4: [39], 5: [48], 6: [57], 7: [66], 8: [1110], 9: [129], 10: [138], 11: [147], 12: [156], 13: [228], 14: [237], 15: [246], 16: [255], 17: [336], 18: [345], 19: [444], 20: [1119], 21: [1128], 22: [1137], 23: [1146], 24: [1155], 25: [1227], 26: [1236], 27: [1245], 28: [1335], 29: [1344], 30: [2226], 31: [2235], 32: [2244], 33: [2334], 34: [3333], 35: [11118], 36: [11127], 37: [11136], 38: [11145], 39: [11226], 40: [11235], 41: [11244], 42: [11334], 43: [12225], 44: [12234], 45: [12333], 46: [22224], 47: [22233], 48: [111117], 49: [111126], 50: [111135], 51: [111144], 52: [111225], 53: [111234], 54: [111333], 55: [112224], 56: [112233], 57: [122223], 58: [222222], 59: [1111116], 60: [1111125], 61: [1111134], 62: [1111124], 63: [1111233], 64: [1112223], 65: [1122222], 66: [11111115], 67: [1111124], 68: [1111133], 69: [11111223], 70: [11112222].

Musical score for A. Schoenberg, *Six pieces* op. 19. The score is presented as a grid of measures, with each measure containing a musical staff and a corresponding permutation label. The measures are numbered 1 through 73. The permutation labels are: 1: [12], 2: [111], 3: [210], 4: [39], 5: [48], 6: [57], 7: [66], 8: [1110], 9: [129], 10: [138], 11: [147], 12: [156], 13: [228], 14: [237], 15: [246], 16: [255], 17: [336], 18: [345], 19: [444], 20: [1119], 21: [1128], 22: [1137], 23: [1146], 24: [1155], 25: [1227], 26: [1236], 27: [1245], 28: [1335], 29: [1344], 30: [2226], 31: [2235], 32: [2244], 33: [2334], 34: [3333], 35: [11118], 36: [11127], 37: [11136], 38: [11145], 39: [11226], 40: [11235], 41: [11244], 42: [11334], 43: [12225], 44: [12234], 45: [12333], 46: [22224], 47: [22233], 48: [111117], 49: [111126], 50: [111135], 51: [111144], 52: [111225], 53: [111234], 54: [111333], 55: [112224], 56: [112233], 57: [122223], 58: [222222], 59: [1111116], 60: [1111125], 61: [1111134], 62: [1111124], 63: [1111233], 64: [1112223], 65: [1122222], 66: [11111115], 67: [1111124], 68: [1111133], 69: [11111223], 70: [11112222], 71: [11111114], 72: [11111123], 73: [11111222].

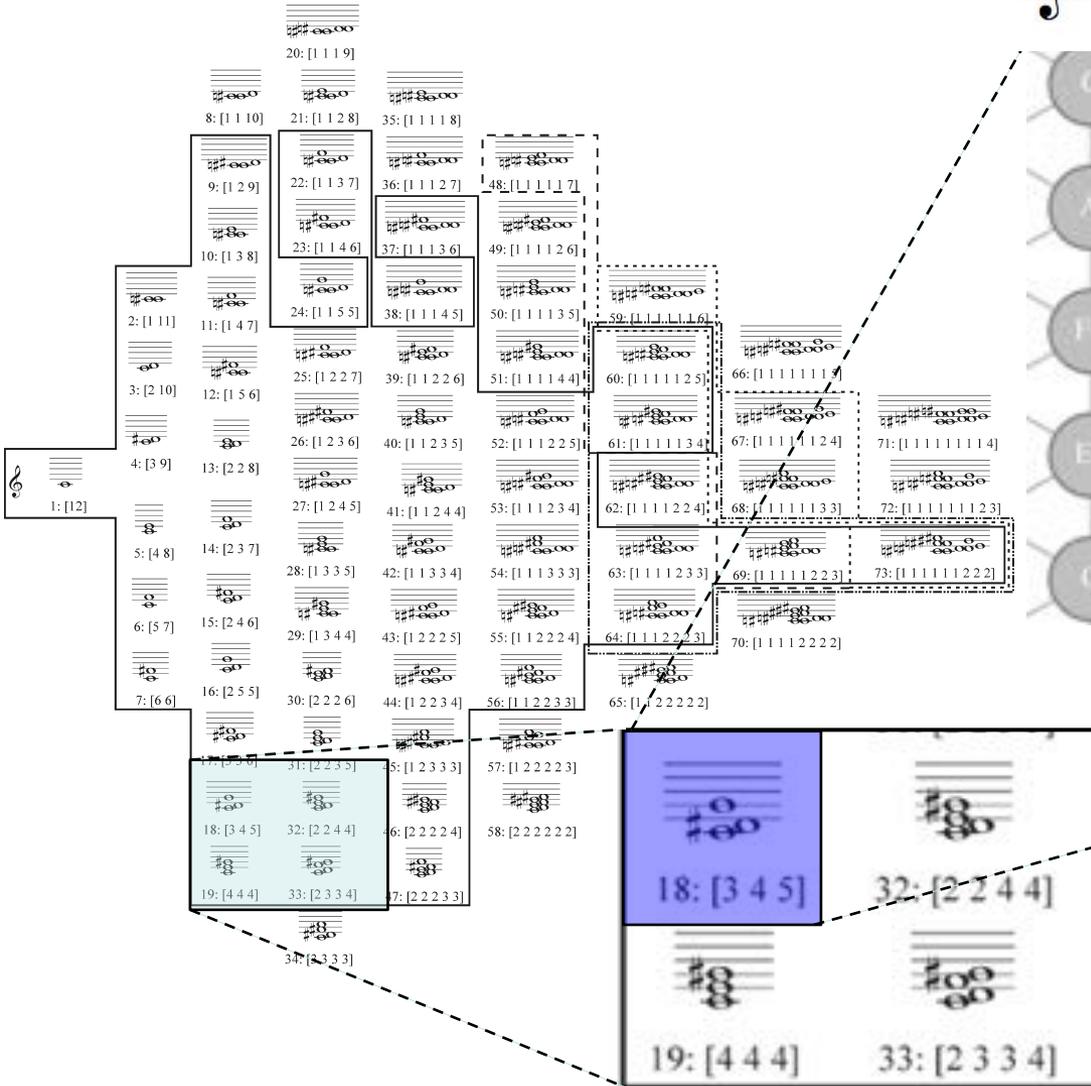
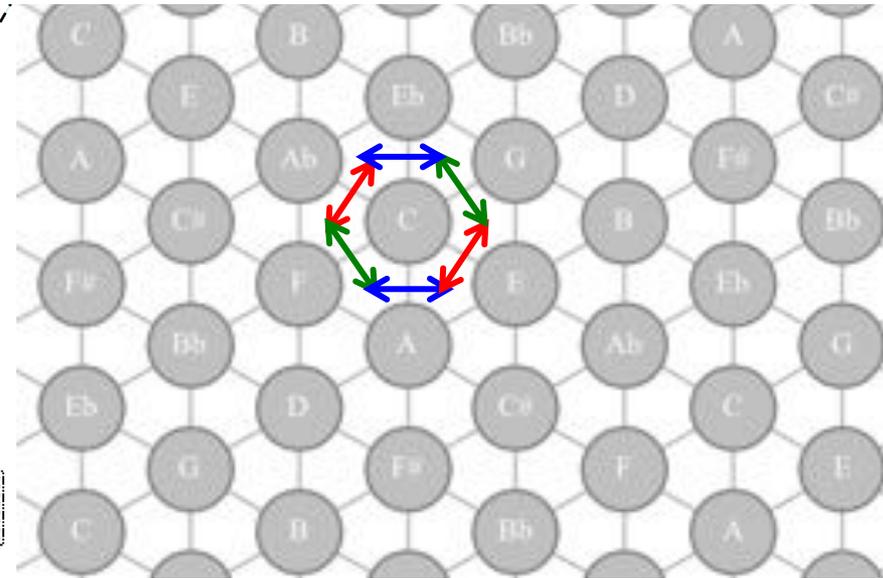
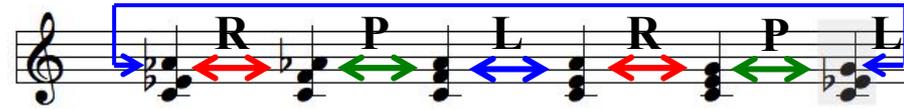
Du permutohèdre au *Tonnetz*



(3 5 4) (5 3 4) (5 4 3) (4 5 3) (4 3 5) (3 4 5)



Du permutohédre au *Tonnetz*

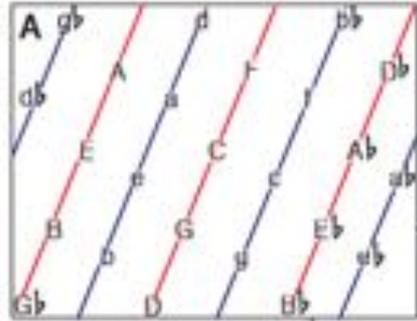


Tonnetz et neurosciences cognitives

PERSPECTIVES: NEUROSCIENCE

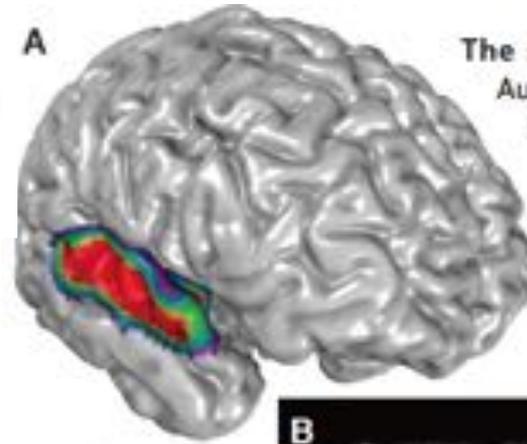
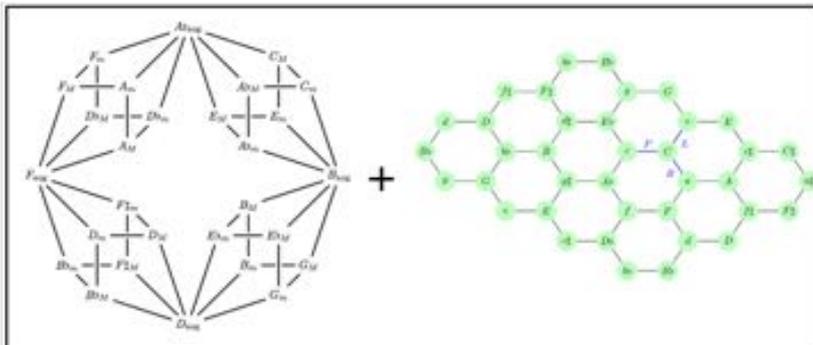
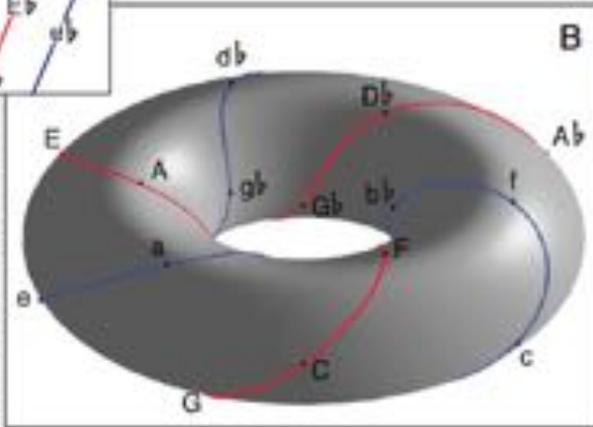
Mental Models and Musical Minds

Robert J. Zatorre and Carol L. Krumhansl

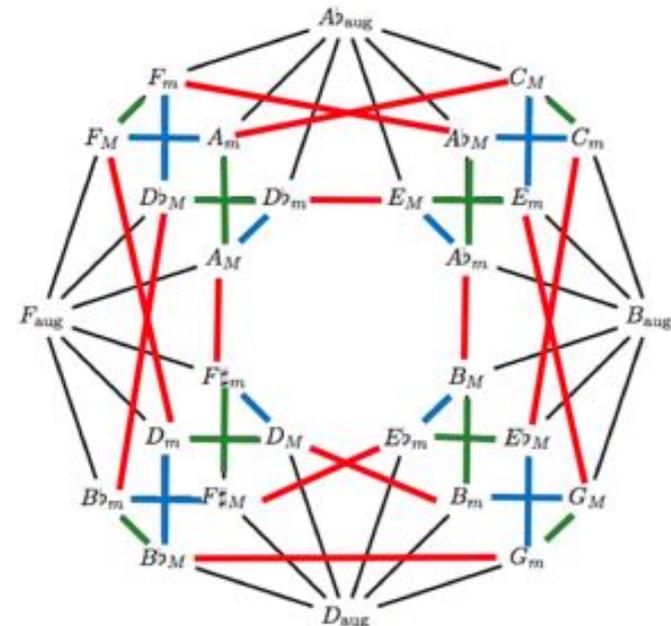
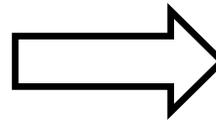
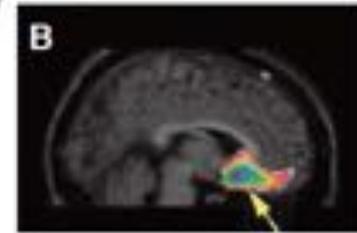


Mental key maps. (A) Unfolded version of the key map, with opposite edges to be considered matched. There is one circle of fifths for major keys (red) and one for minor keys (blue), each

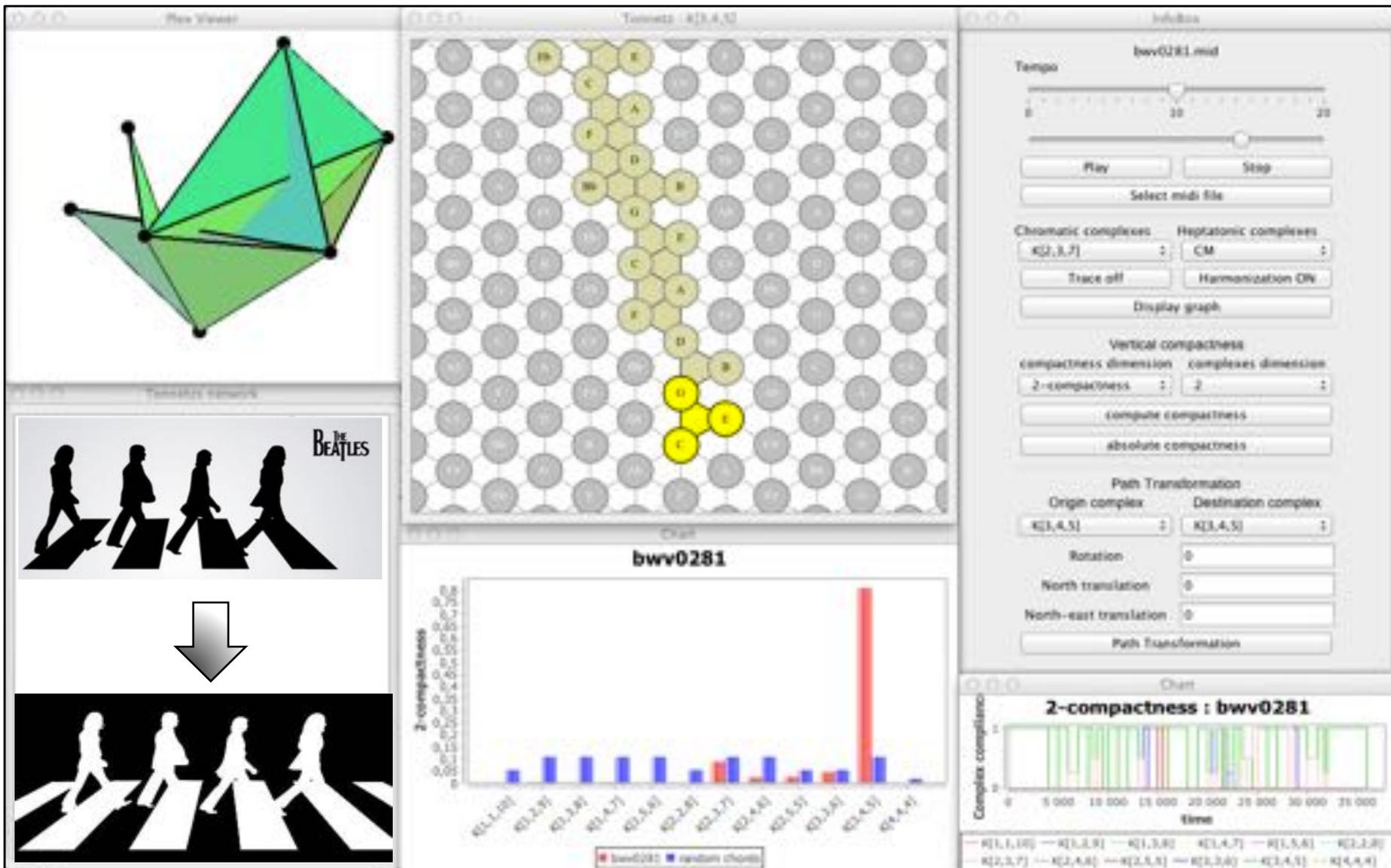
wrapping the torus three times. In this way, every major key is flanked by its relative minor on one side (for example, C major and a minor) and its parallel minor on the other (for example, C major and c minor). (B) Musical keys as points on the surface of a torus.



The sensation of music. (A) Auditory cortical areas in the superior temporal gyrus that respond to musical stimuli. Regions that are most strongly activated are shown in red. (B) Metabolic activity in the ventromedial region of the frontal lobe increases as a tonal stimulus becomes more consonant.

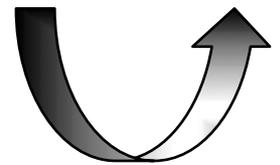
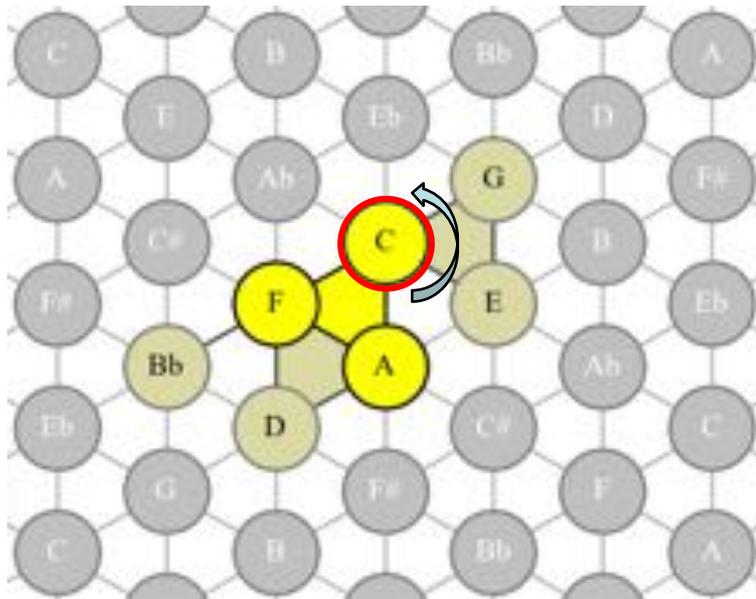
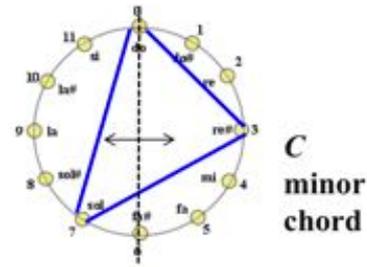
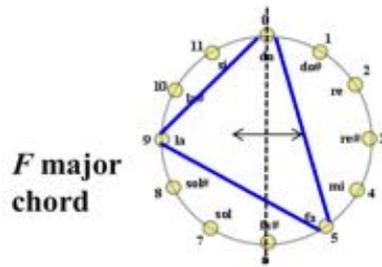
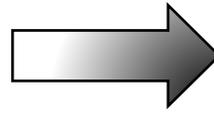


Harmonie négative ou dualité majeur/mineur

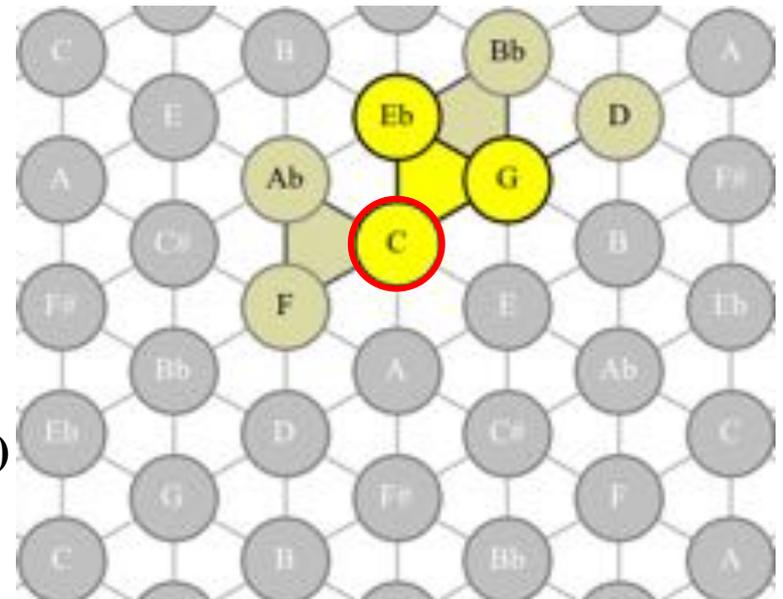


→ <http://www.lacl.fr/~lbigio/hexachord>

Harmonie négative et rotations dans le Tonnetz

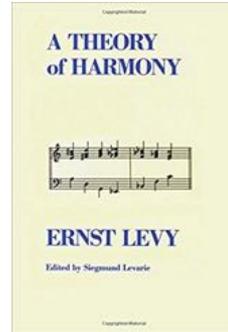


Rotation
(autour du do)



La « Negative/Symmetric Harmony » (de Jacob Collier/Steve Colemann)

La série des harmoniques supérieurs



**Ernst Lévy
(1895-1981)**



Steve Coleman

La série (imaginaire) des harmoniques inférieurs

- Ernst Lévy, *A Theory of Harmony*, Albany, New York, 1985
- Jacob Collier, « Negative Harmony » (vidéos online)
- Steve Coleman, « Symmetrical Movement Concept » (online)



C. Corea, J. Collier & H. Hancock

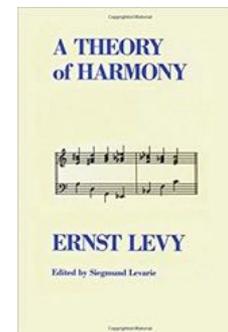
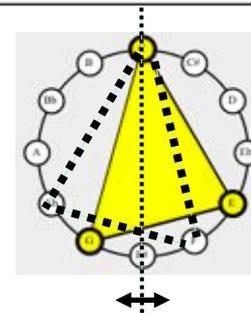
La « Negative/Symmetric Harmony » (de Jacob Collier/Steve Colemann)

La série des harmoniques supérieurs



C

Fm



Ernst Lévy
(1895-1981)



Steve Coleman



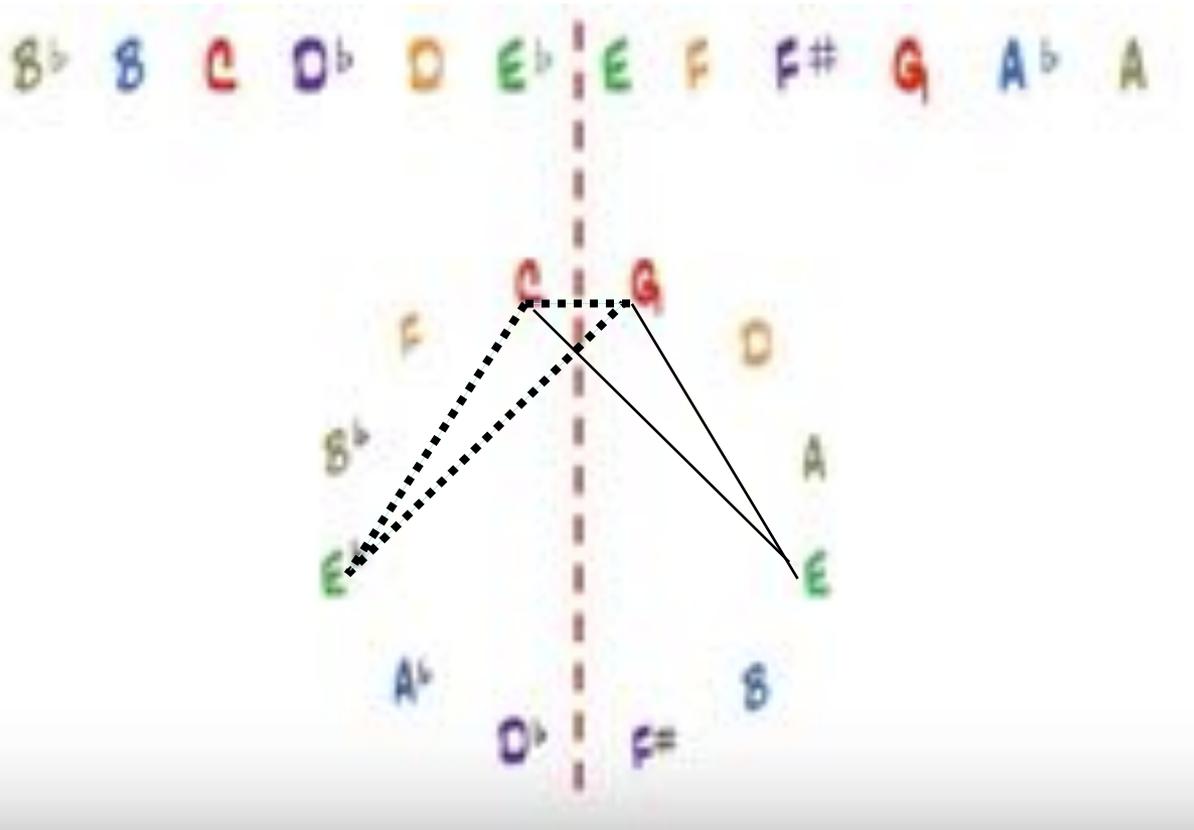
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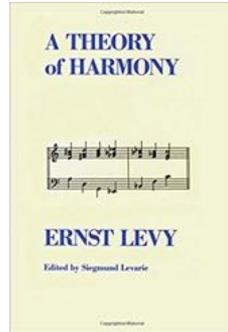
C. Corea, J. Collier & H. Hancock

La « Negative/Symmetric Harmony » (de Jacob Collier/Steve Colemann)



Paul Croteau, Negative Harmony - Is It A Thing?
https://www.youtube.com/watch?v=eBW5gab0_xs

- Ernst Lévy, *A Theory of Harmony*, Albany, New York, 1985
- Jacob Collier, « Negative Harmony » (vidéos online)
- Steve Coleman, « Symmetrical Movement Concept » (online)



Ernst Lévy
(1895-1981)

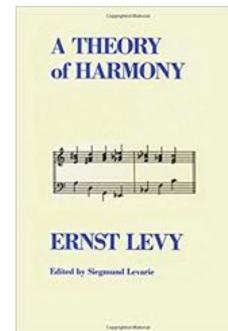
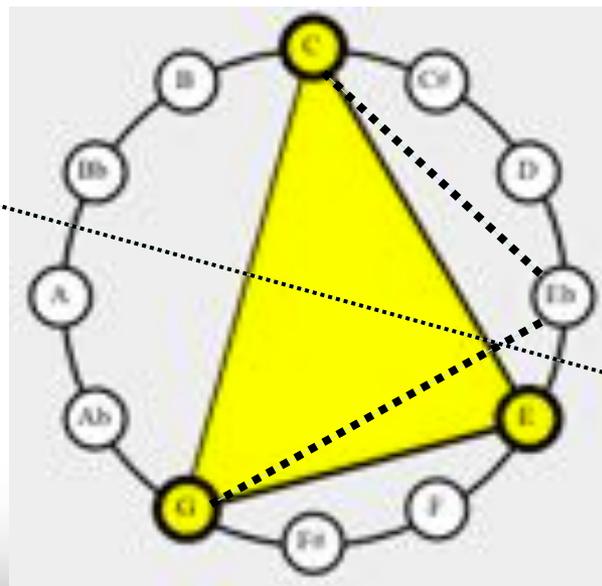
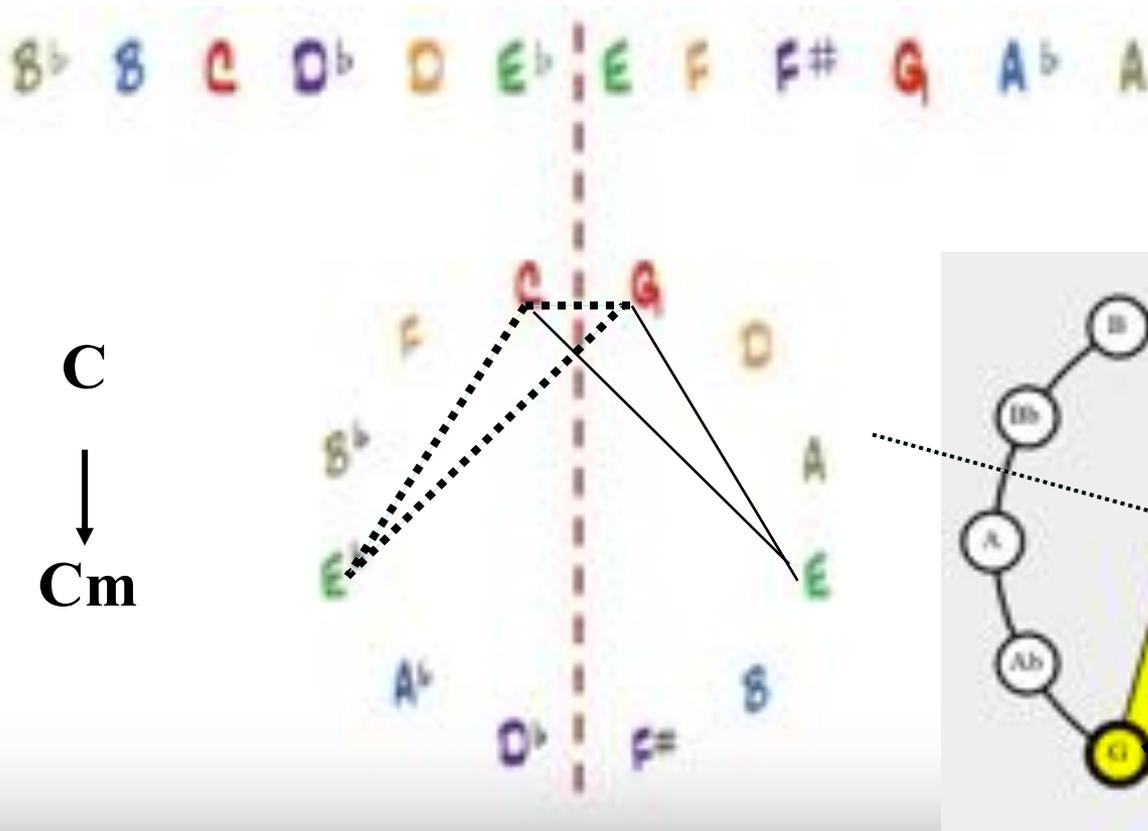


Steve Coleman



C. Corea, J. Collier & H. Hancock

La « Negative/Symmetric Harmony » (de Jacob Collier/Steve Colemann)



Ernst Lévy
(1895-1981)



Steve Coleman

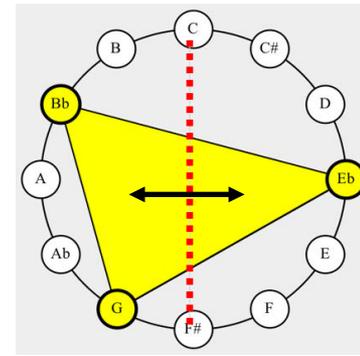
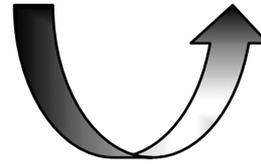
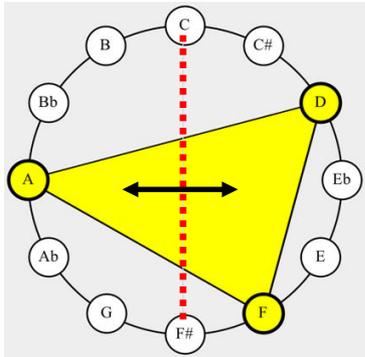
Paul Croteau, Negative Harmony - Is It A Thing?
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C. Corea, J. Collier & H. Hancock

Harmonie négative dans la musique pop italienne



Symétrie

Centro di gravità permanente (testo e musica: Franco Battiato)

Una vecchia bretone con un cappello e un ombrello di carta di riso e canna di bambù. Capitani coraggiosi furbi contrabbandieri macedoni. Gesuiti euclidei vestiti come dei bonzi per entrare a corte degli imperatori della dinastia dei Ming.

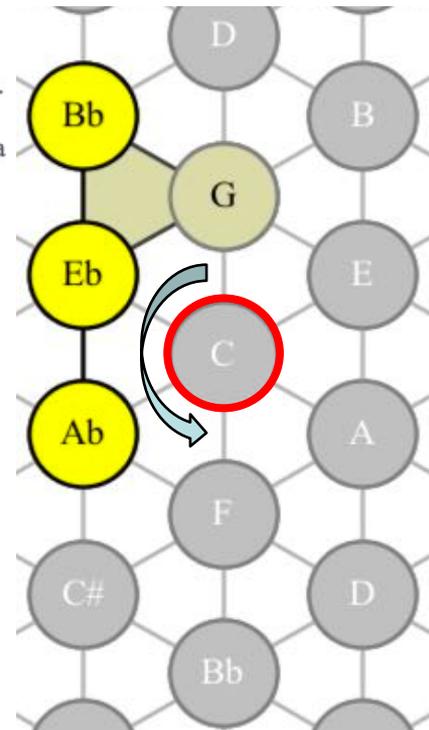
Cerco un centro di gravità permanente che non mi faccia mai cambiare idea sulle cose sulla gente avrei bisogno di...

Cerco un centro di gravità permanente che non mi faccia mai cambiare idea sulle cose sulla gente Over and over again.

Per le strade di Pechino erano giorni di maggio tra noi si scherzava a raccogliere ortiche. Non sopporto i cori russi la musica finto rock la new wave italiana il free jazz punk inglese. Neanche la nera africana.

Cerco un centro di gravità permanente che non mi faccia mai cambiare idea sulle cose sulla gente avrei bisogno di...

Cerco un centro di gravità permanente che non mi faccia mai cambiare idea sulle cose sulla gente Over and over again Uacciuuariuari... you are a woman in love baby come into my life baby i need your love i want your love over and over again.

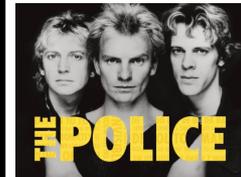


Rotation (autour du do)

Le projet SMIR (<http://repmus.ircam.fr/moreno/smir>)



Signal-based
Music
Information
Retrieval



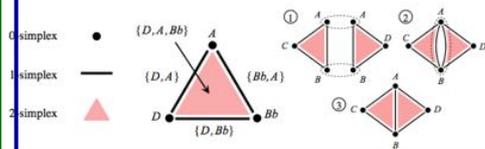
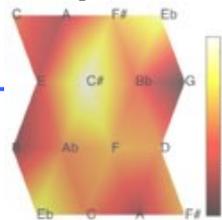
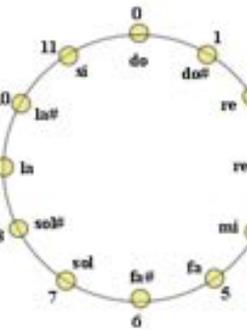
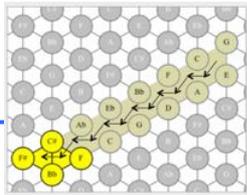
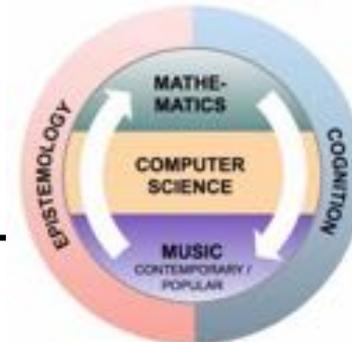
Oleg Berg



Modèles
algébriques

Modèles
topologiques

Modèles
mathématiques



Modèles computationnels

Modèles cognitifs

Structural Symbolic Music
Information Research