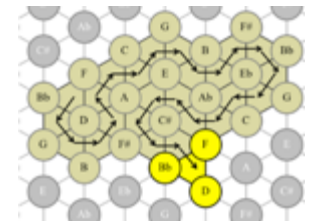
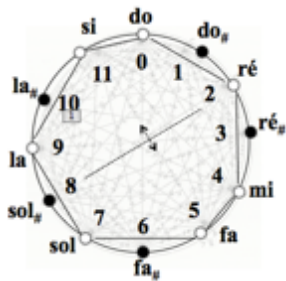


Modèles mathématiques et computationnels dans la chanson

Analyse de la musique et des répertoire III :
Musiques actuelles

(partie IV : modèles mathématiques et computationnels)



Moreno Andreatta

IRMA & ITI CREAA, Université de Strasbourg

Equipe Représentations Musicales

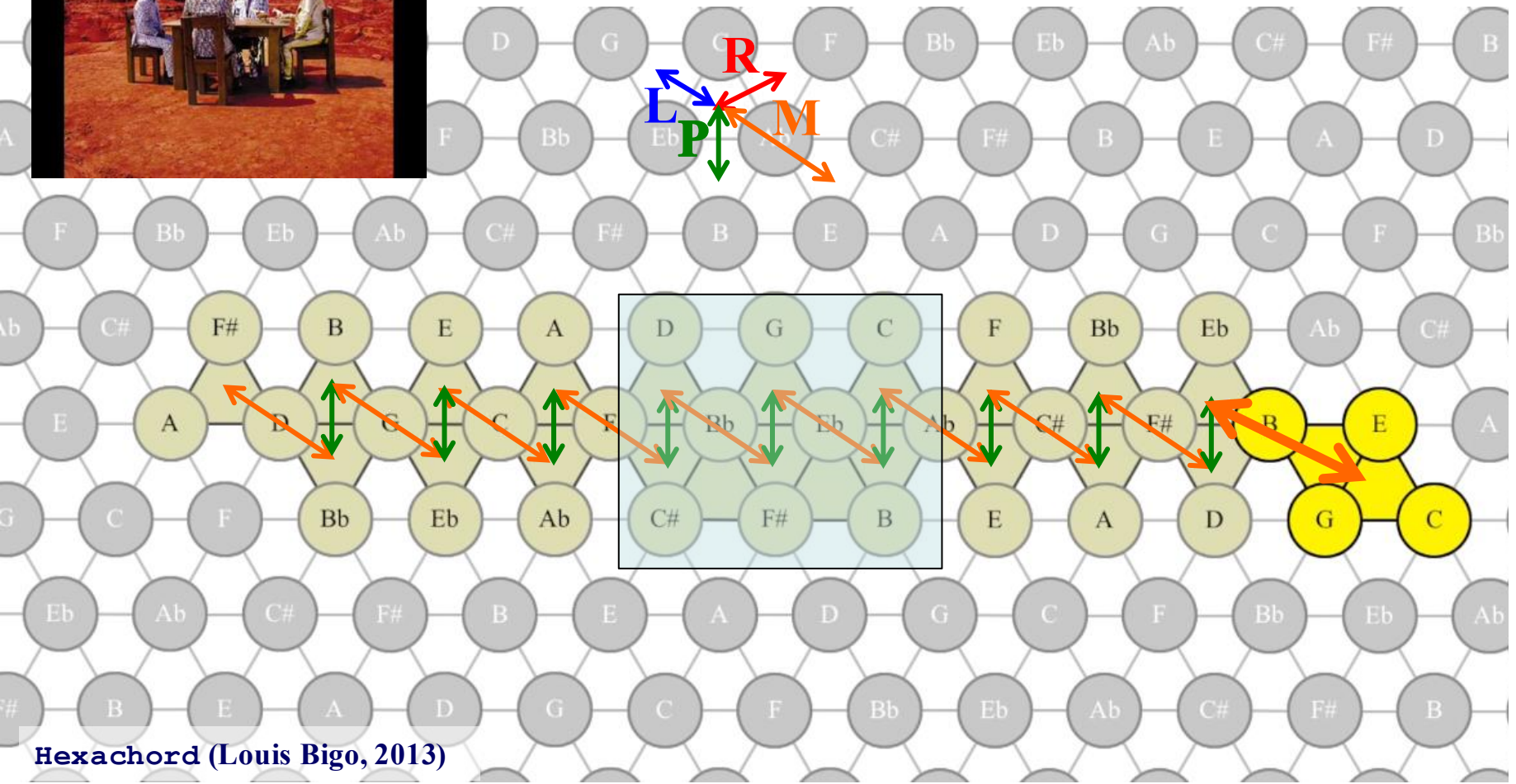
IRCAM / CNRS UMR 9912 / Sorbonne Université



Utilisation inconsciente (?) des symétries chez *Muse*



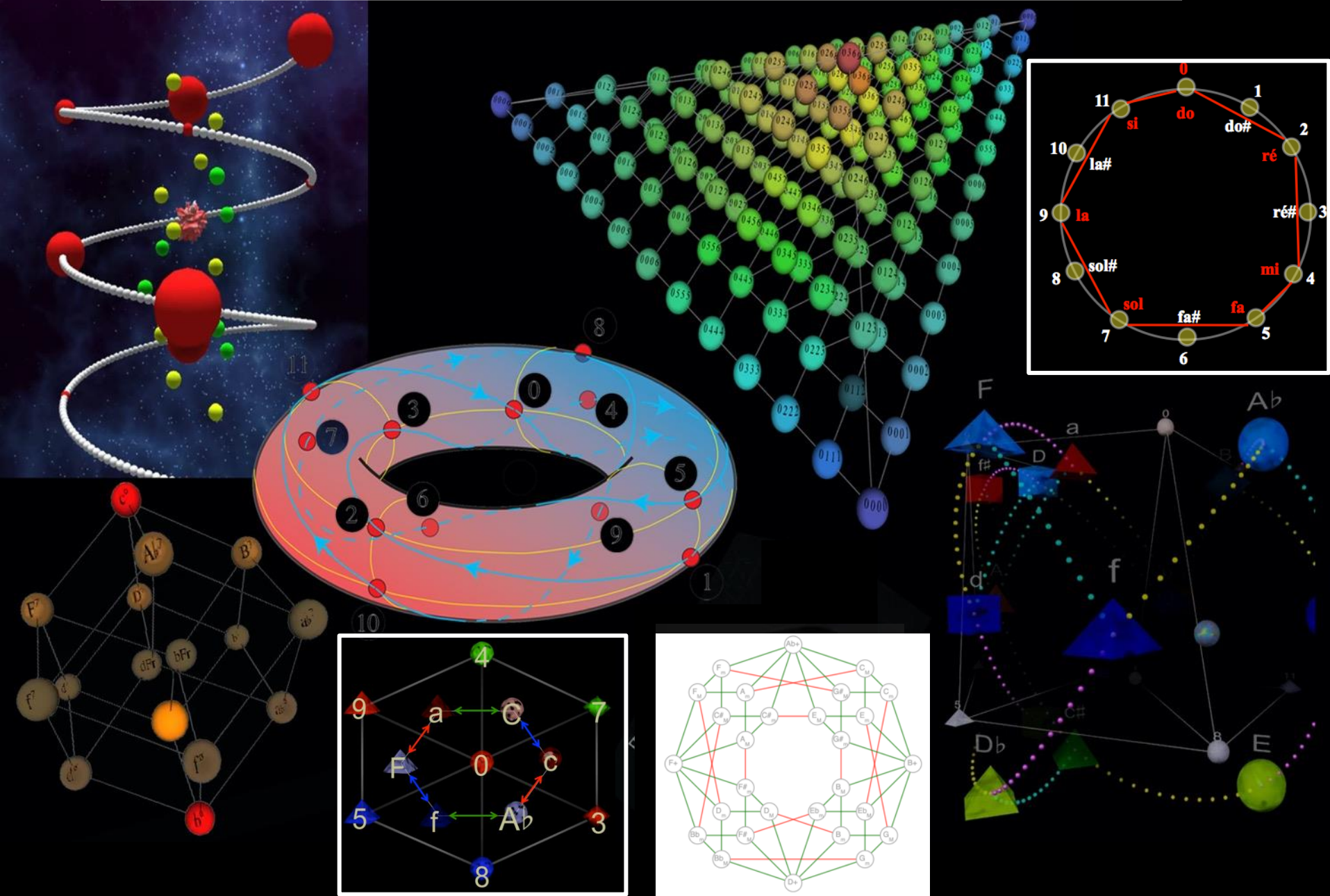
“Take a bow” (*Black Holes and Revelations*, 2006)



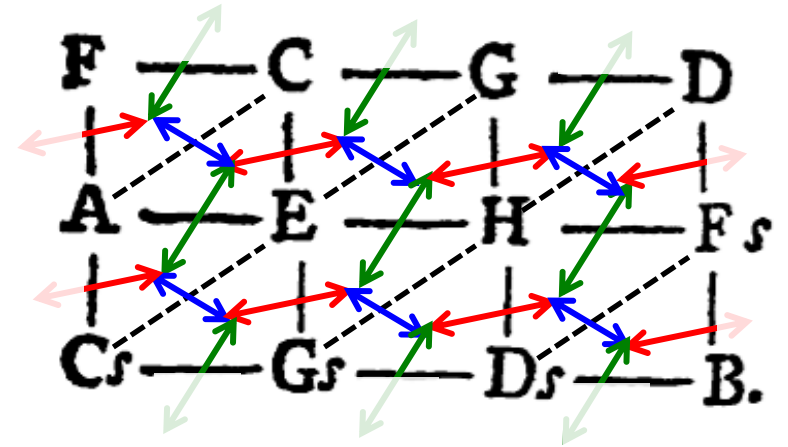
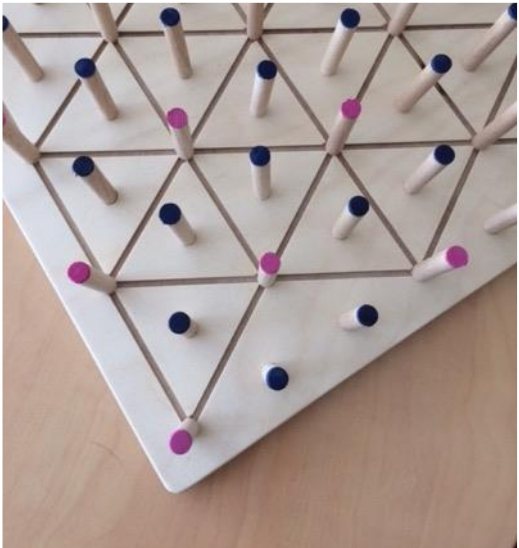
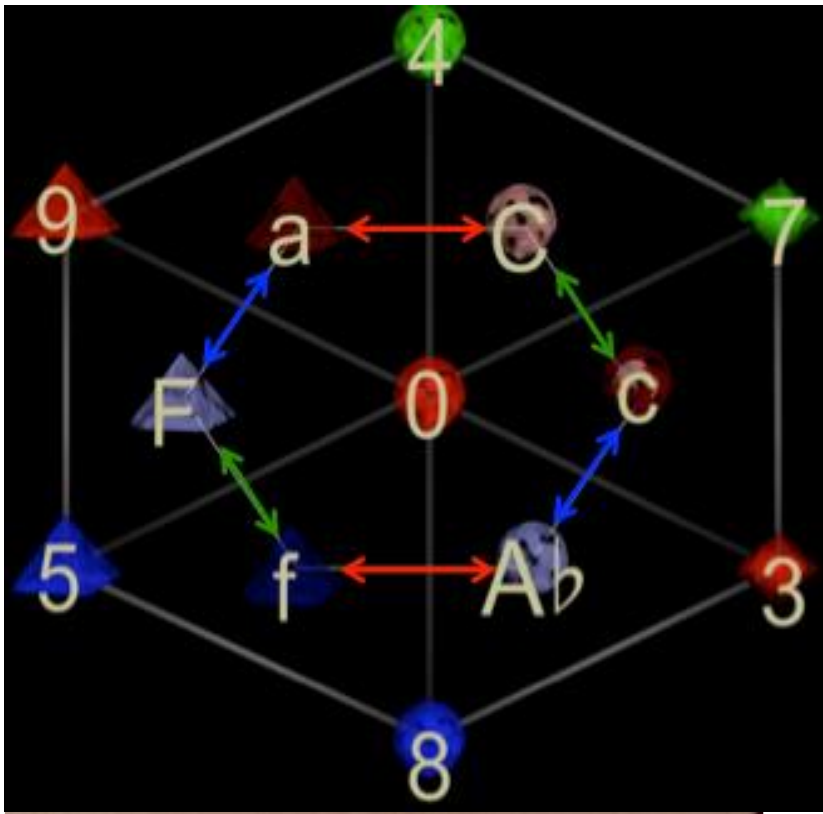
Hexachord (Louis Bigo, 2013)

→
axe temporel

La galaxie des modèles géométriques au service de la musique



Le Tonnetz (ou nid musical d'abeilles)

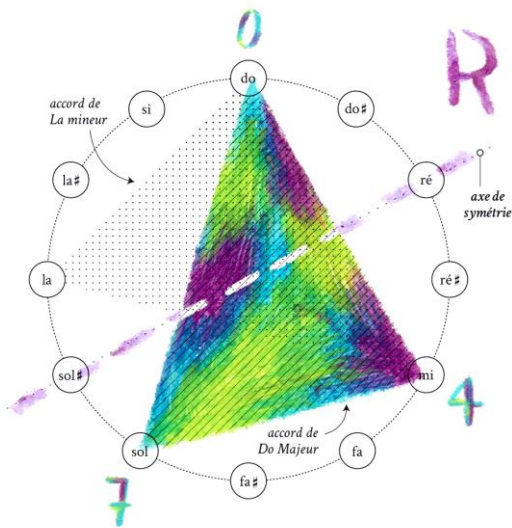


Speculum Musicum (1773)



Leonhard Euler

Les trois symétries néo-riemanniennes

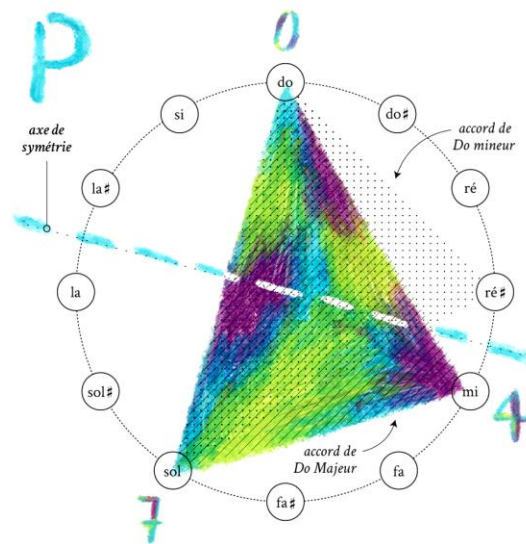


R = RELATIF

C majeur



A mineur

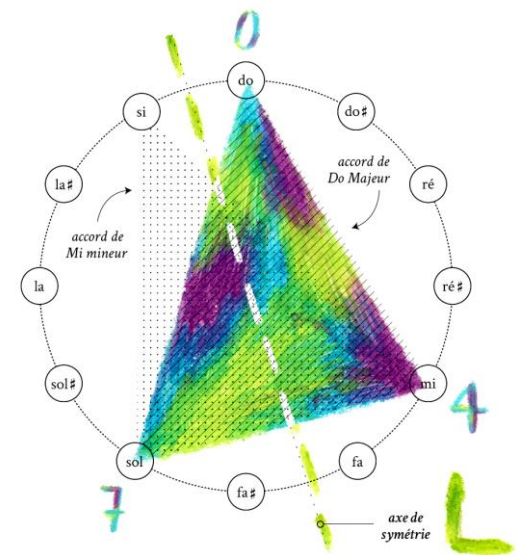


P = PARALLÈLE

C majeur



C mineur



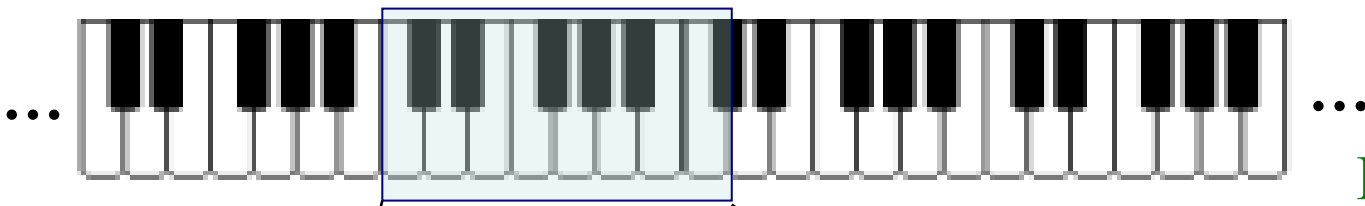
**L = LEADING-TONE
(EXCHANGE)**

C majeur



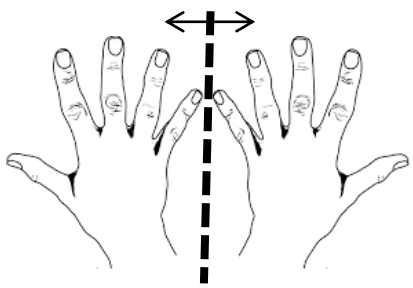
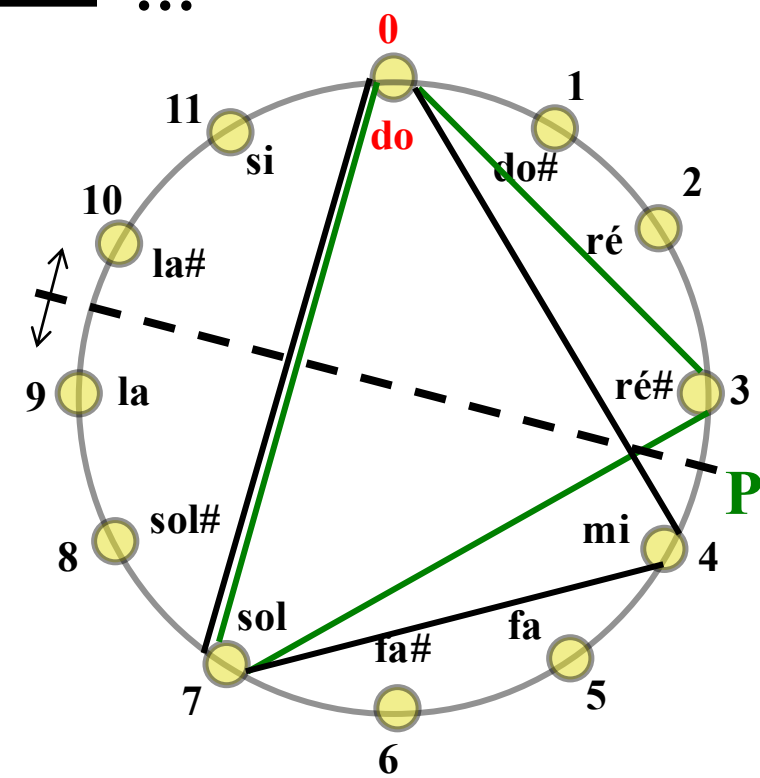
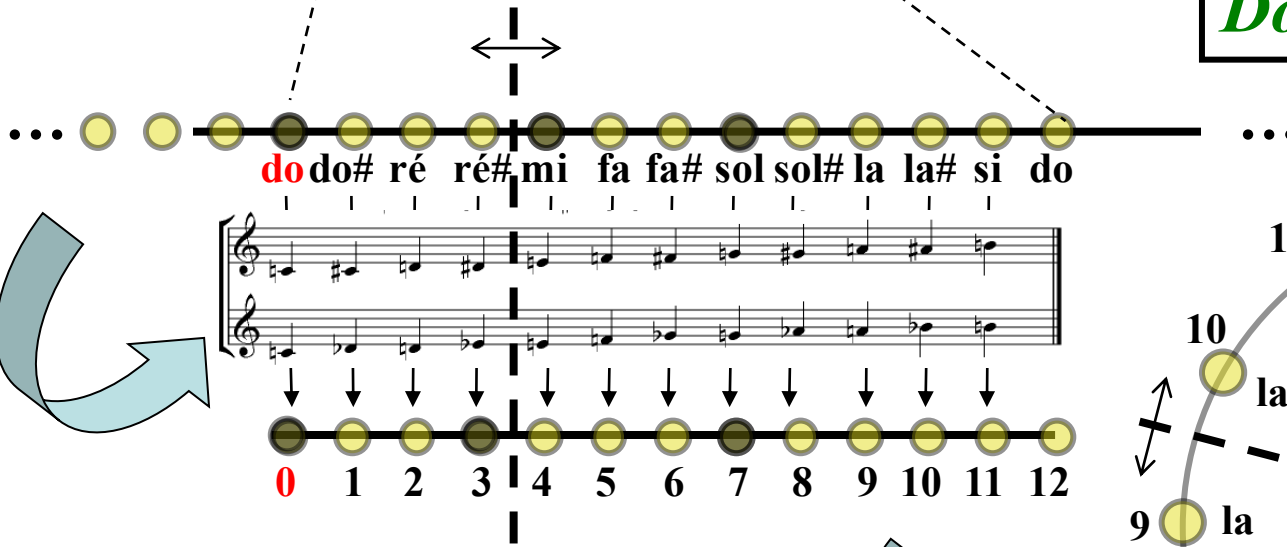
E mineur

Les inversions sont des symétries axiales

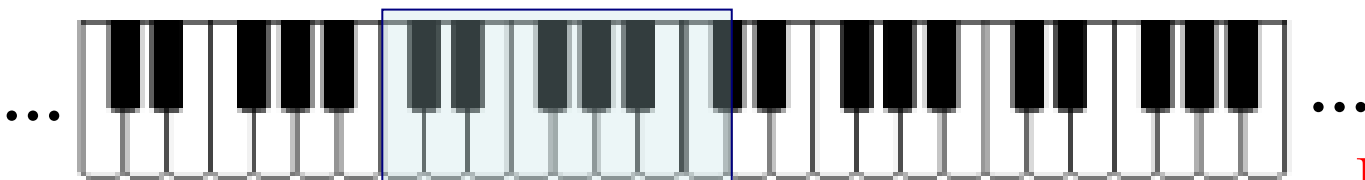


P comme **parallèle**

Do maj = {0,4,7}
Do min = {0,3,7}

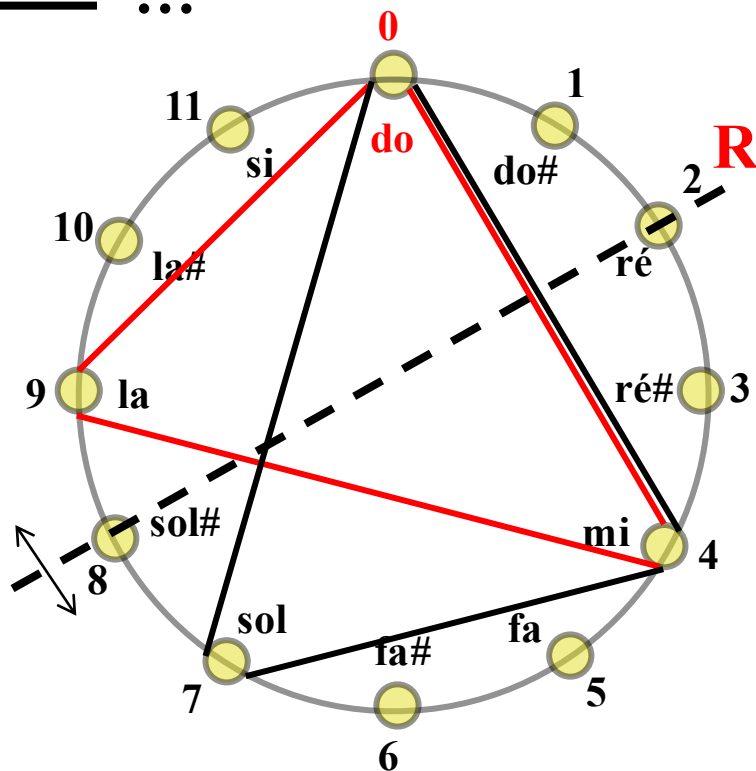
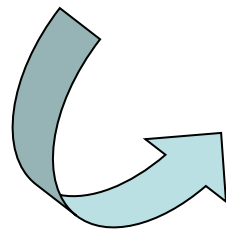
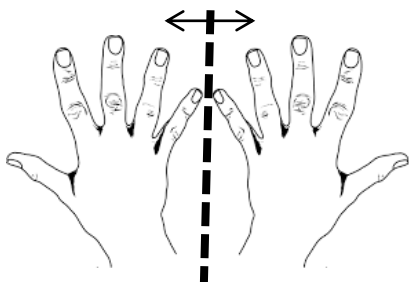
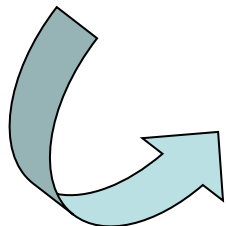
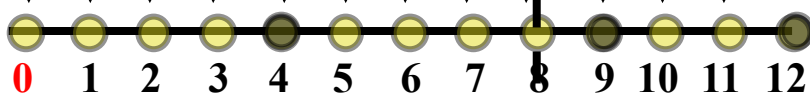
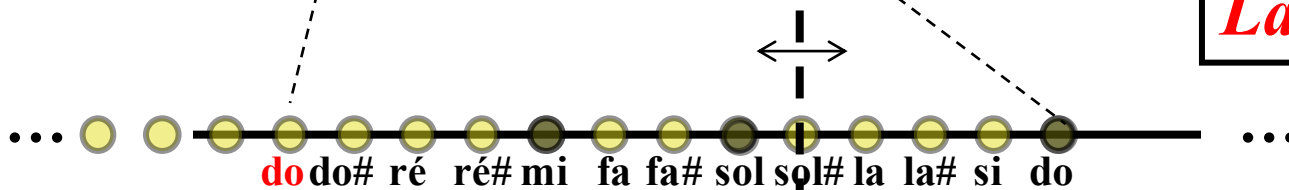


Les inversions sont des symétries axiales

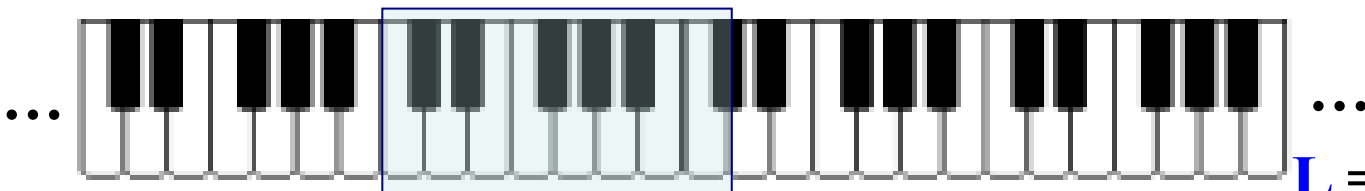


R comme **relatif**

Do maj = {0,4,7}
La min = {0,4,9}



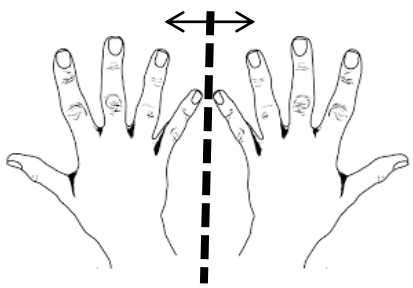
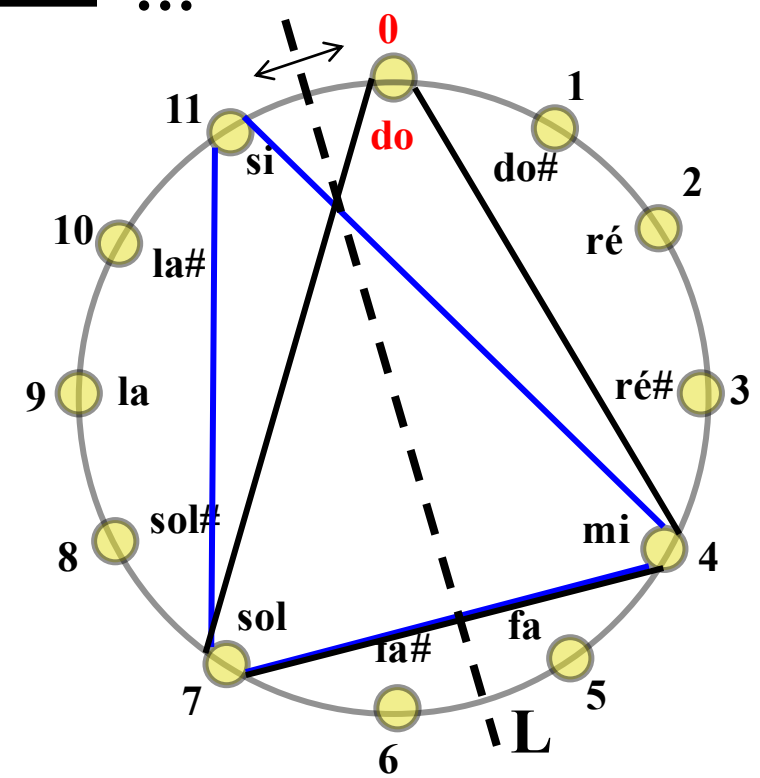
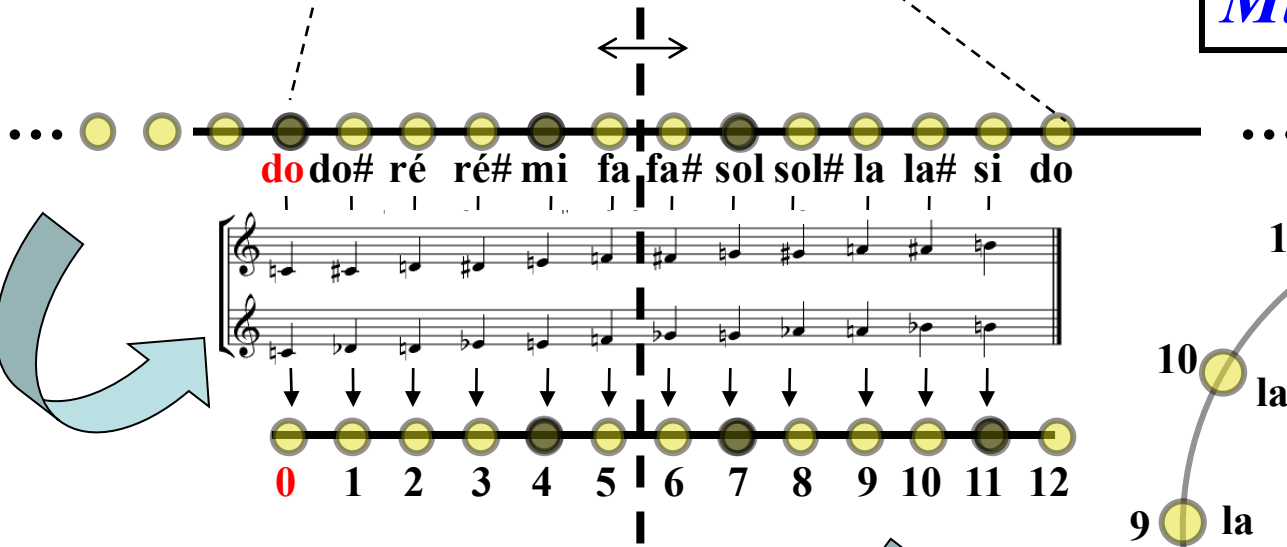
Les inversions sont des symétries axiales



L = Leading Tone

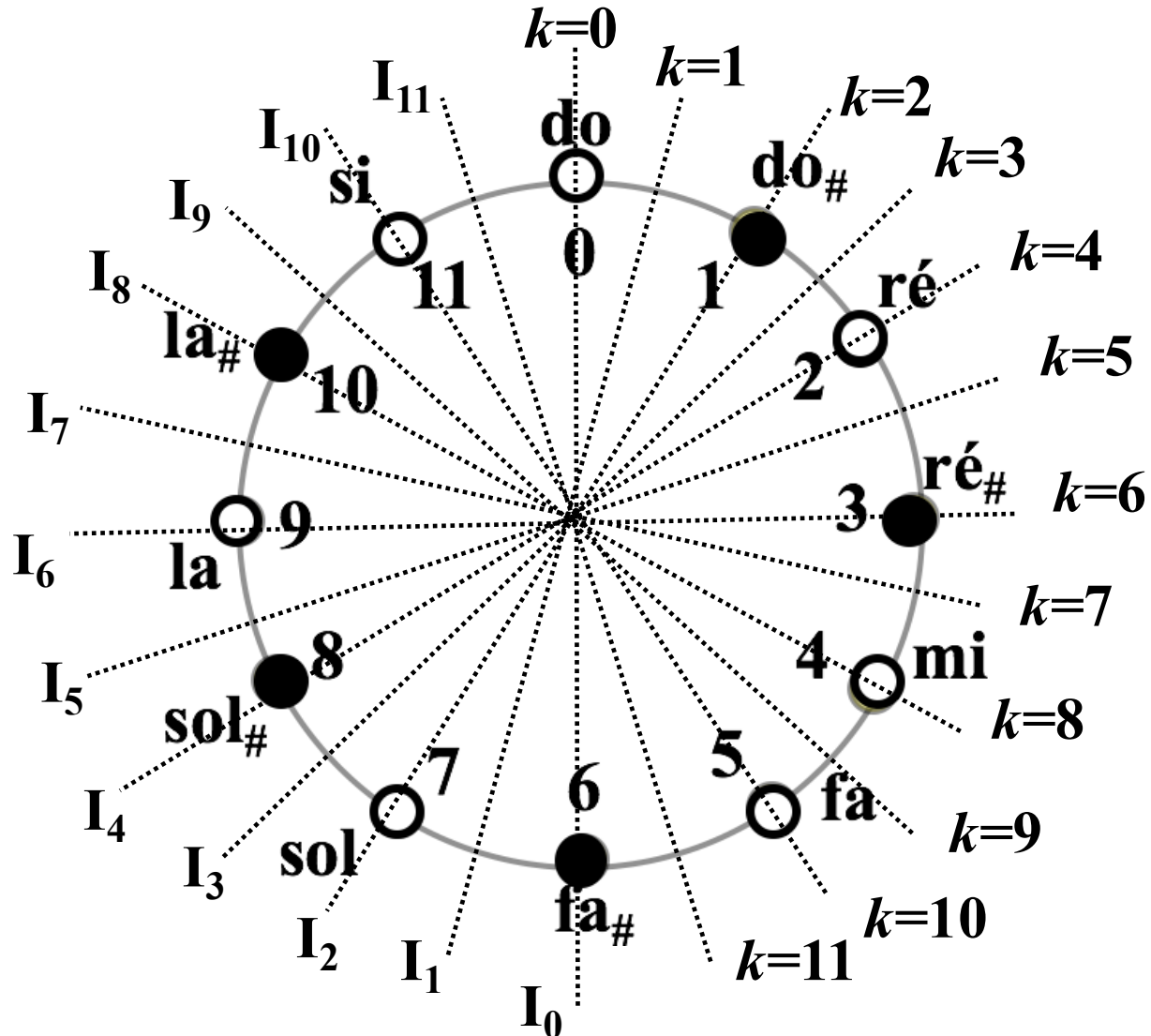
Do maj = {0,4,7}

Mi min = {4,7,11}



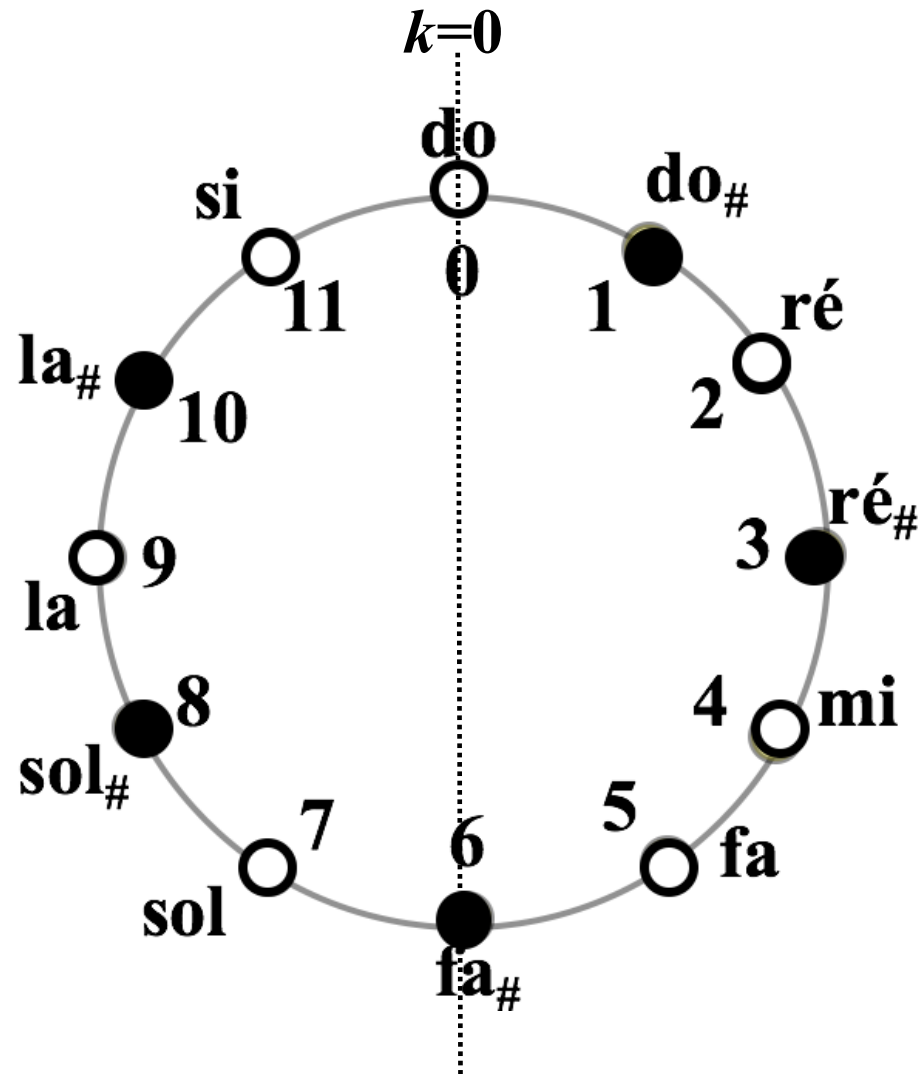
Les inversions sont des symétries axiales généralisées

$$x \xrightarrow{I_k} k-x \text{ modulo } 12$$



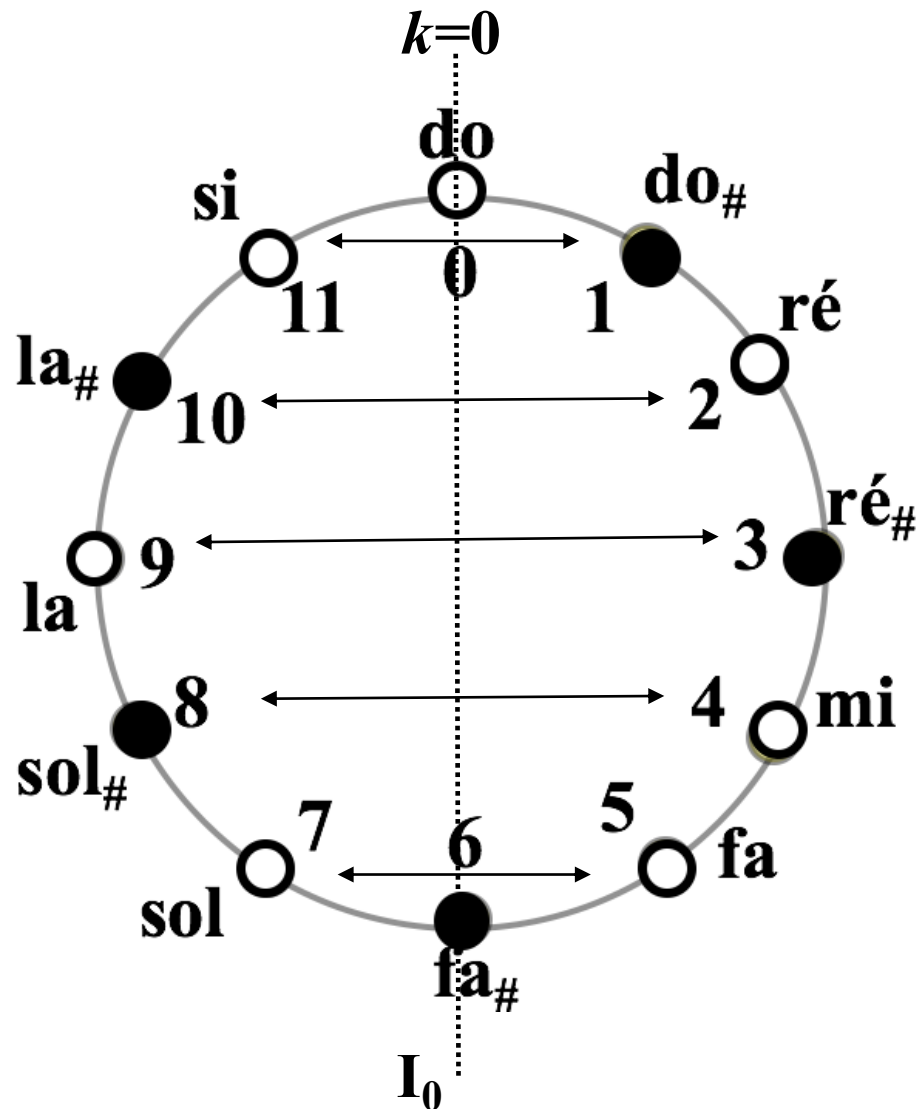
Quelques exemples

$$x \xrightarrow{I_0} -x \text{ modulo } 12$$



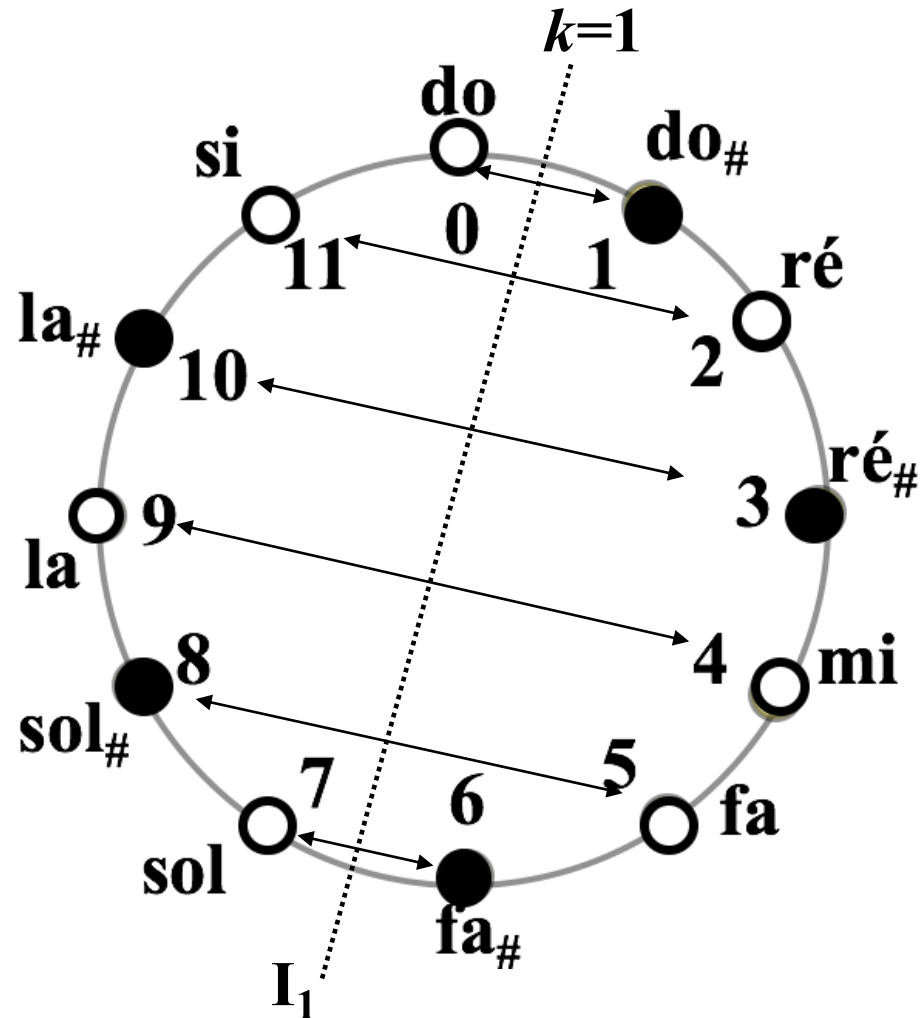
Quelques exemples

$$x \xrightarrow{I_0} -x \text{ modulo } 12$$



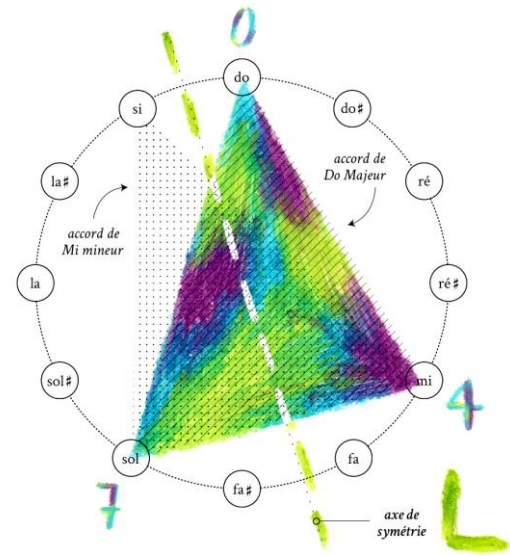
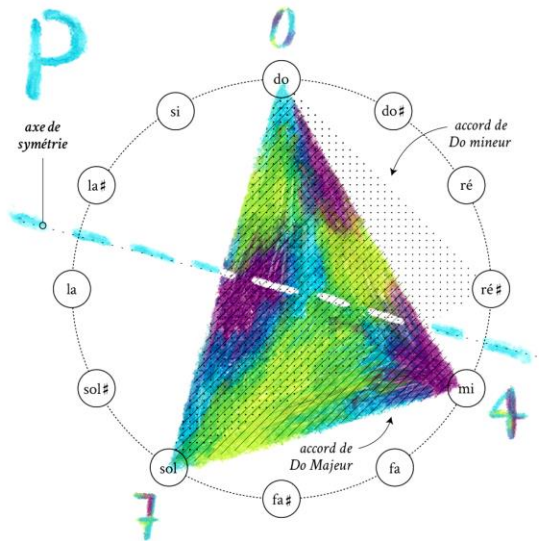
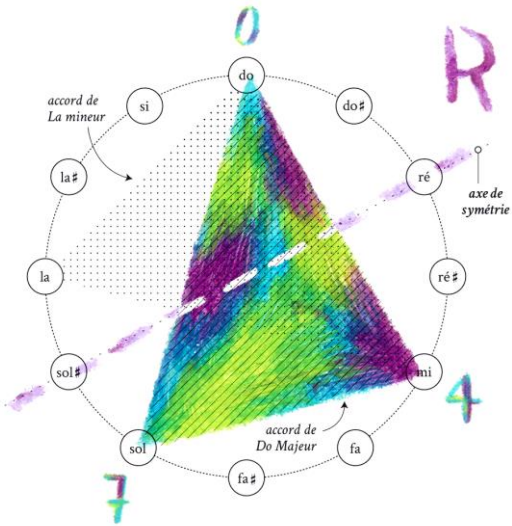
Les inversions sont des symétries axiales généralisées

$$x \xrightarrow{I_1} 1-x \text{ modulo } 12$$



Retour sur les trois symétries néo-riemanniennes

$$x \xrightarrow{I_k} k-x \text{ modulo } 12$$



R = RELATIF

$$I_k = ?$$

C majeur



A mineur

P = PARALLÈLE

$$I_k = ?$$

C majeur



C mineur

L = LEADING-TONE

(EXCHANGE)

$$I_k = ?$$

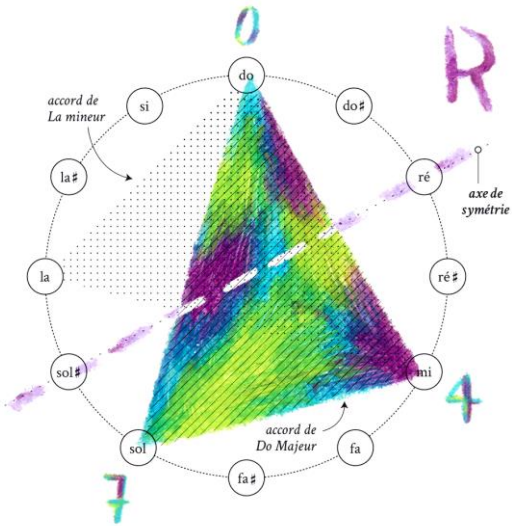
C majeur



E mineur

Retour sur les trois symétries néo-riemanniennes

$$x \xrightarrow{I_k} k-x \text{ modulo } 12$$

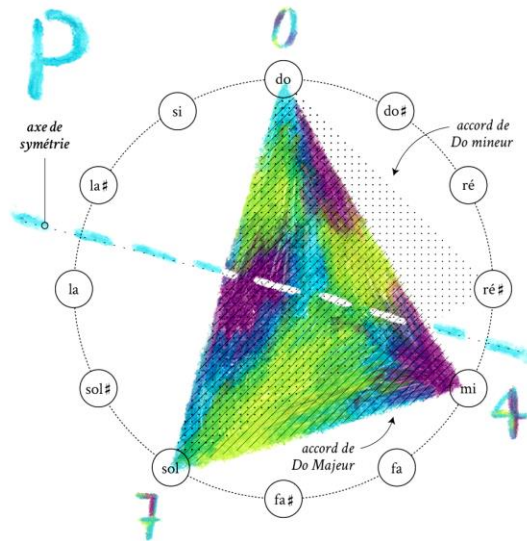


R = RELATIF

C majeur



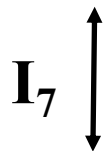
A mineur



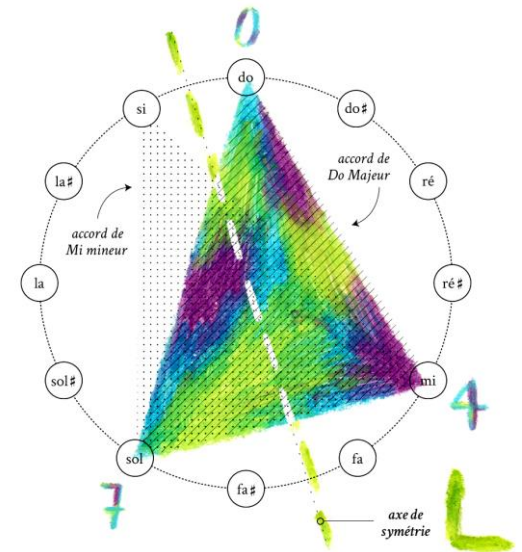
P = PARALLÈLE

$I_k = ?$

C majeur



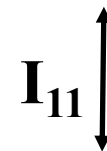
C mineur



**L = LEADING-TONE
(EXCHANGE)**

$I_k = ?$

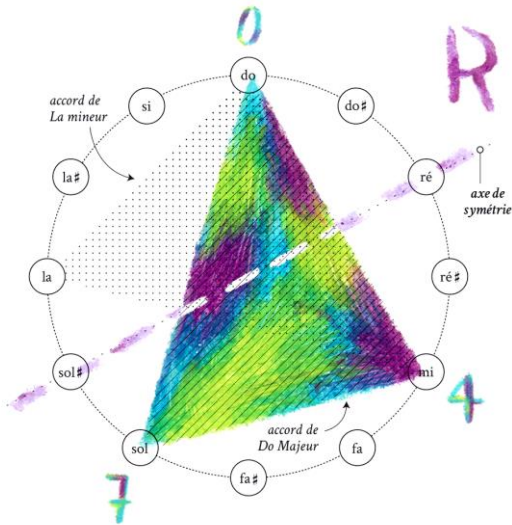
C majeur



E mineur

Retour sur les trois symétries néo-riemanniennes

$$x \xrightarrow{I_4} 4-x \text{ modulo } 12$$

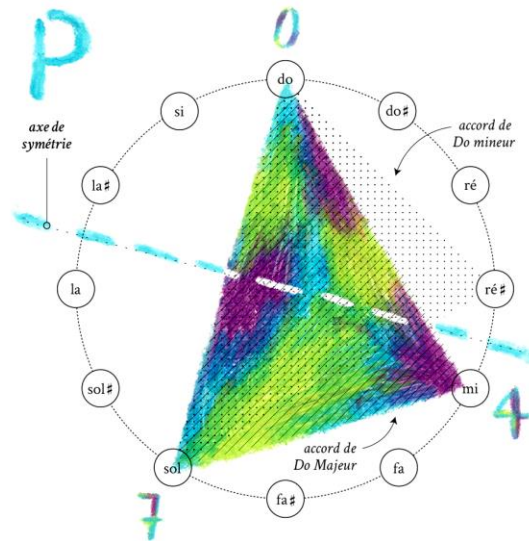


R = RELATIF

$\{0,4,7\}$

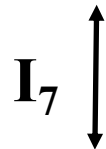


$\{4-0,4-4,4-7\} = \{4,0,9\}$

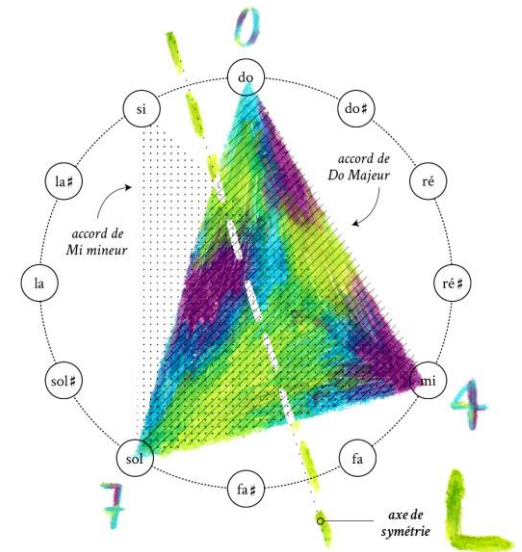


P = PARALLÈLE

C majeur



C mineur



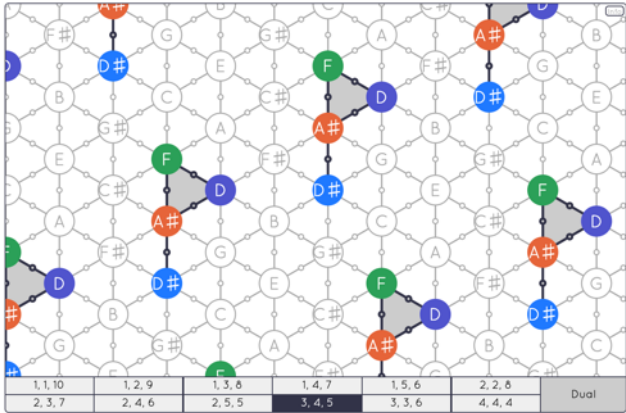
**L = LEADING-TONE
(EXCHANGE)**

C majeur

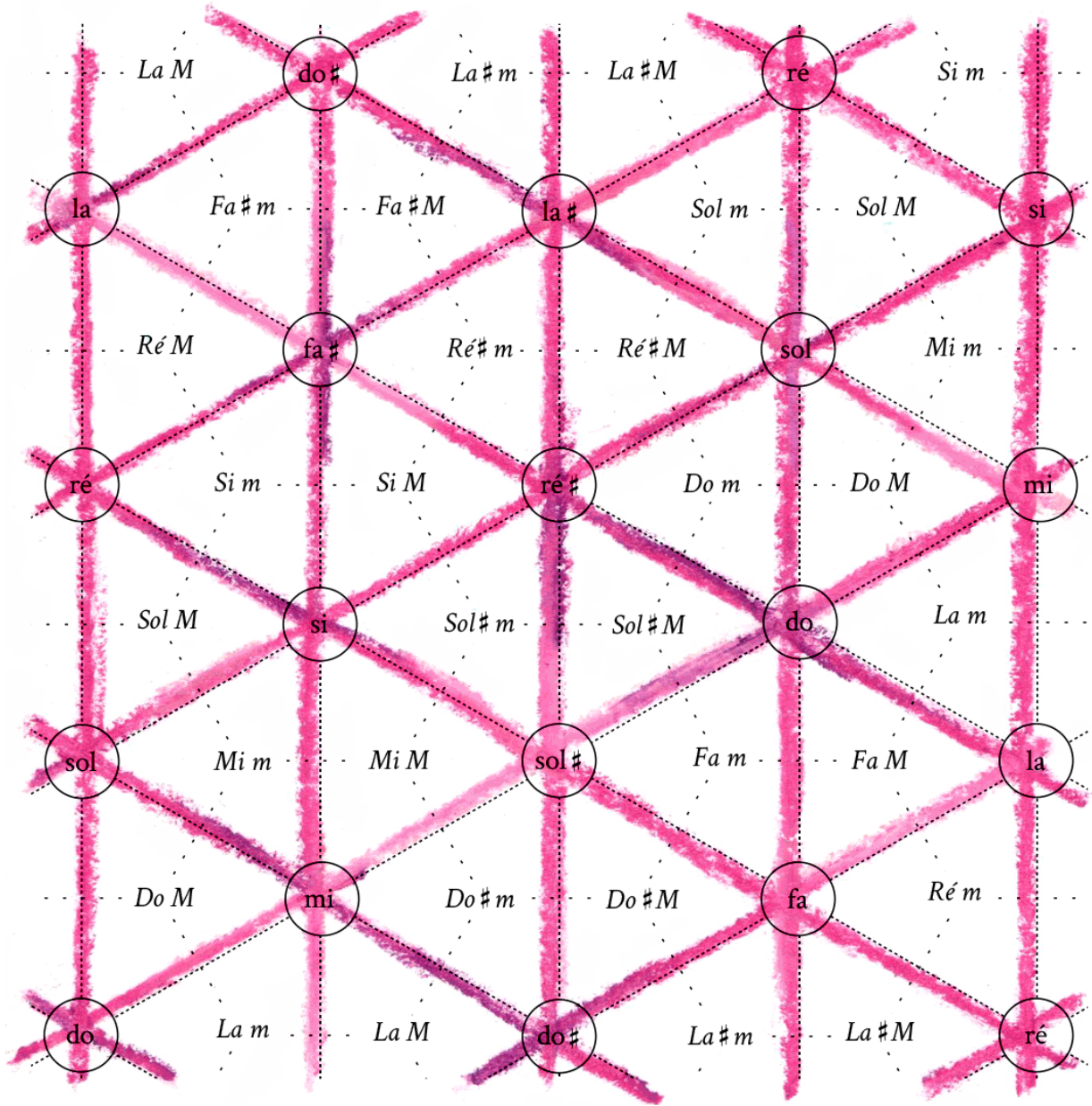
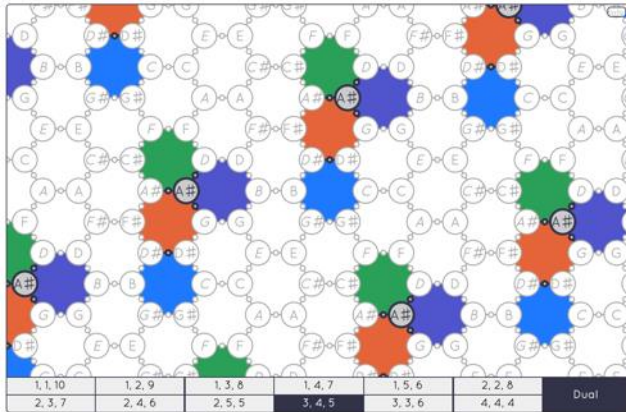
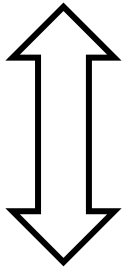


E mineur

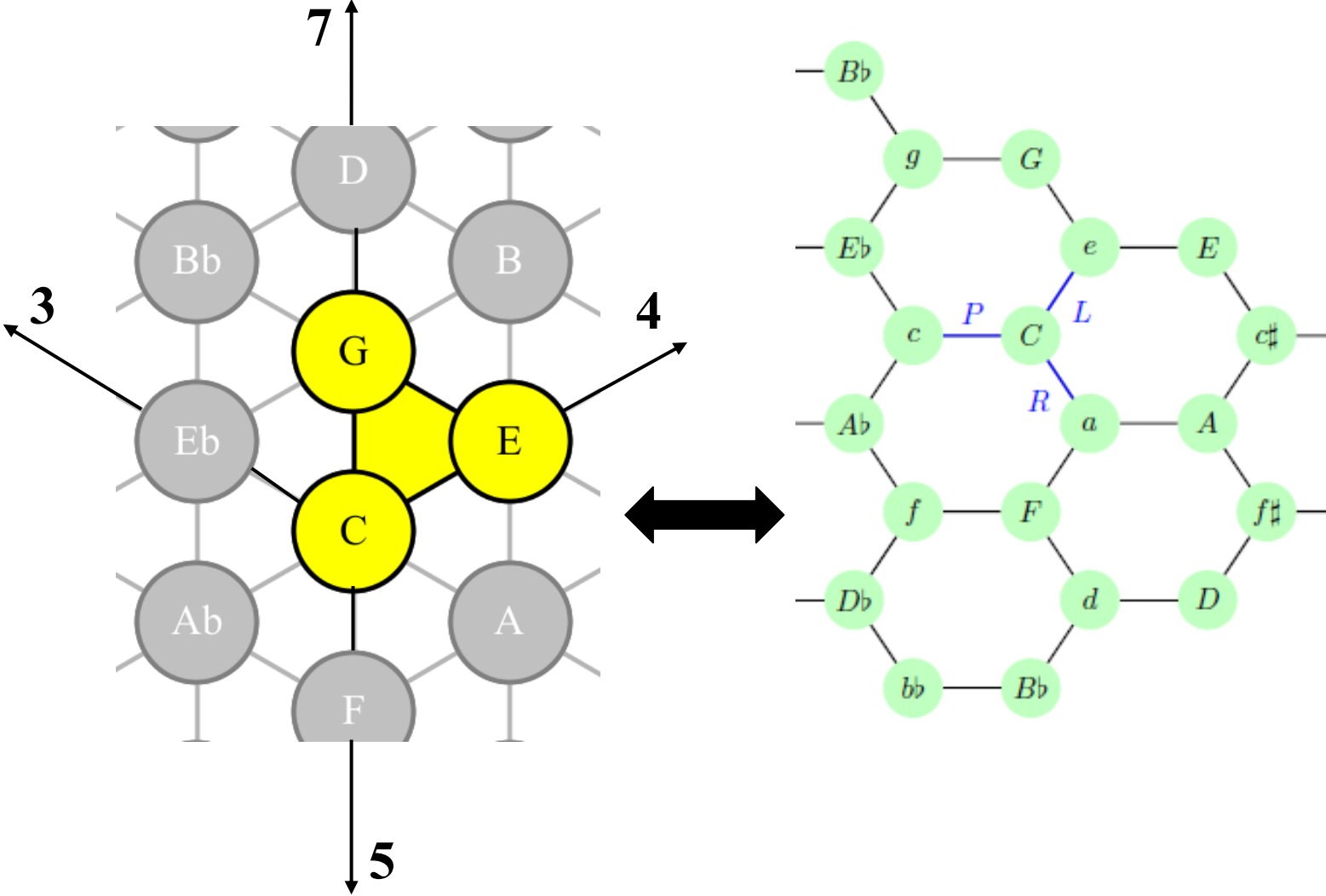
Du Tonnetz à l'espace dual



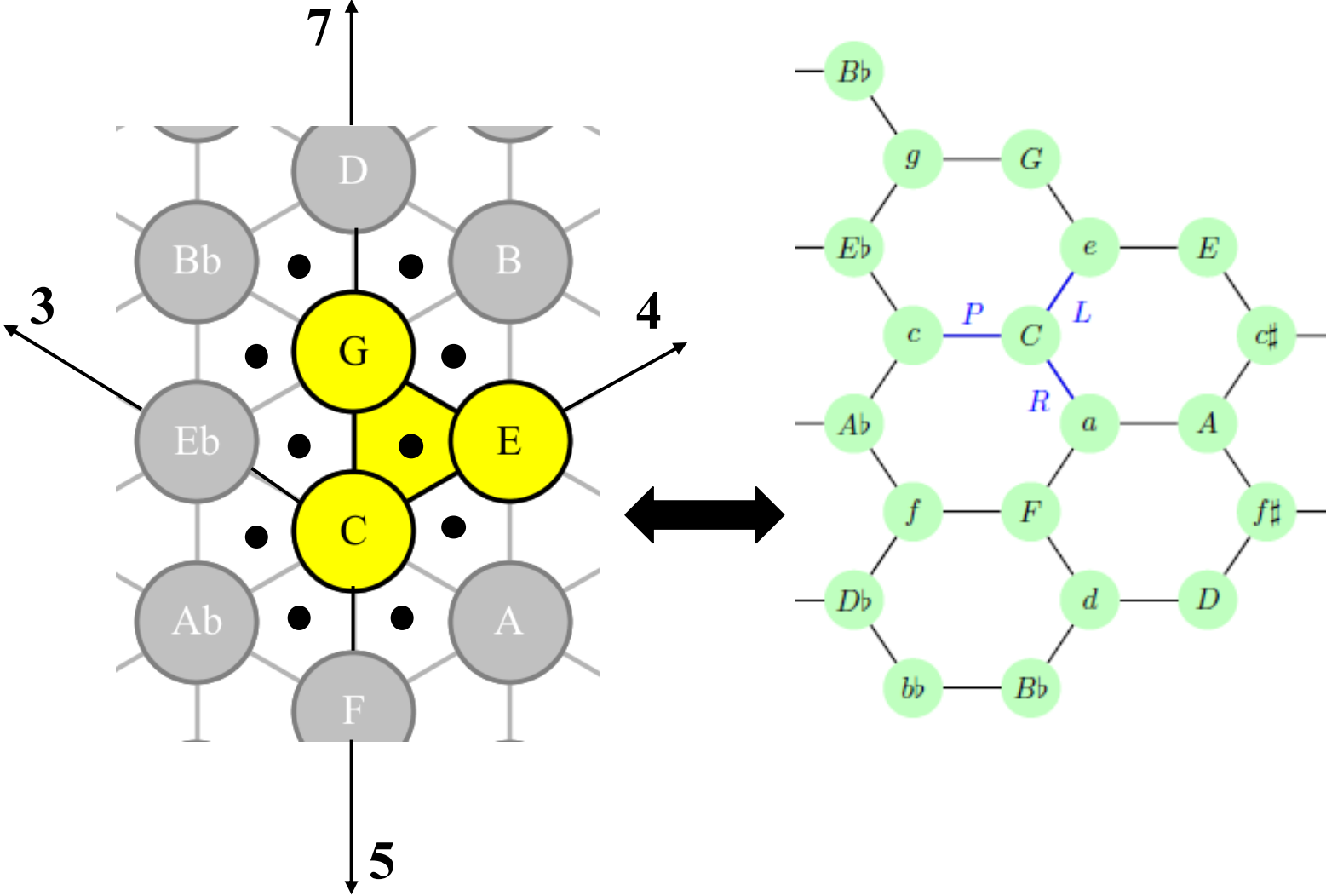
duality



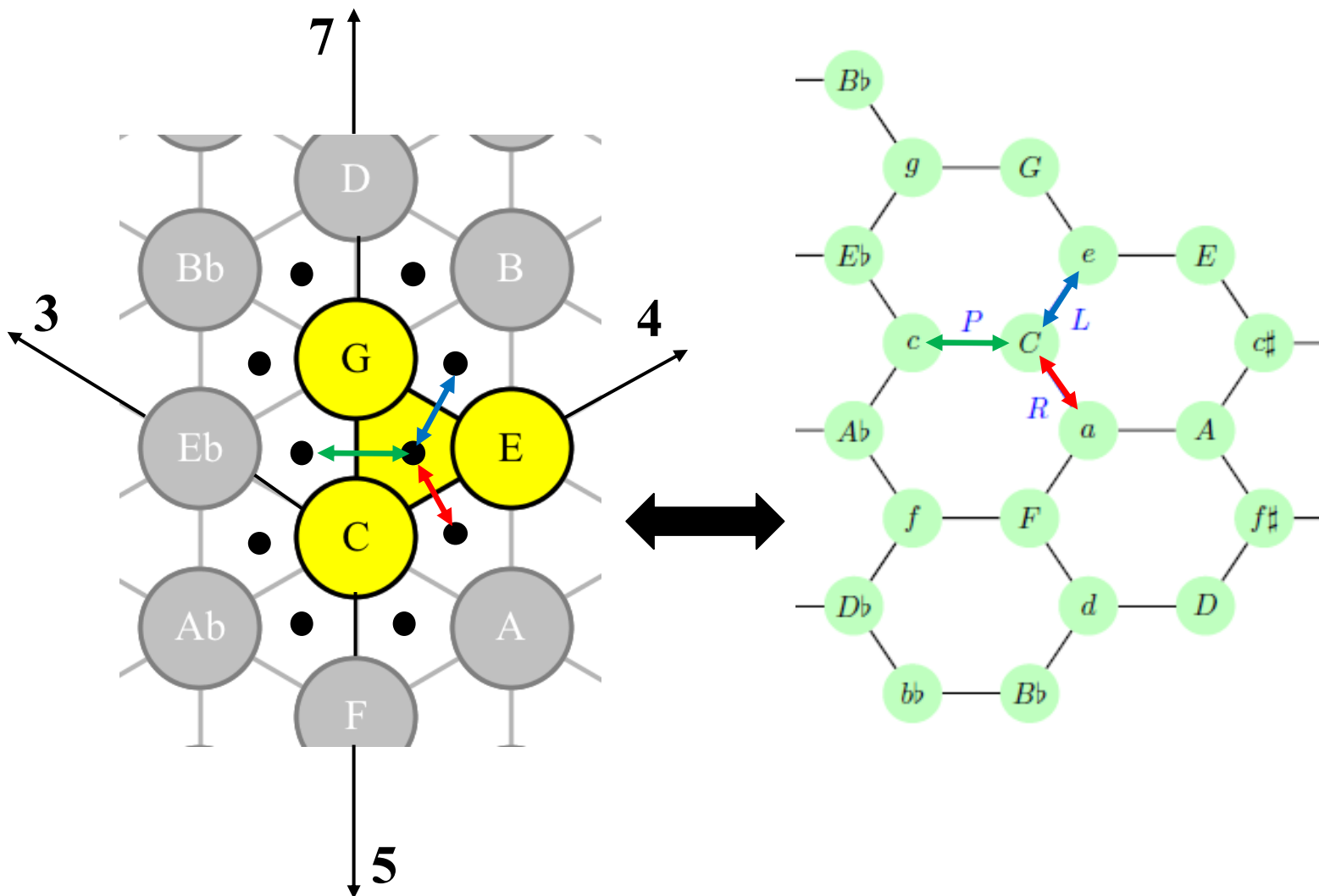
Construction du maillage hexagonal à partir du Tonnetz



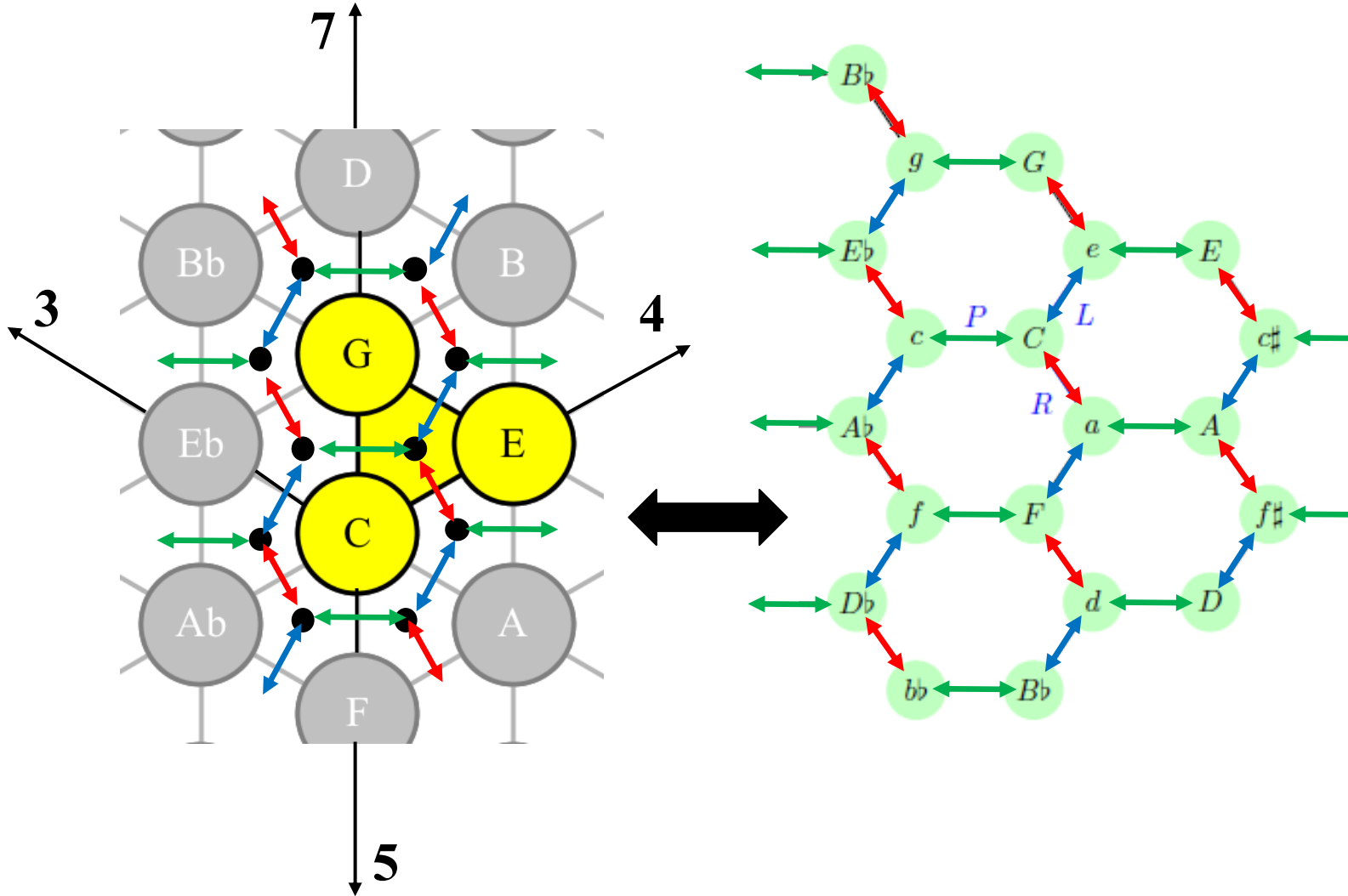
Construction du maillage hexagonal à partir du Tonnetz



Construction du maillage hexagonal à partir du Tonnetz



Construction du maillage hexagonal à partir du Tonnetz





MAGIC IN THE AIR

Sol

Ré

La

Si-

Feel the magic in the air. Allez, allez, allez

Levez les mains en l'air Allez, allez, allez
(x2)

(x4 avec toutes les voix)

Ré
Comme d'habitude on est calés

La **Si-**
Comme toujours ça va aller

Sol **Ré**
On sème l'ambiance à gogo

La **Si-**
Tous ensemble on fait le show

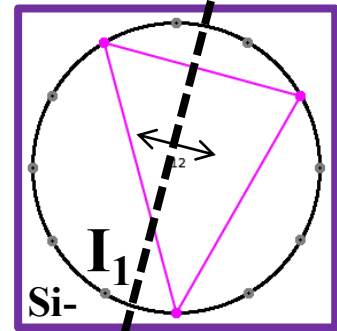
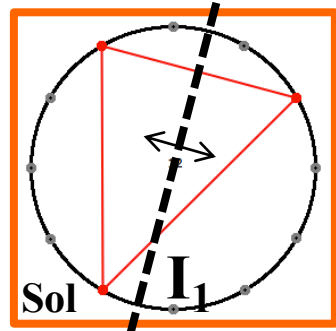
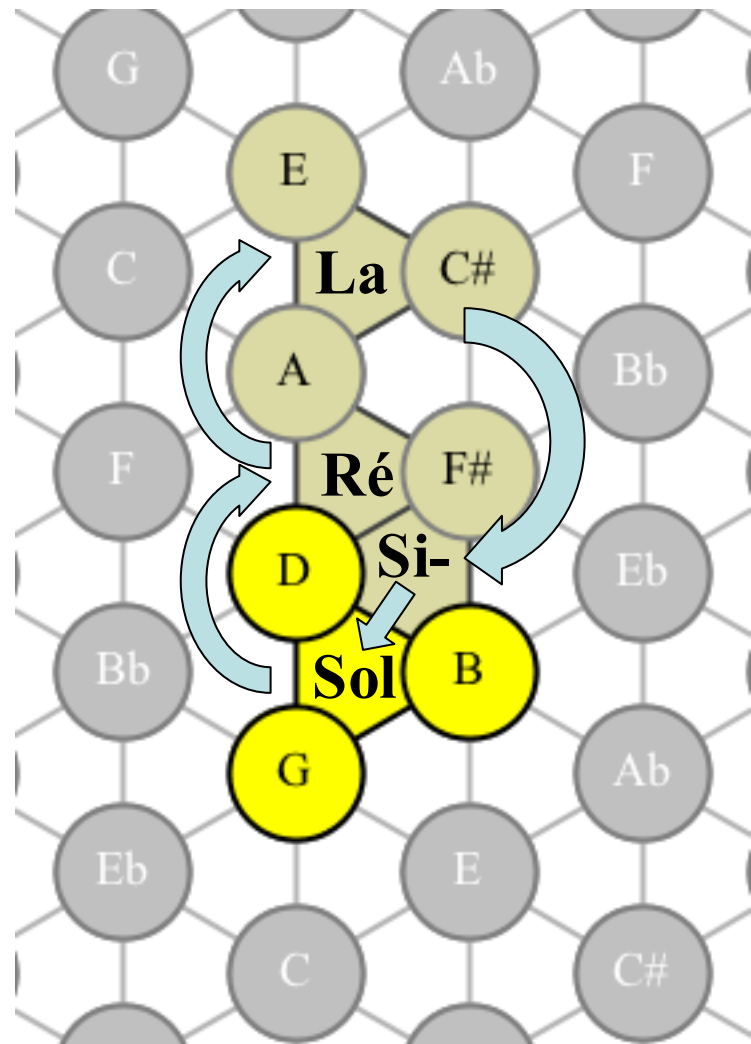
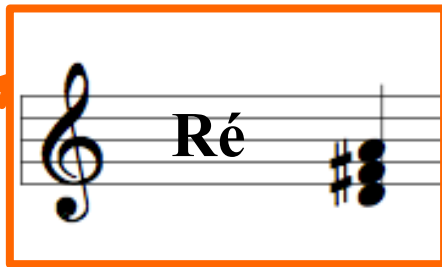
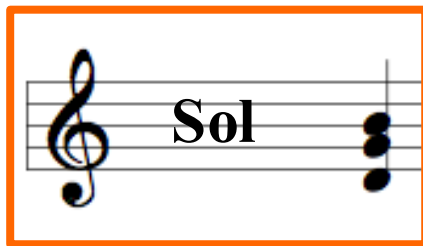
Sol **Ré**
On t'invite à la magie Y'a pas de raccourci

La **Si-**
Oublie tes soucis Viens faire la folie

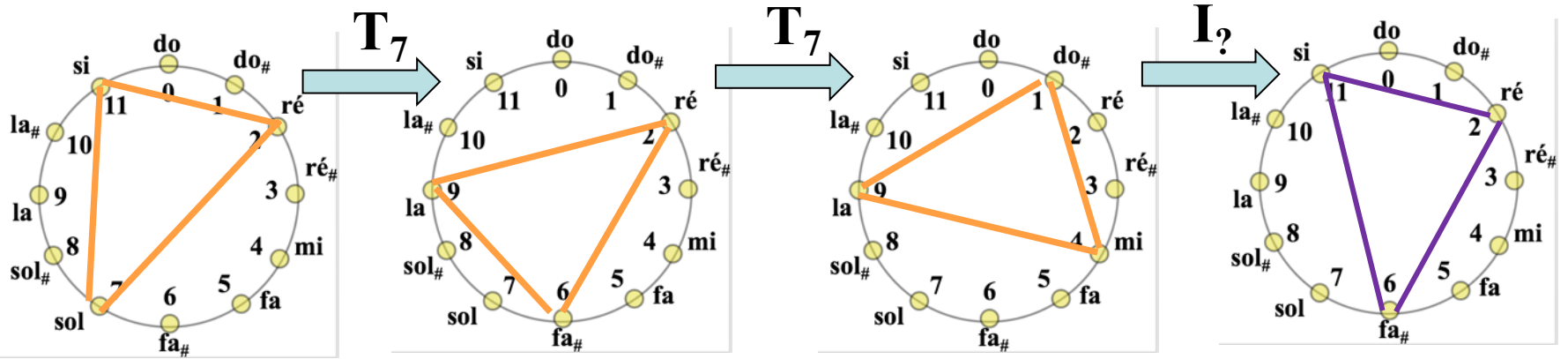
Sol **Ré**
On t'invite à la magie Y'a pas de raccourci

La **Si-**
Oublie tes soucis Oh oh oh oh oh oh

Sol
Feel the magic in the air ...



Quelques exemples analytiques

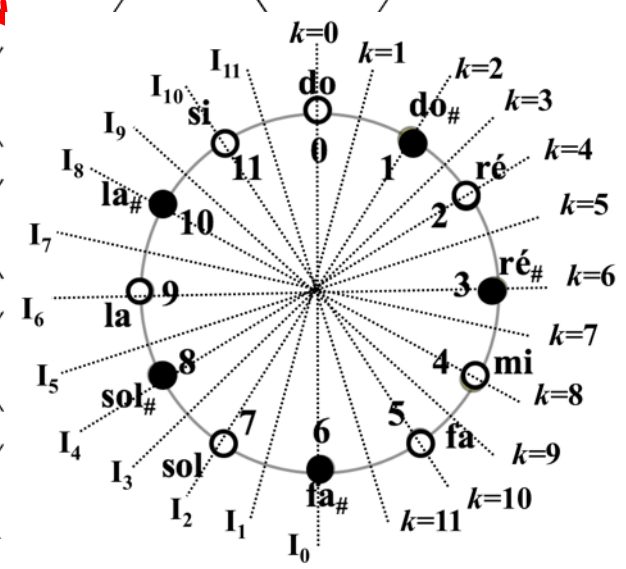
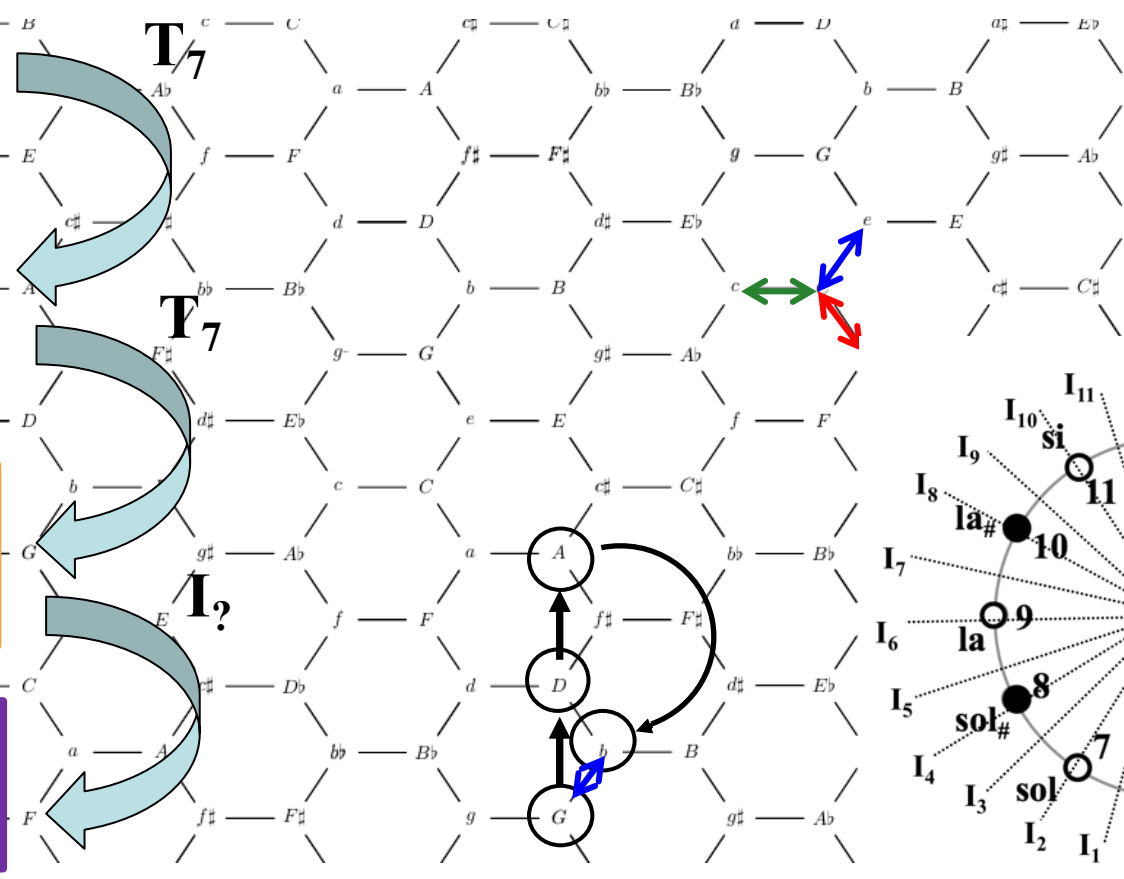


Musical notation for the note Sol (G4).

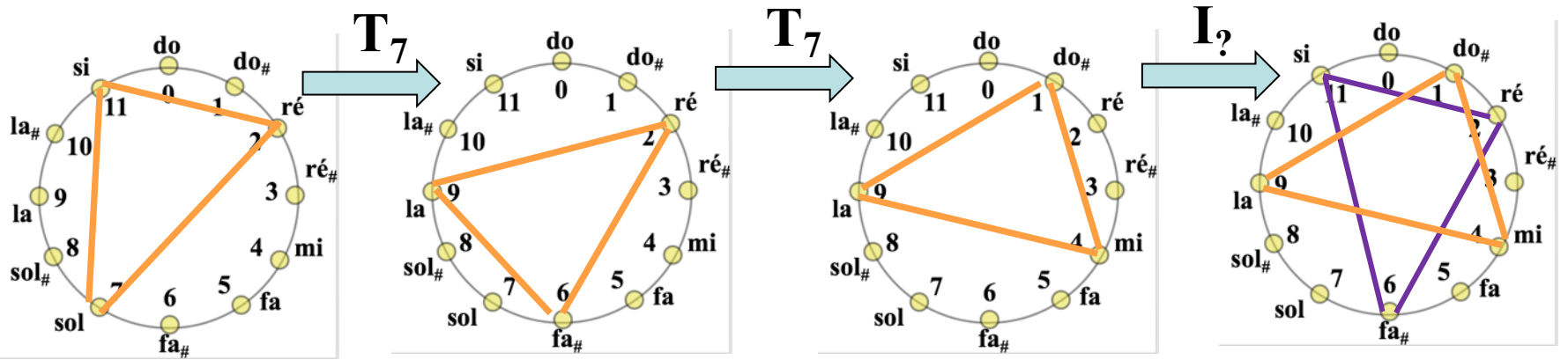
Musical notation for the note Ré (D4).

Musical notation for the note La (A3).

Musical notation for the note Si (B3).



Quelques exemples analytiques

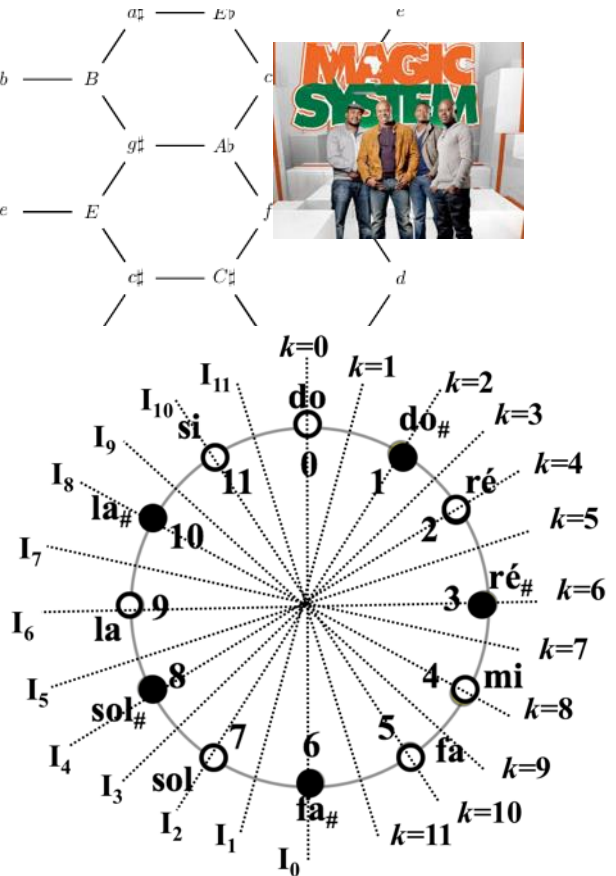
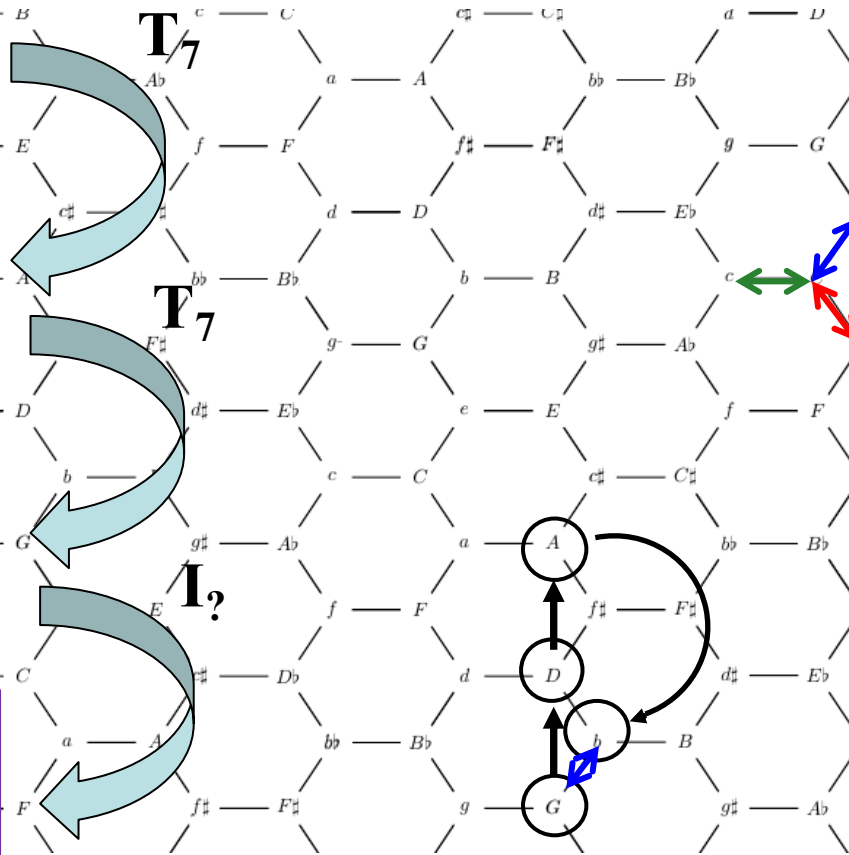


Musical staff for Sol (G4).

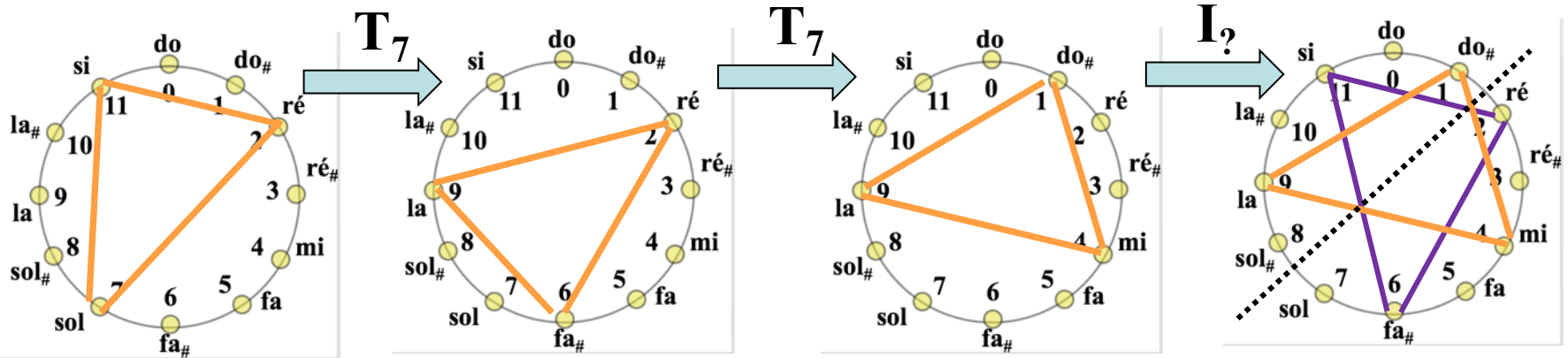
Musical staff for Ré (D4).

Musical staff for La (A3).

Musical staff for Si (B3).



Quelques exemples analytiques

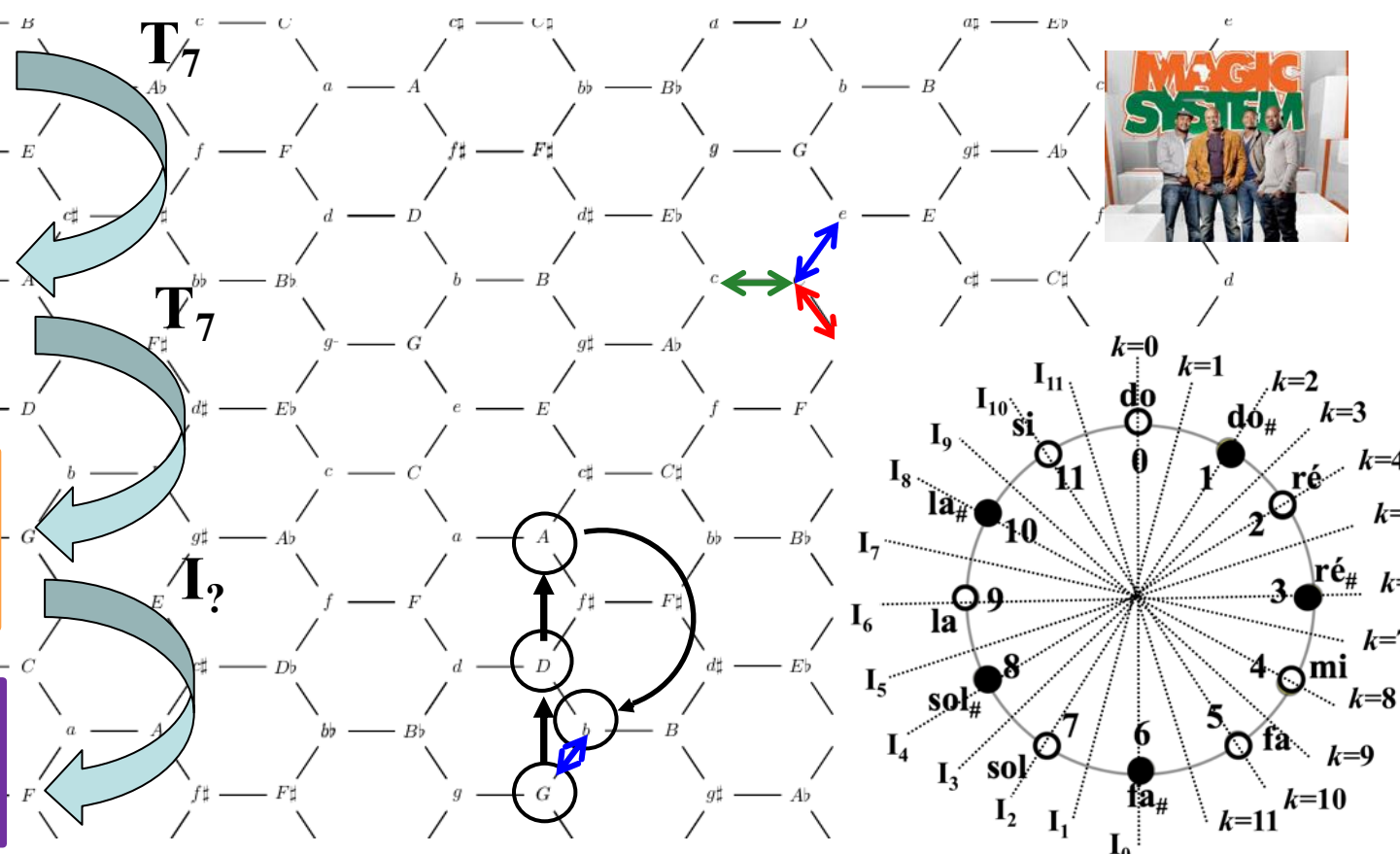


Musical staff showing the chord Sol (G3, B2, D3).

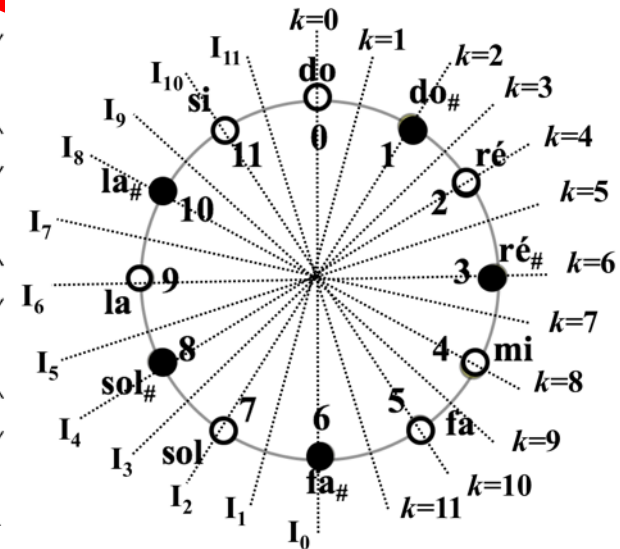
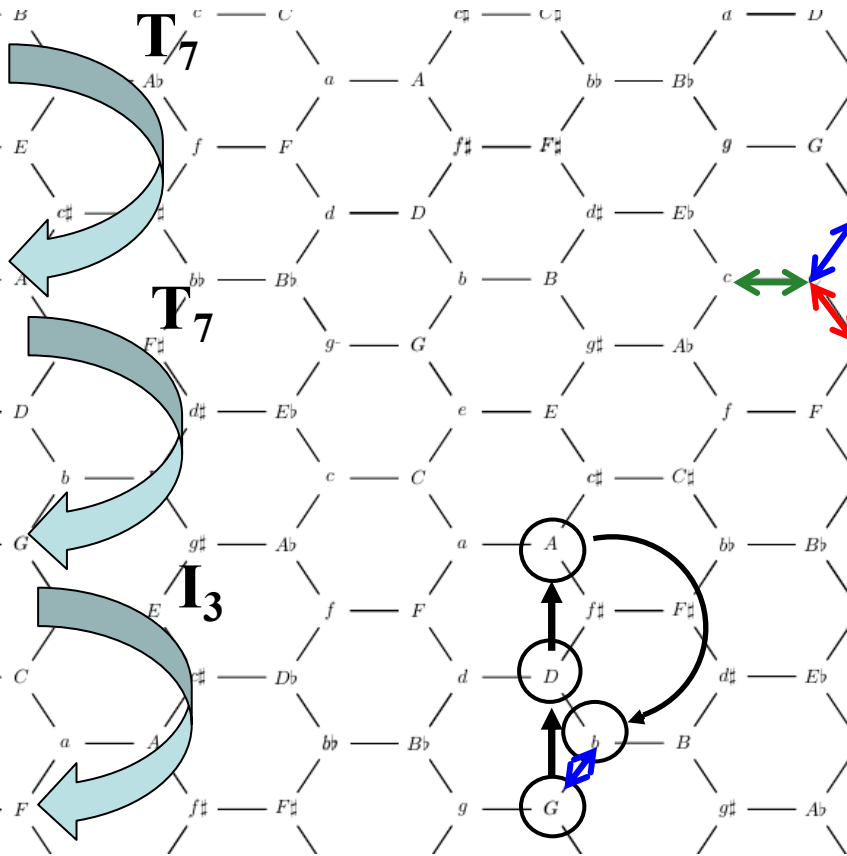
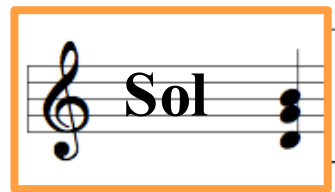
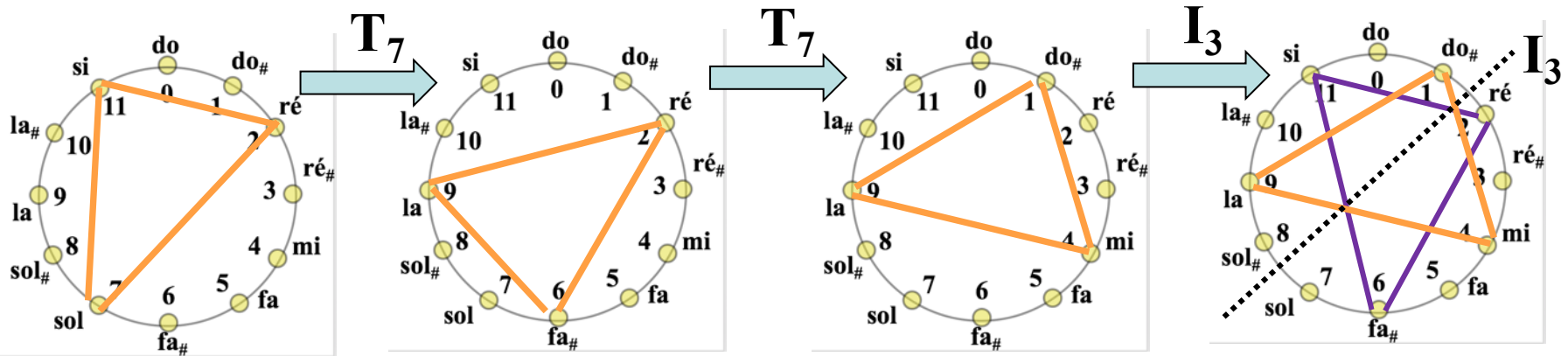
Musical staff showing the chord Ré (D3, F#3, A3).

Musical staff showing the chord La (A3, C#4, E4).

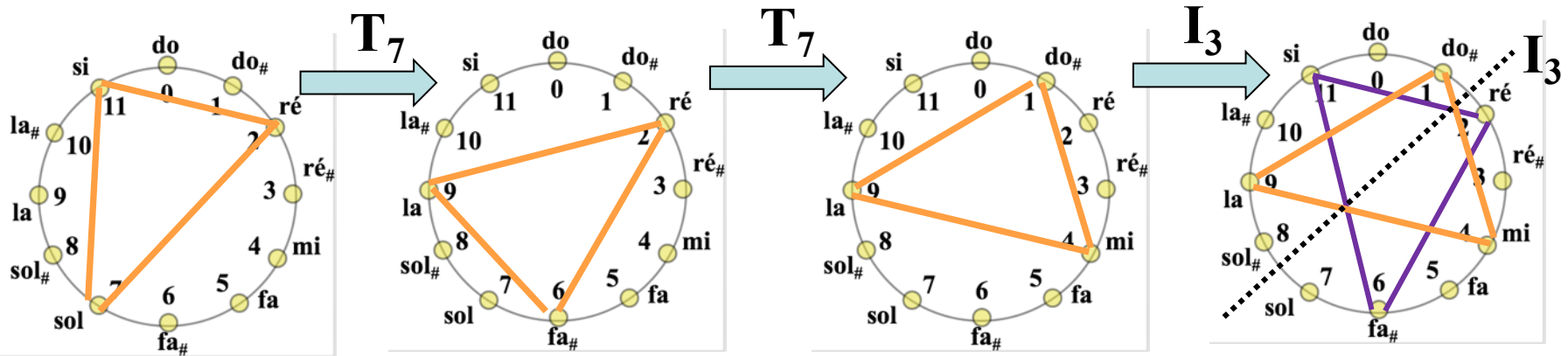
Musical staff showing the chord Si (B3, D#4, F#4).



Quelques exemples analytiques



Quelques exemples analytiques

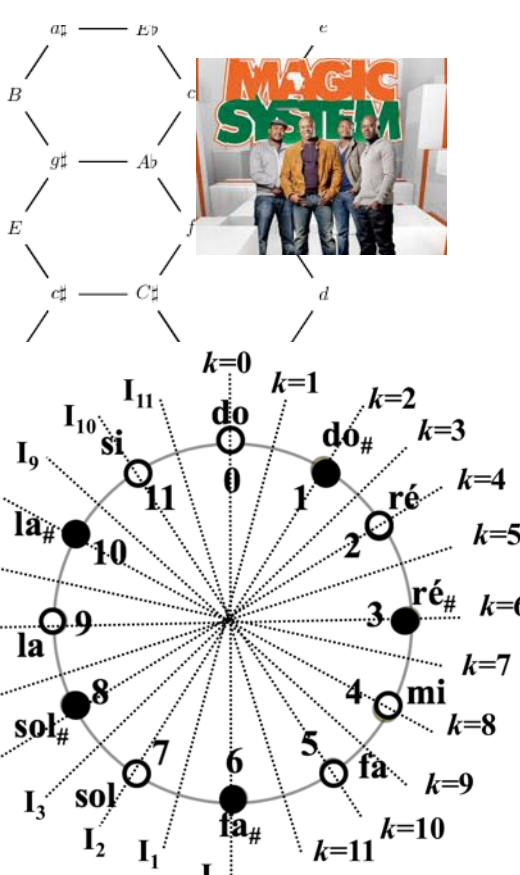
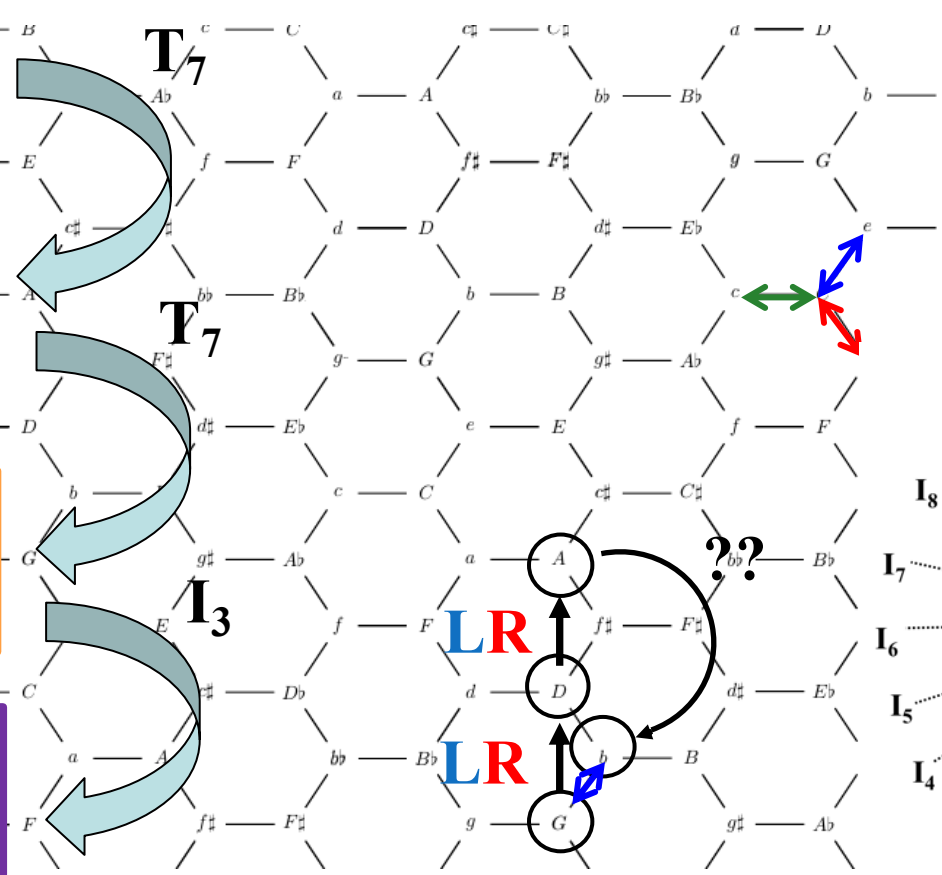


Musical staff showing the note Sol (G3) on a treble clef. The note is highlighted with an orange box.

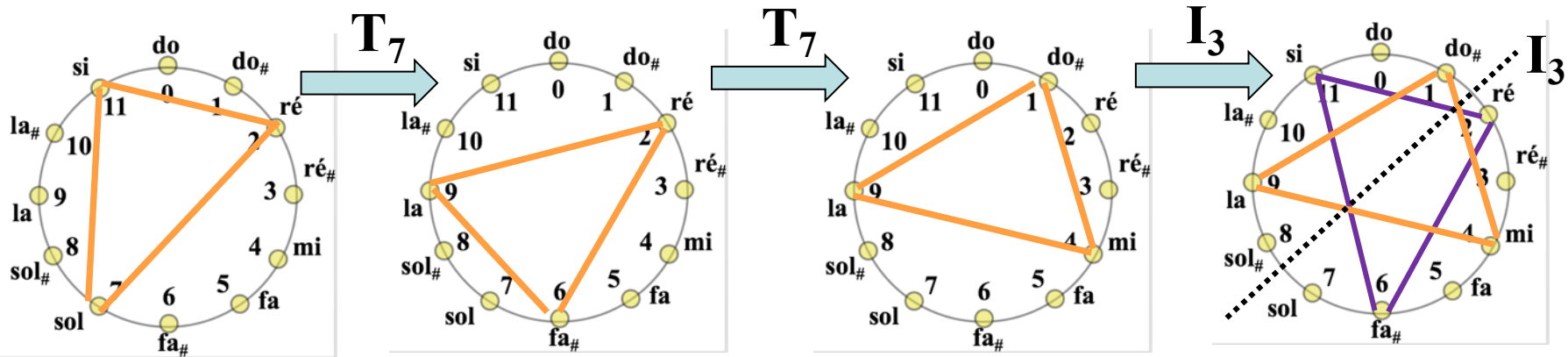
Musical staff showing the note Ré (D4) on a treble clef. The note is highlighted with an orange box.

Musical staff showing the note La (A3) on a treble clef. The note is highlighted with an orange box.

Musical staff showing the note Si (B3) on a treble clef. The note is highlighted with a purple box.



Quelques exemples analytiques

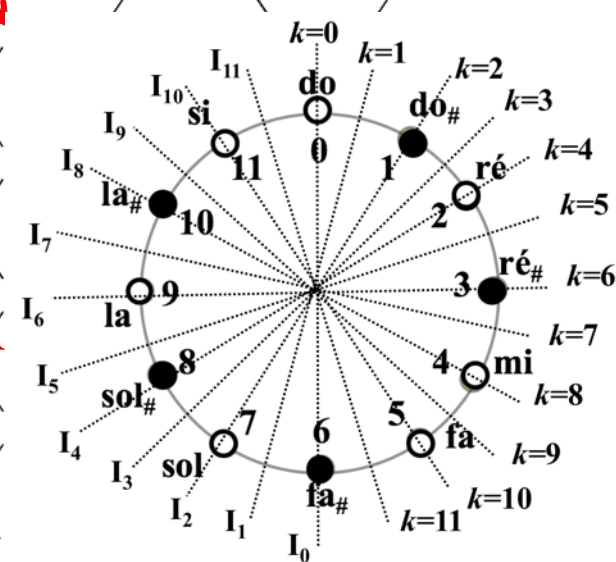
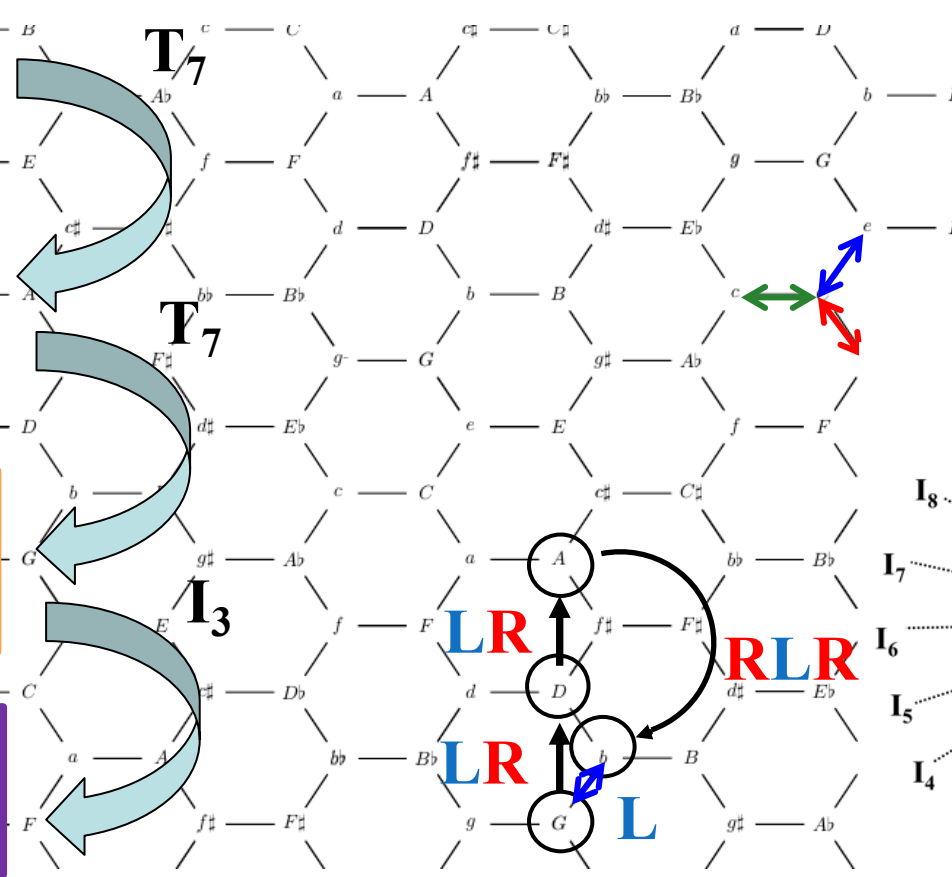


Musical staff showing the note Sol (G3) on a treble clef.

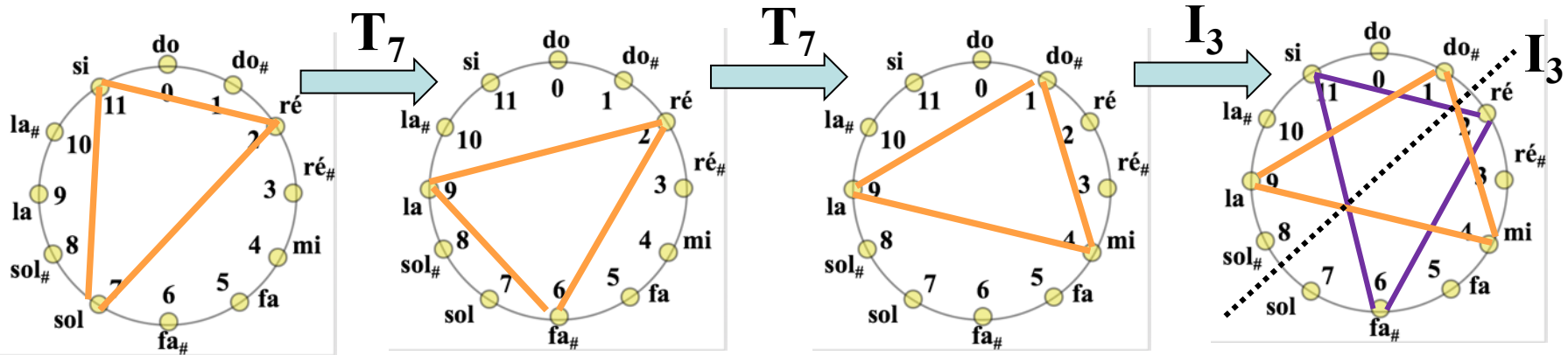
Musical staff showing the note Ré (D4) on a treble clef.

Musical staff showing the note La (A3) on a treble clef.

Musical staff showing the note Si (B3) on a treble clef.



Quelques exemples analytiques

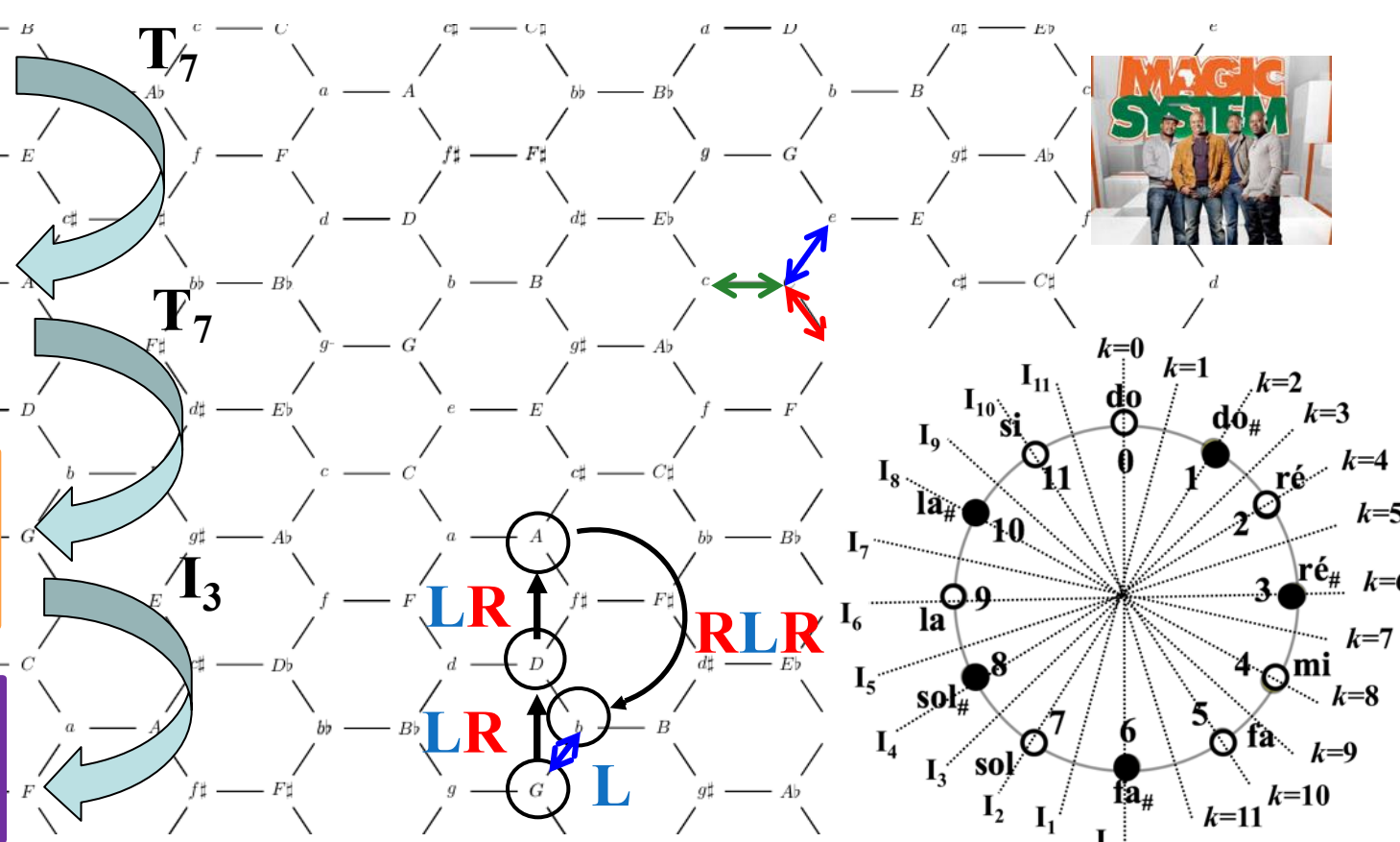


Musical notation for the note Sol (G) on a treble clef staff.

Musical notation for the note Ré (D) on a treble clef staff.

Musical notation for the note La (A) on a treble clef staff.

Musical notation for the note Si (B) on a treble clef staff.



La trajectoire spatiale de l'Anatole

Harmonic Progressions

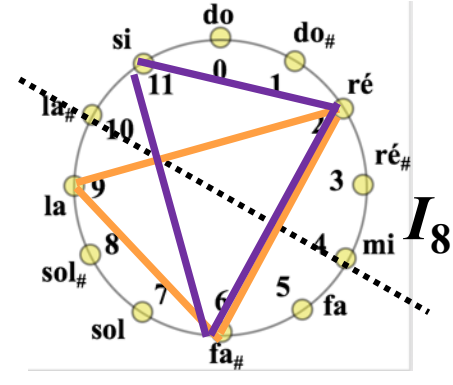
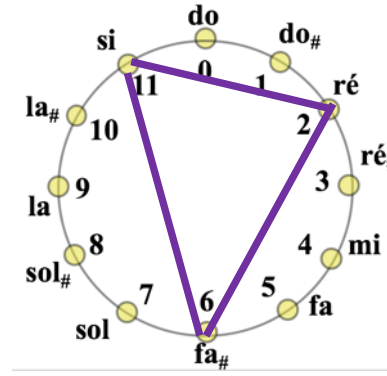
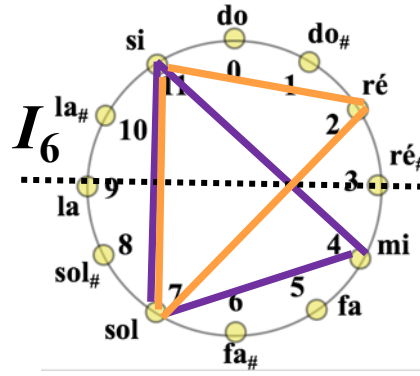
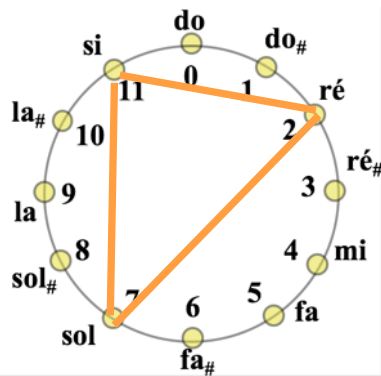
In Paolo Conte

Sotto le Stelle del Jazz



Supervision Moreno Andreatta
Modelisation Gilles Baroin 2016

Quelques exemples analytiques : une Anatole...



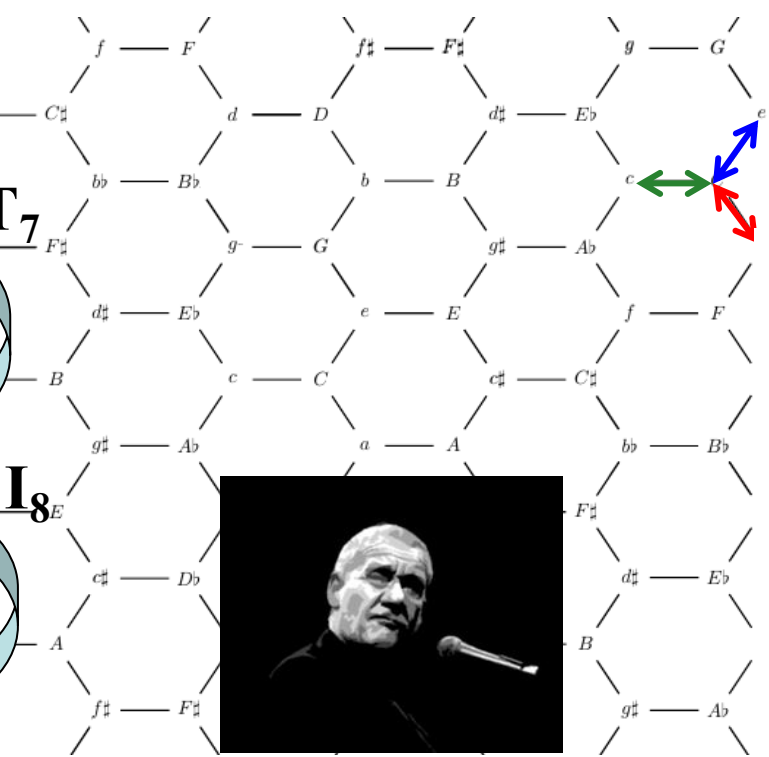
G

Em

Bm

D

I₆ **I₇** **I₈**

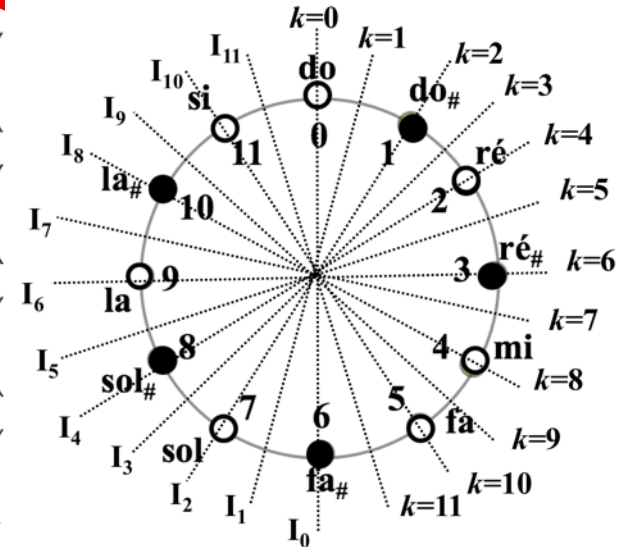


iii → V → I → vi

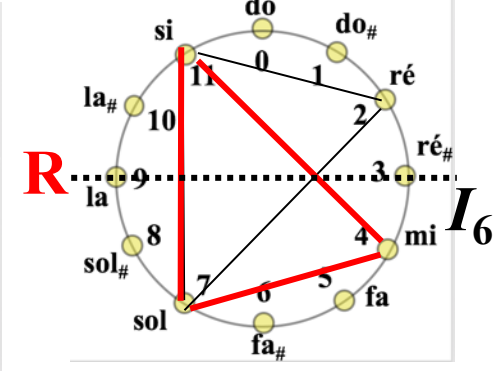
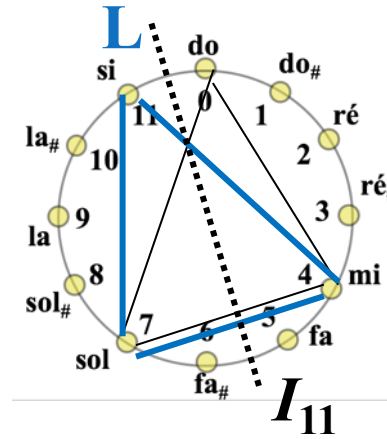
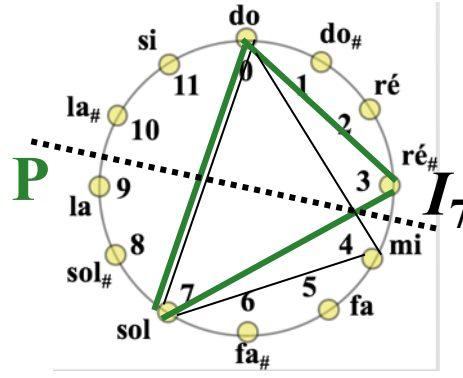
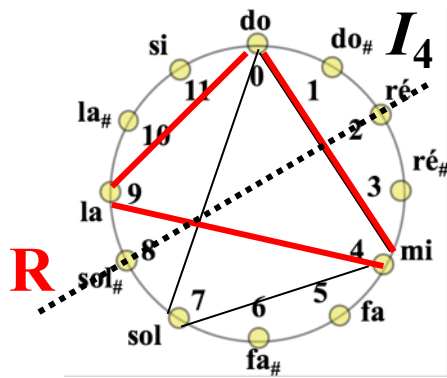
V → I → vi → iii

I → vi → iii → V

vi → iii → V → I



Quelques exemples analytiques : ...chez Paolo Conte



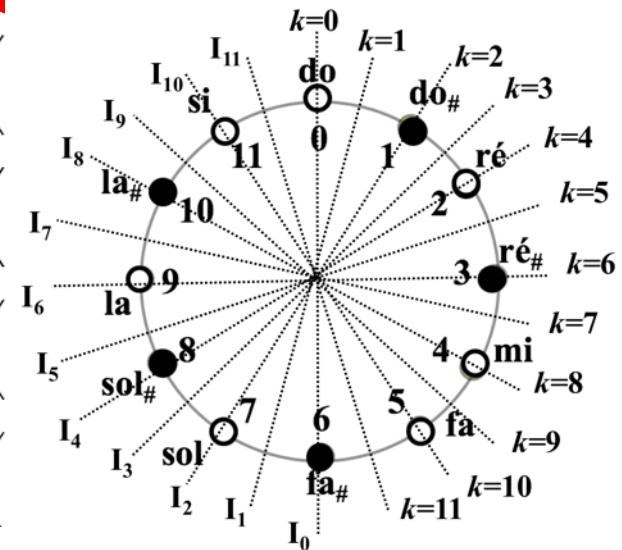
Musical score and chord progression diagram for Paolo Conte's "L". The score shows four staves with chords G, Em, Bm, and D. The chord progression diagram below shows the relationships between chords: $E \rightarrow f \rightarrow F \rightarrow f\sharp \rightarrow F\sharp \rightarrow g \rightarrow G$ and $e \rightarrow a \rightarrow A \rightarrow b \rightarrow B \rightarrow c \rightarrow C \rightarrow c\sharp \rightarrow C\sharp \rightarrow d \rightarrow D \rightarrow d\sharp \rightarrow E\flat \rightarrow e \rightarrow E \rightarrow f \rightarrow F \rightarrow f\sharp \rightarrow F\sharp \rightarrow g \rightarrow G \rightarrow g\sharp \rightarrow Ab \rightarrow a \rightarrow A \rightarrow a\sharp \rightarrow B \rightarrow b \rightarrow B\flat \rightarrow c \rightarrow C \rightarrow c\sharp \rightarrow D\flat \rightarrow e \rightarrow E \rightarrow f \rightarrow F \rightarrow f\sharp \rightarrow F\sharp \rightarrow g \rightarrow G \rightarrow g\sharp \rightarrow Ab$. Red arrows indicate the progression, and purple circles highlight the chords D, G, and e. A portrait of Paolo Conte is included at the bottom.

$iii \rightarrow V \rightarrow I \rightarrow vi$

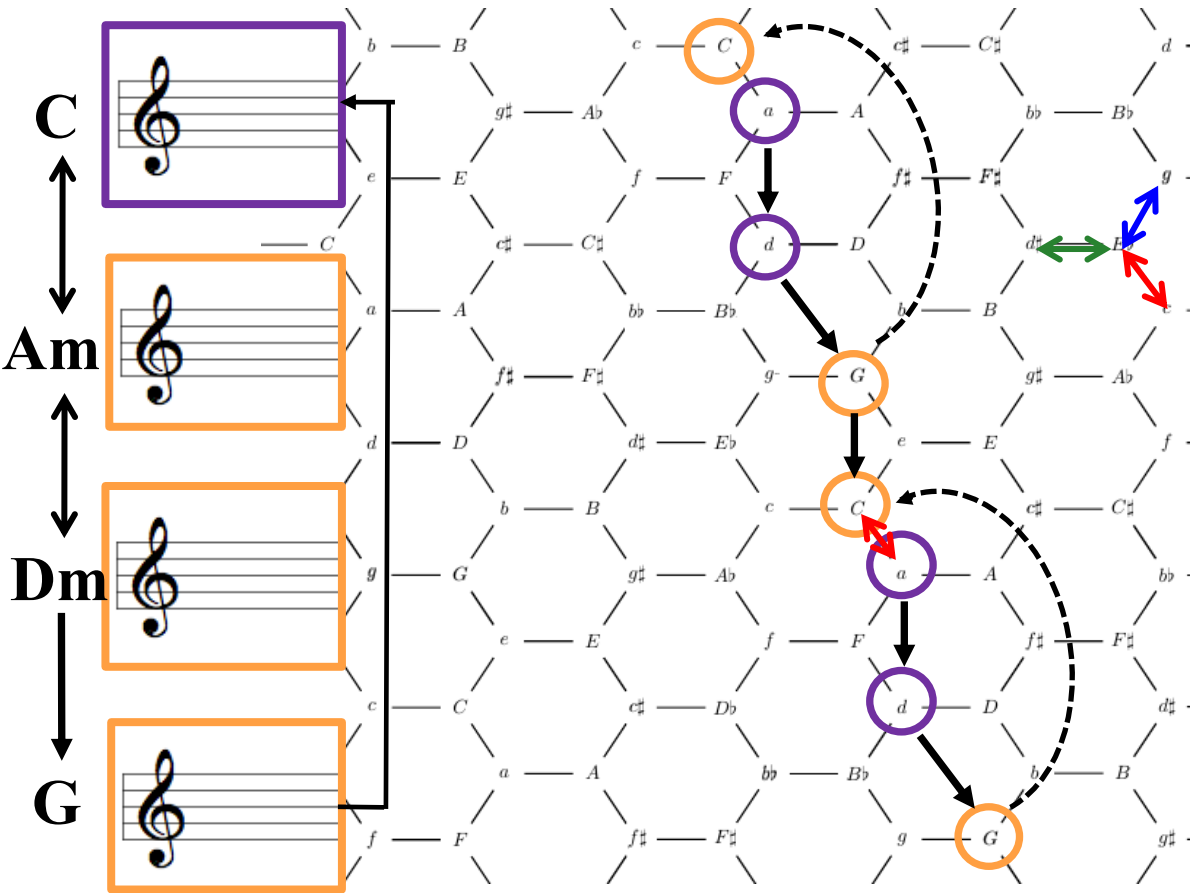
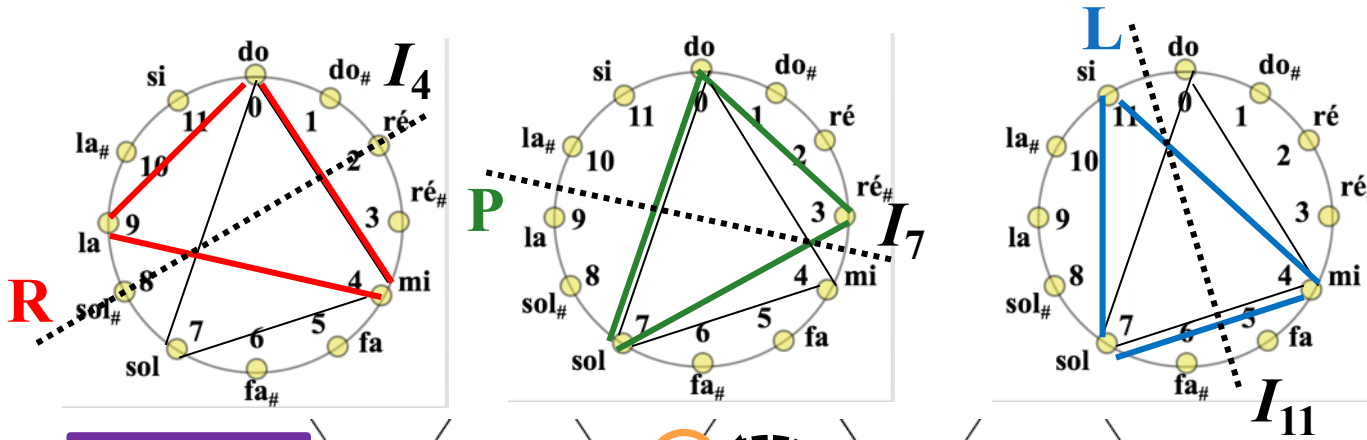
$V \rightarrow I \rightarrow vi \rightarrow iii$

$I \rightarrow vi \rightarrow iii \rightarrow V$

$vi \rightarrow iii \rightarrow V \rightarrow I$



Autres Anatoles et autres trajectoires

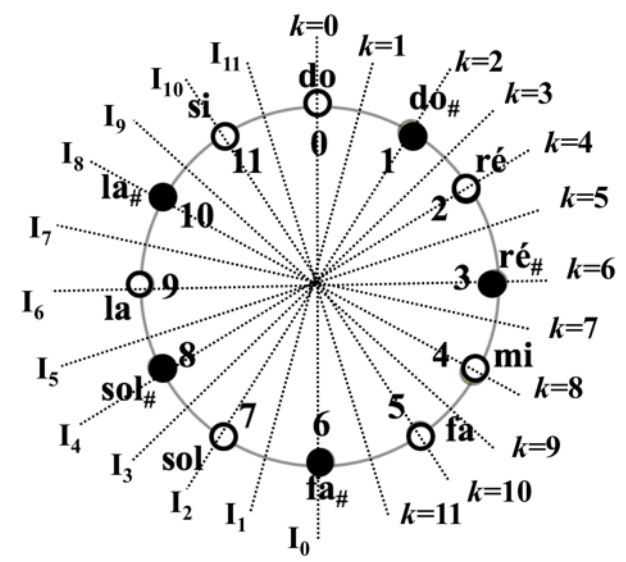


ii → V → I → vi

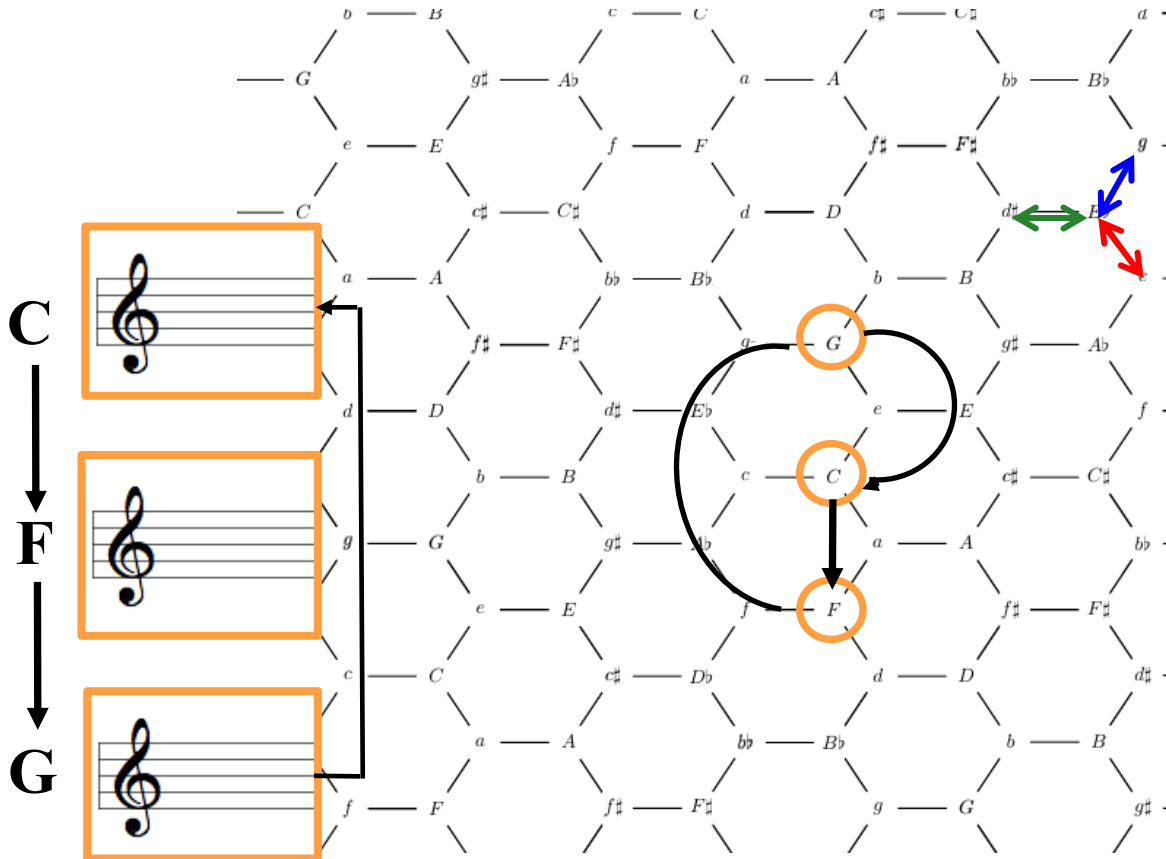
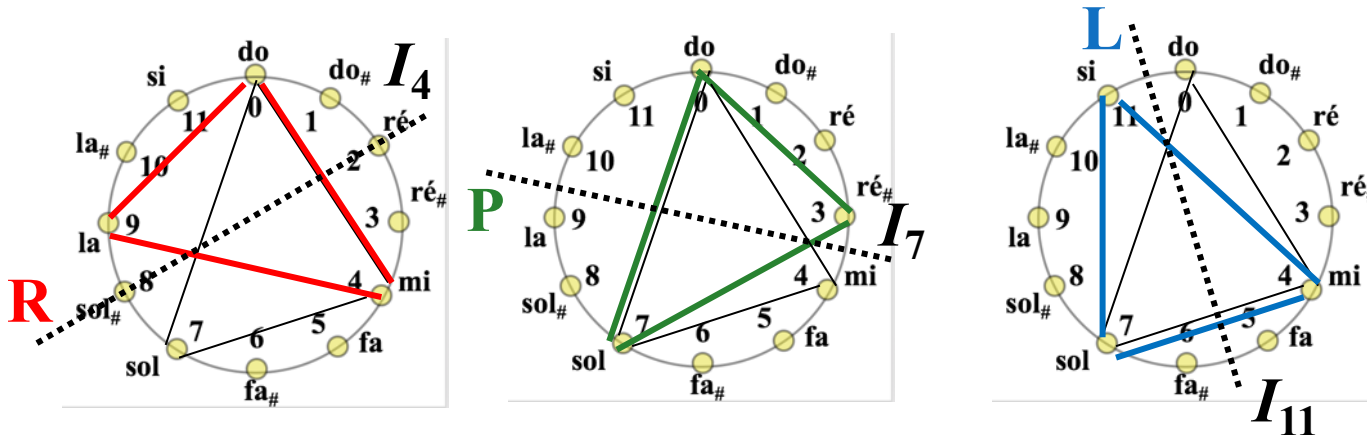
V → I → vi → ii

I → vi → ii → V

vi → ii → V → I



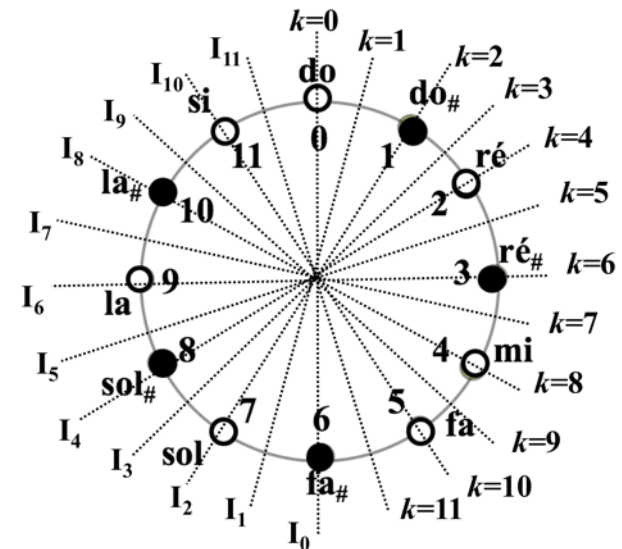
Boucles harmoniques dans la pop



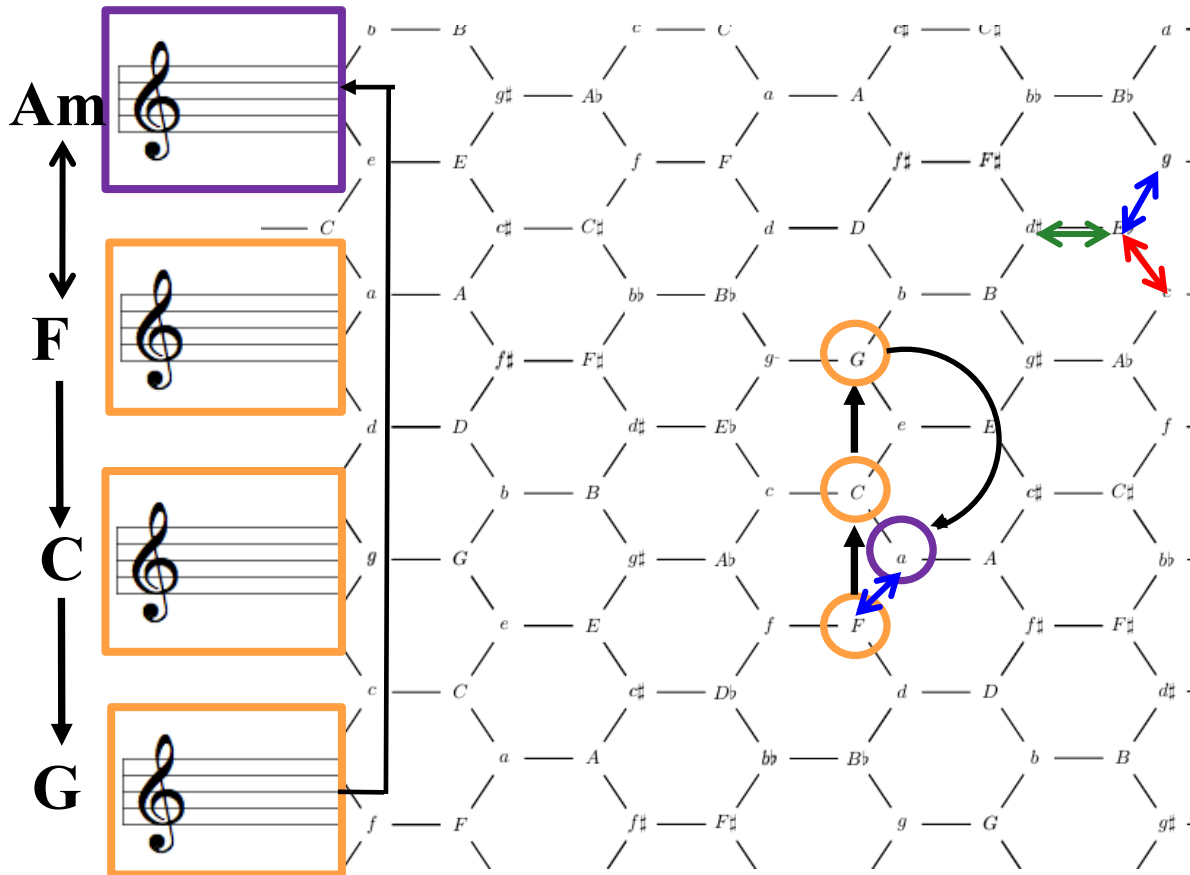
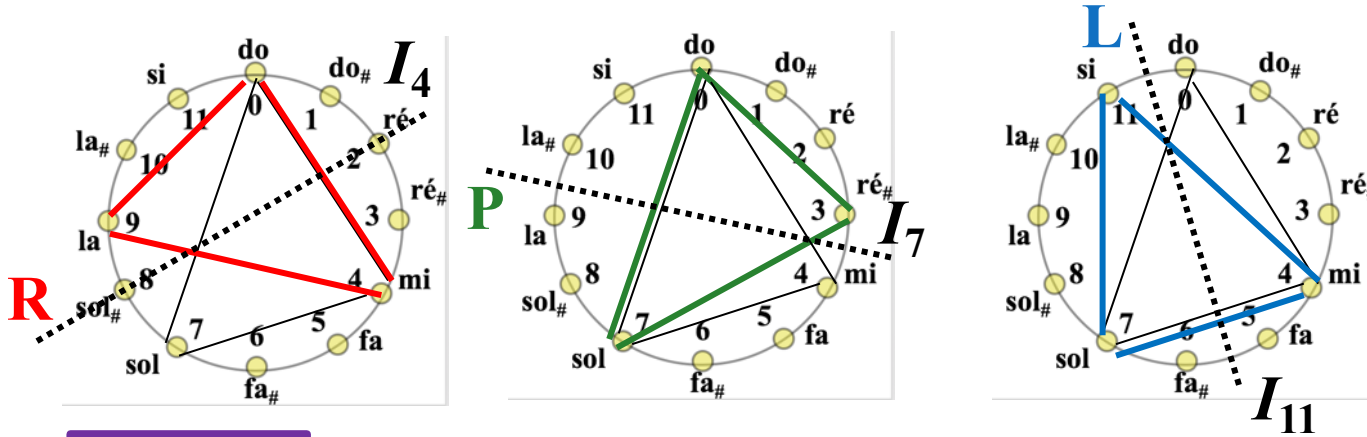
$I \rightarrow IV \rightarrow V$

$IV \rightarrow V \rightarrow I$

$V \rightarrow I \rightarrow IV$



Boucles harmoniques dans la pop

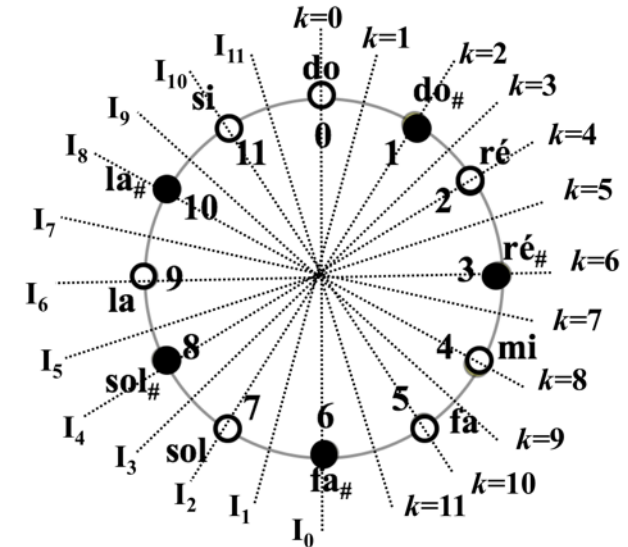


vi → IV → I → V

IV → I → V → vi

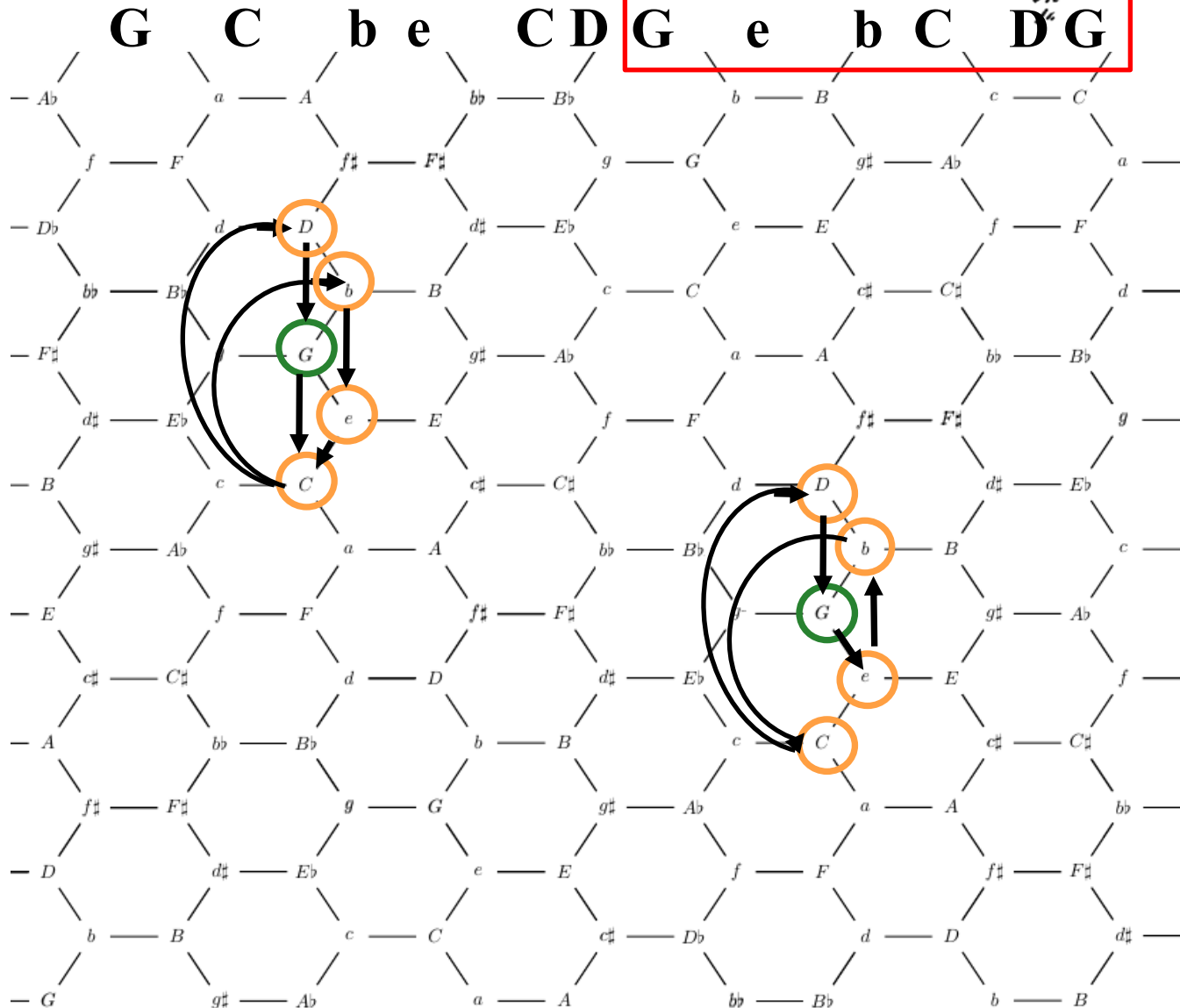
I → V → vi → IV

V → vi → IV → I



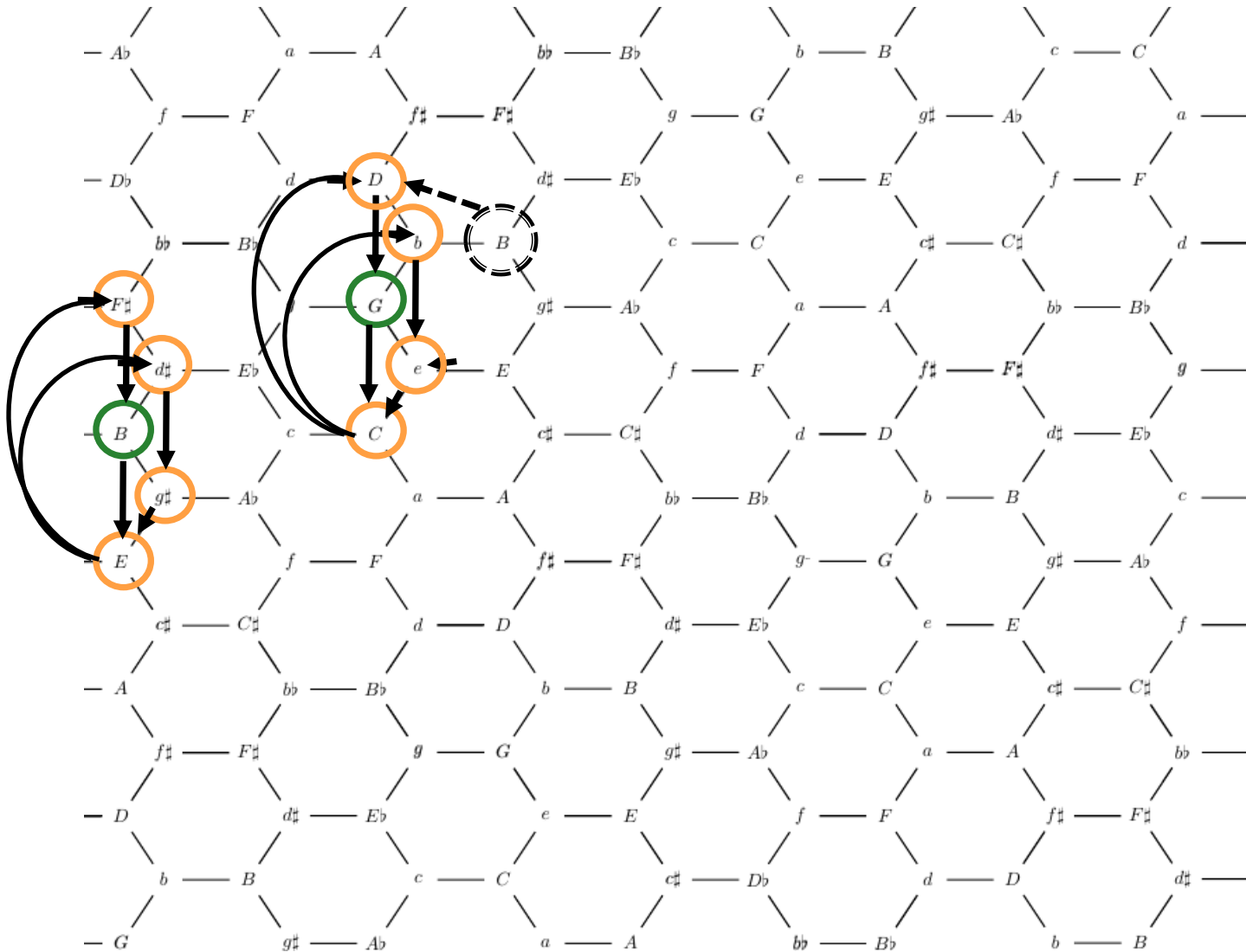
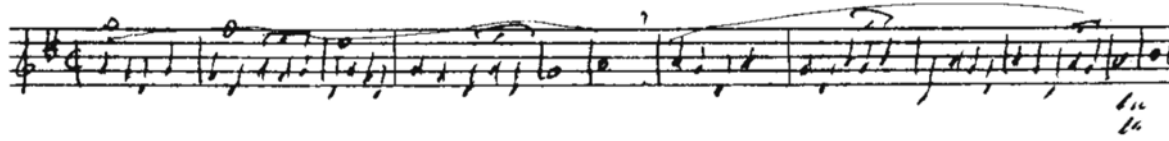
Retour sur un tube permutatif

Se telefonando, 1966
(Costanzo/Morricone/Mina)



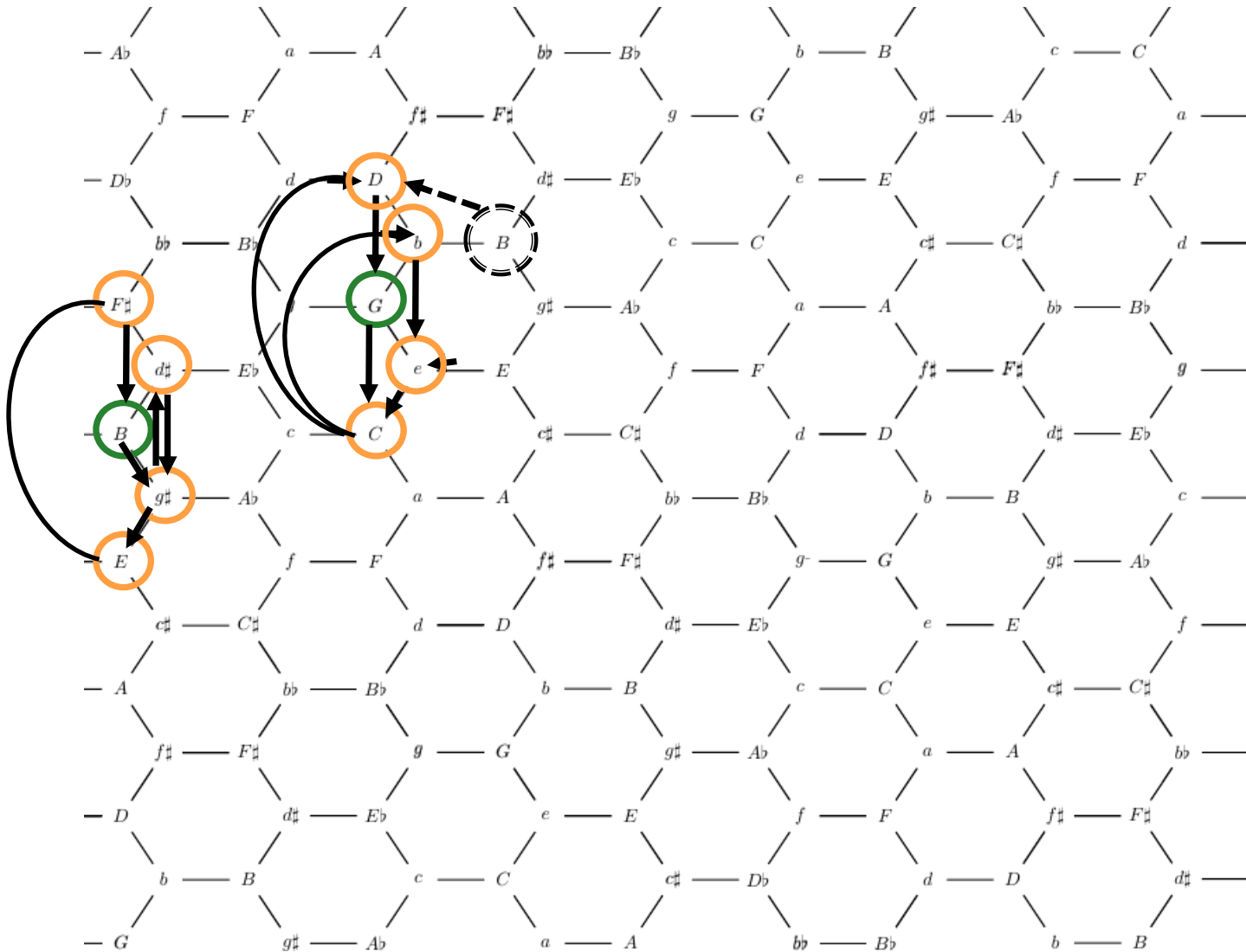
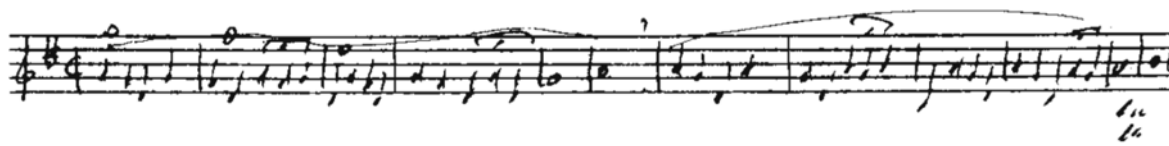
Retour sur un tube permutatif

Se telefonando, 1966
(Costanzo/Morricone/Mina)



Retour sur un tube permutatif

Se telefonando, 1966
(Costanzo/Morricone/Mina)



Mise en évidence des symétries dans la musica pop

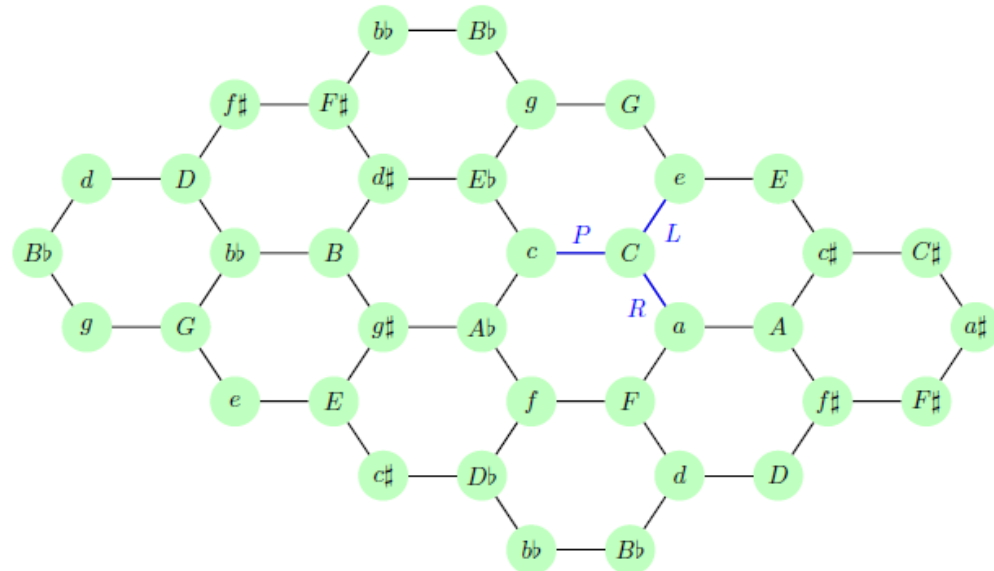
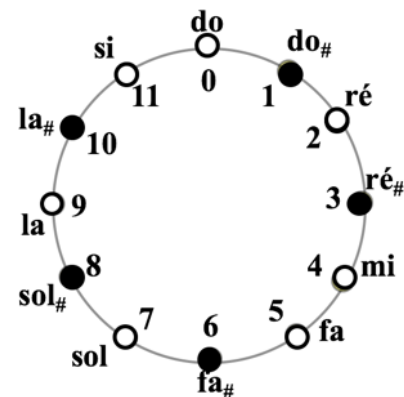
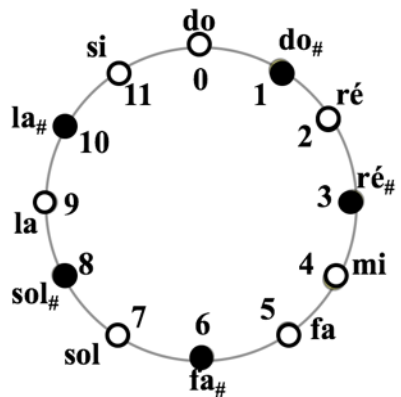
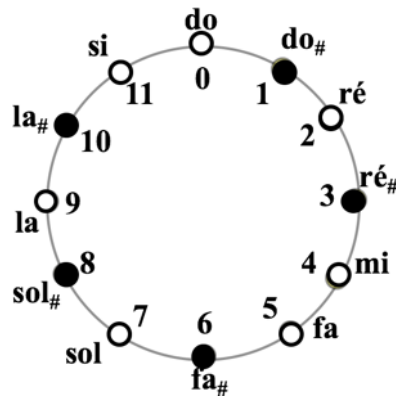
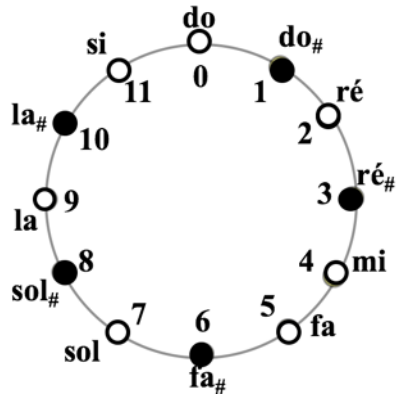
- Guy Capuzzo, "Neo-Riemannian Theory and the Analysis of Pop-Rock Music", Music Theory Spectrum 26(2), p. 177-199, 2004

Synthesizer

D- ↔ F- ↔ Db+ ↔ Bb+ ↔



Shake the disease - 1985
(Depeche Mode) – min. 2'17''



Mise en évidence des symétries dans la musica pop

- Guy Capuzzo, "Neo-Riemannian Theory and the Analysis of Pop-Rock Music", Music Theory Spectrum 26(2), p. 177-199, 2004

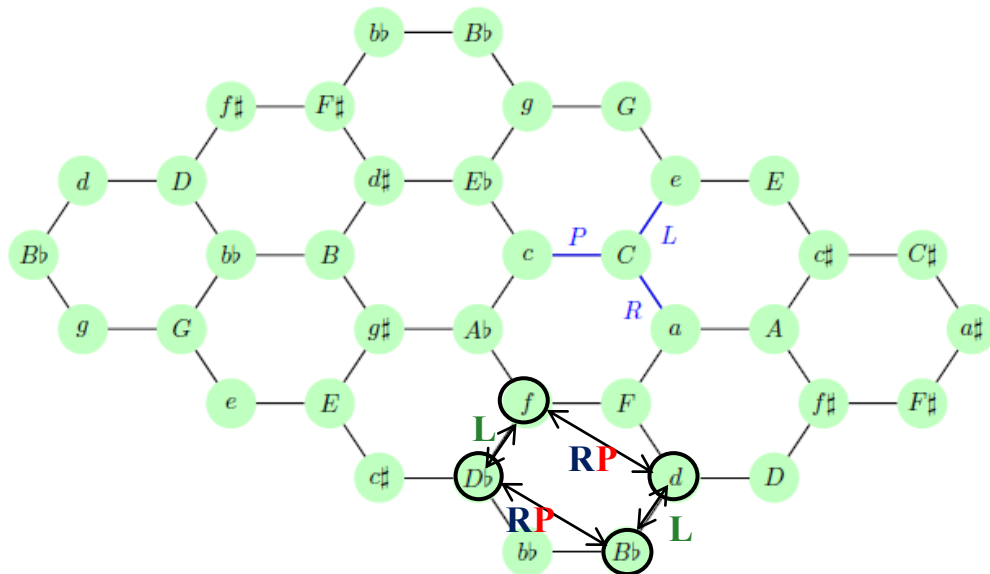
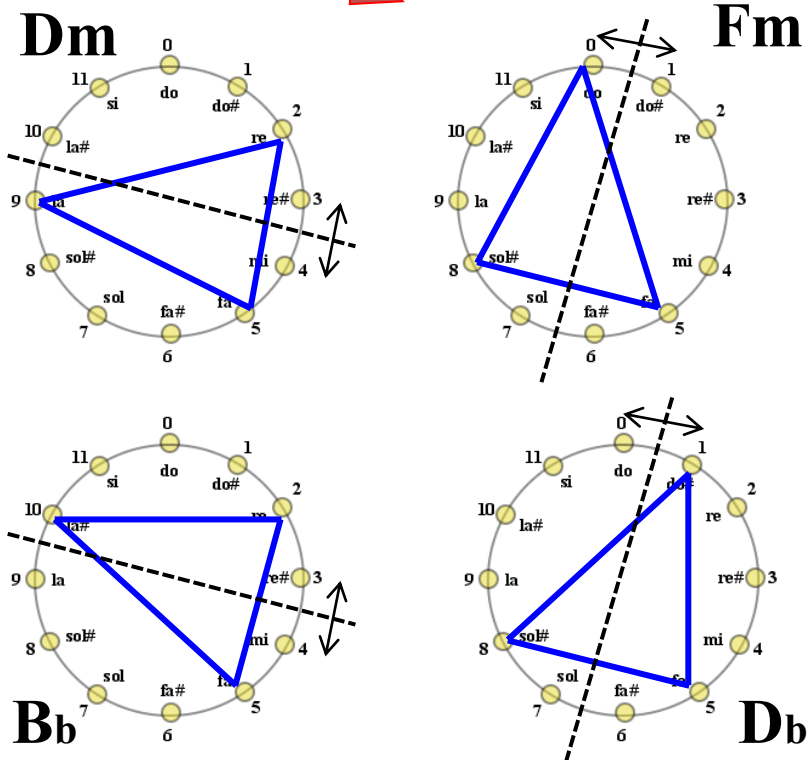
Synthesizer

D- \leftrightarrow **RP** F- \leftrightarrow **L** Db+ \leftrightarrow **RP** Bb+ \leftrightarrow **L**

Séquence **RPLRPL**

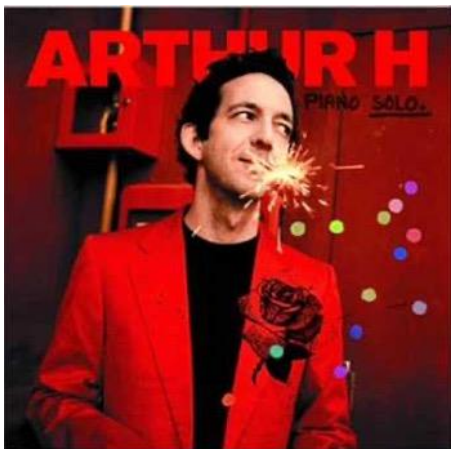


Shake the disease - 1985
(Depeche Mode) – min. 2'17''

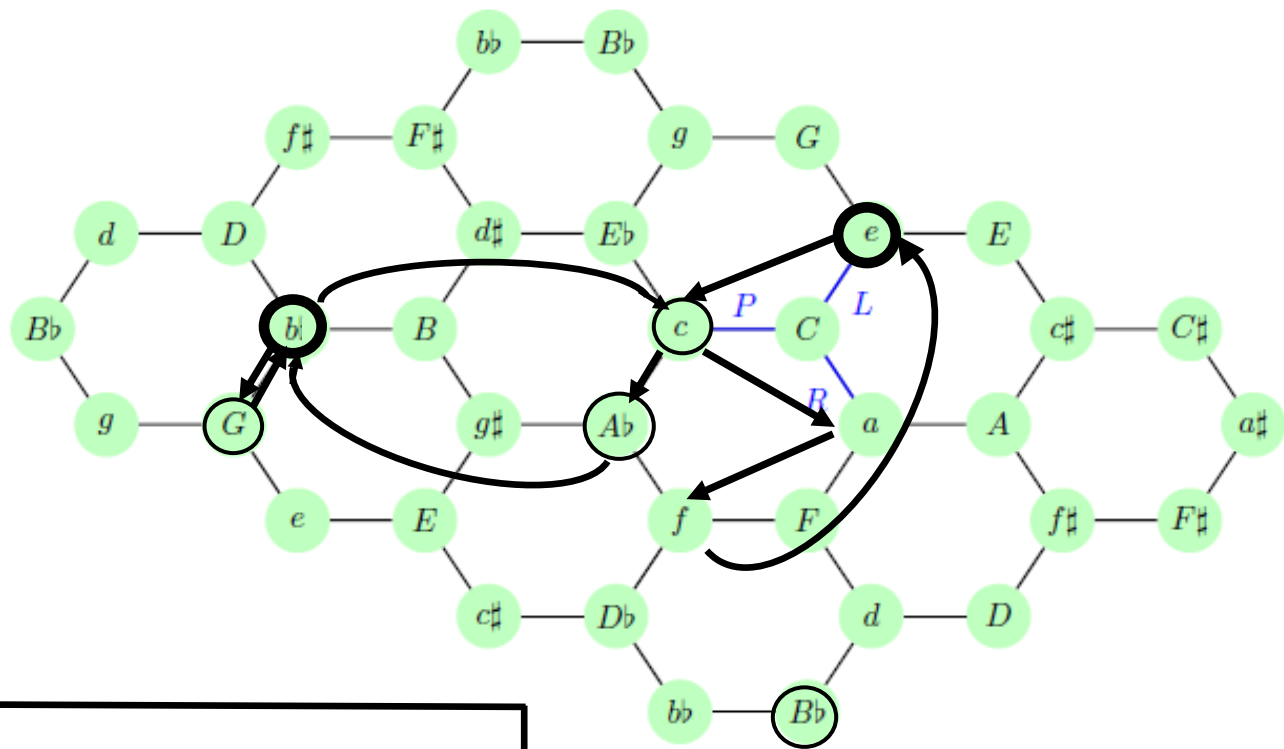


(Source <http://www.mathsintheair.org/>)

Parcours harmoniques chez Arthur H



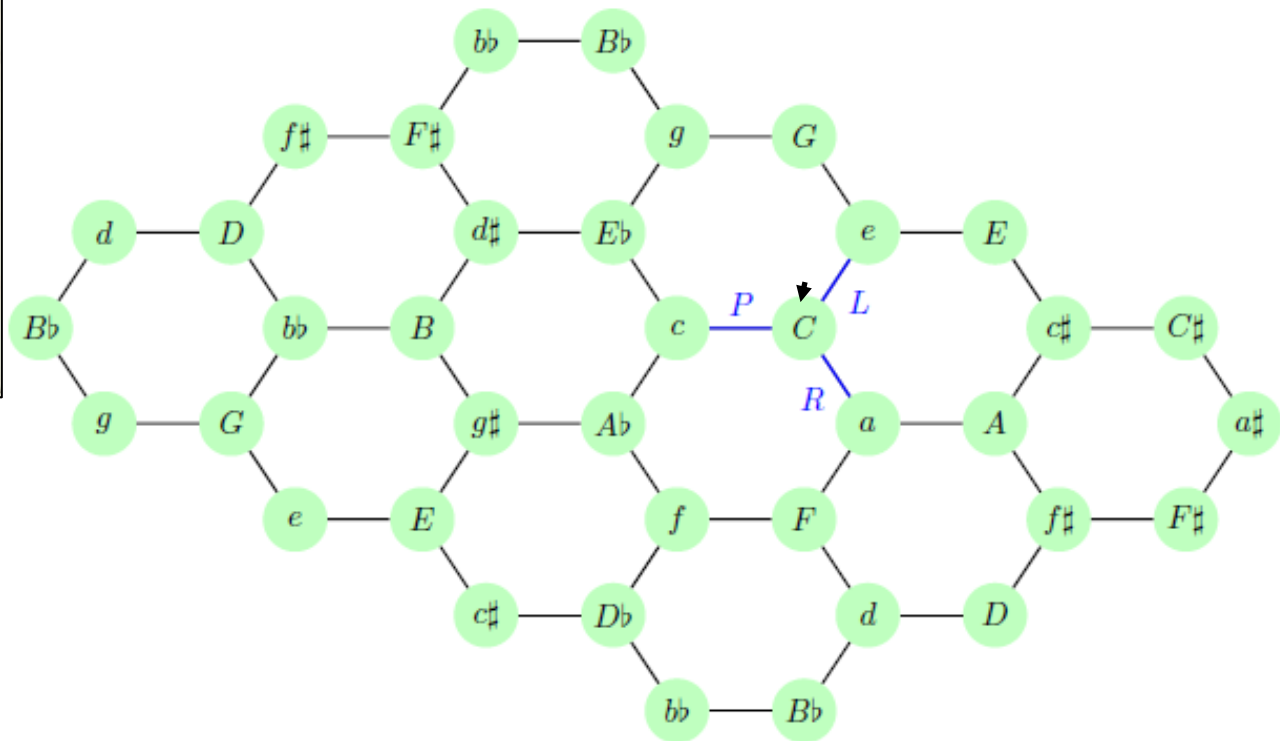
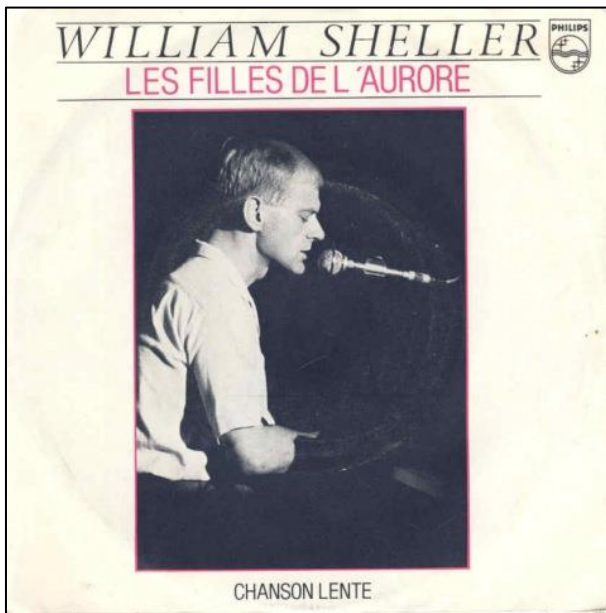
Le Baron noir
(album *Piano solo*, 2002)



Cycle 1 : $Bm \xrightarrow{PLPR} Cm \xrightarrow{L} Ab \xrightarrow{PRP} Bm \xrightarrow{L} G \xrightarrow{L} Bm \xrightarrow{L} G \xrightarrow{L} Bm$

Cycle 2 : $Em \xrightarrow{LP} Cm \xrightarrow{PL} Em \xrightarrow{LP} Cm \xrightarrow{PR} Am \xrightarrow{LP} Fm$
 $\xrightarrow{PLRL} Em$

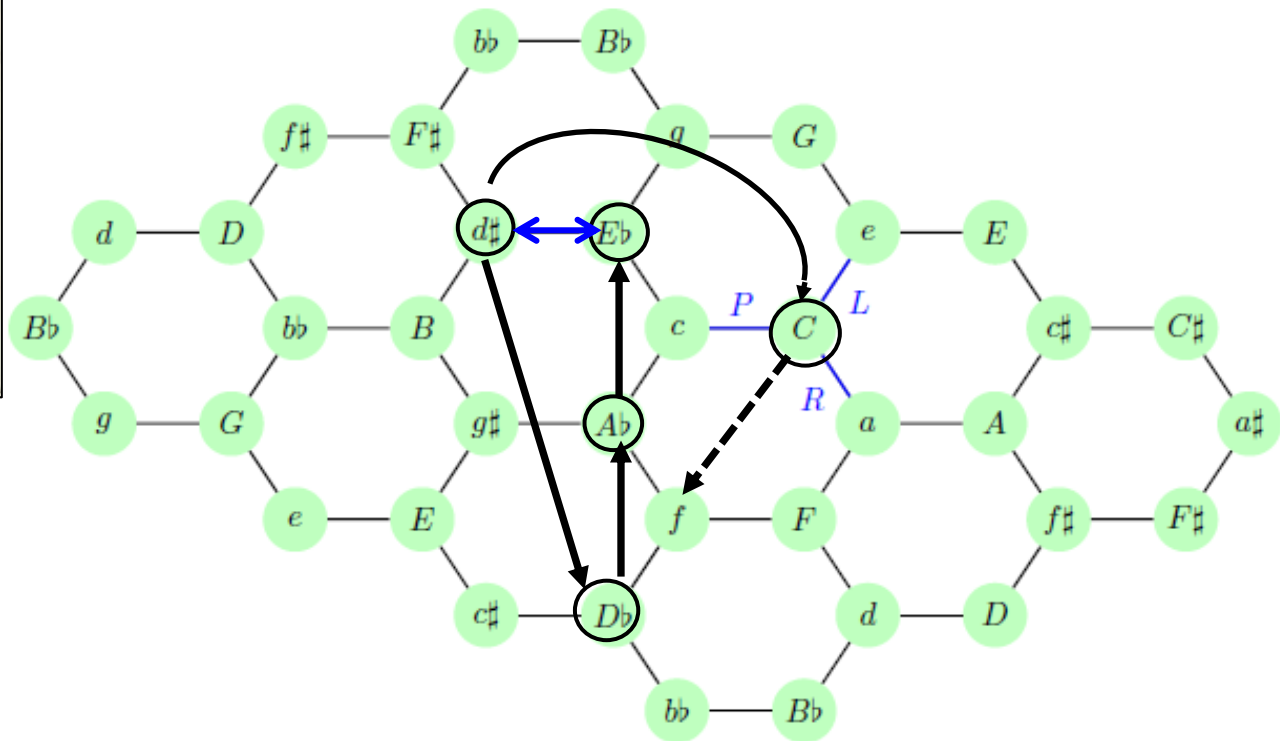
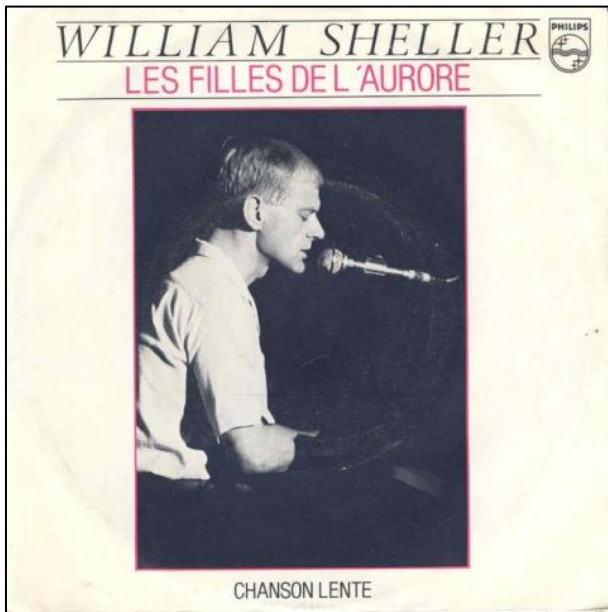
Parcours harmoniques chez William Sheller



min. 0'33''

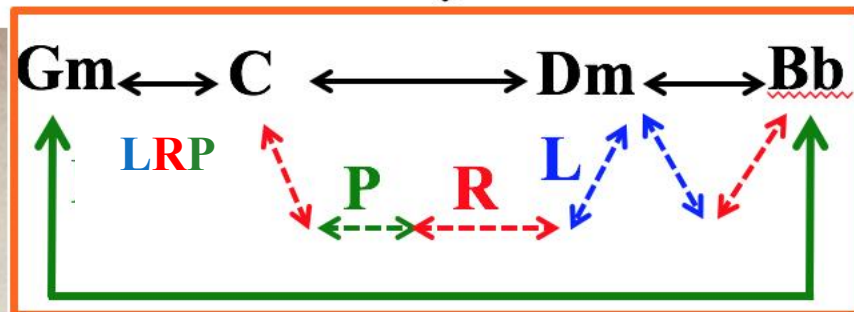
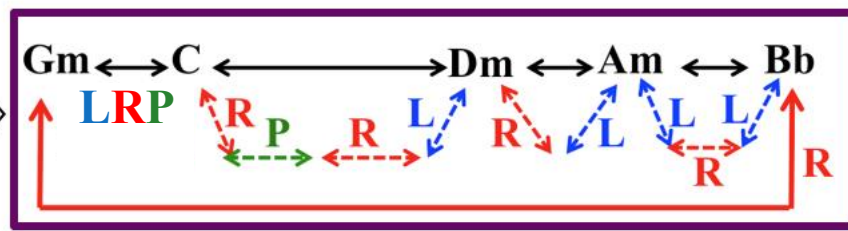
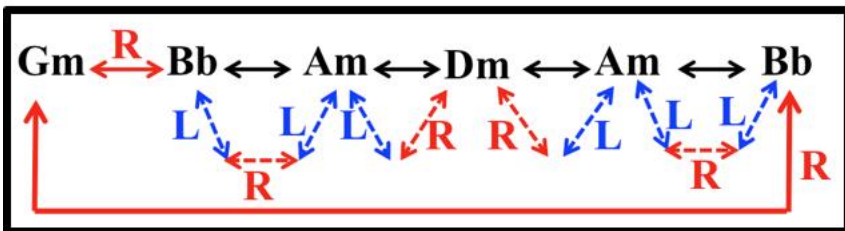


Parcours harmoniques chez William Sheller



min. 0'33''





MON APACHE

(Arman Méliès)

Cette promesse, c'est de l'or
que tu caches
en attendant les apaches
et leurs centaures

D'où vient la soie de ton ventre
et d'où vient
l'ardeur de ces beaux élans
que tu défends

les vaisseaux
logés au creux de ta peau
couleur d'encre

O mon inouïe amazone
tu nous quittes
et l'été se fait automne
black light, white heat

O mon inouïe antilope
dans tes flancs
et leurs reflets roux d'enfance
dort un cyclope

Où vont les flots noirs
de cendre

Une flèche en plein cœur
un ciel à la dérive
et je meurs
de nous survivre

Une flèche en plein cœur
un ciel à la dérive
et je meurs
de nous survivre

Un aiezan sur la grève
de nouveau enfin libre
et je crève
de nous survivre

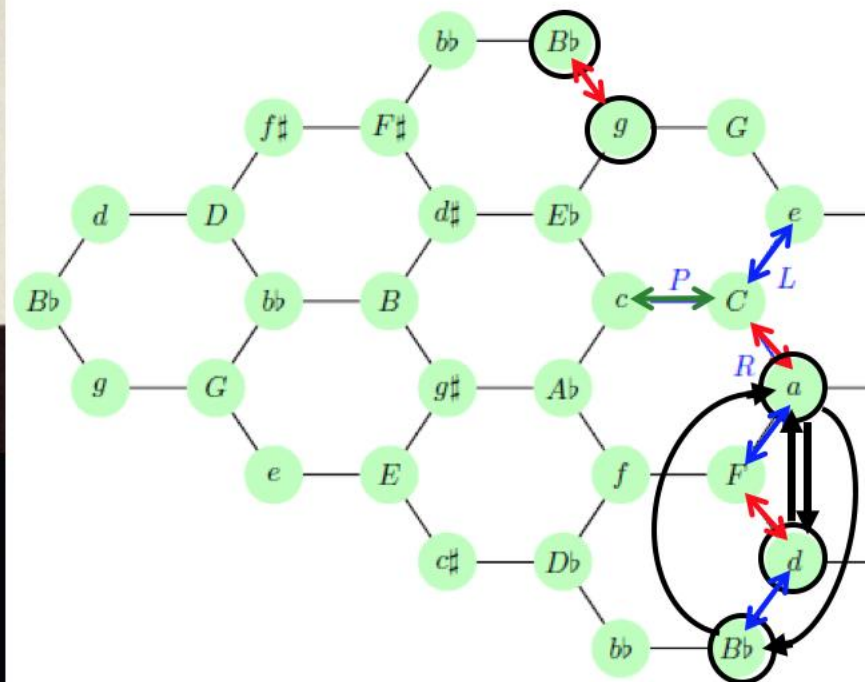
Un aiezan sur la grève
de nouveau enfin libre
et je crève
de nous survivre

Cette lueur plus encore
tu la caches
en attendant les apaches
et leurs trésors

Cette promesse c'est de l'or
que tu caches
en attendant
les apaches

Cette promesse c'est de l'or
que tu caches
moi je t'attends

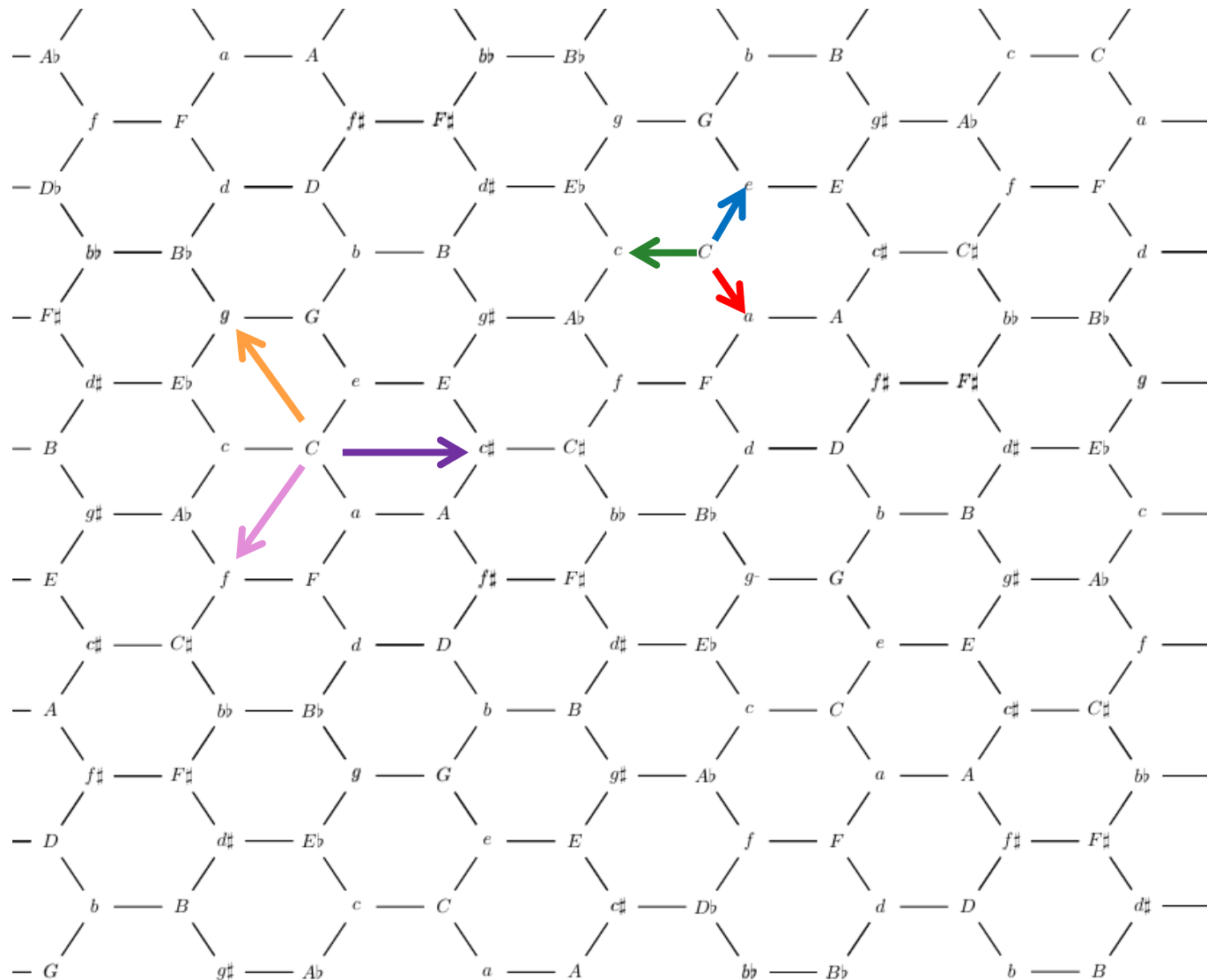
Mon apache



LØVE
Julien Doré

Une boucle harmonique et ses raccourcis :

SLIDE (S), NEBENVERWANDT (N) et FAR FIFTH (F)

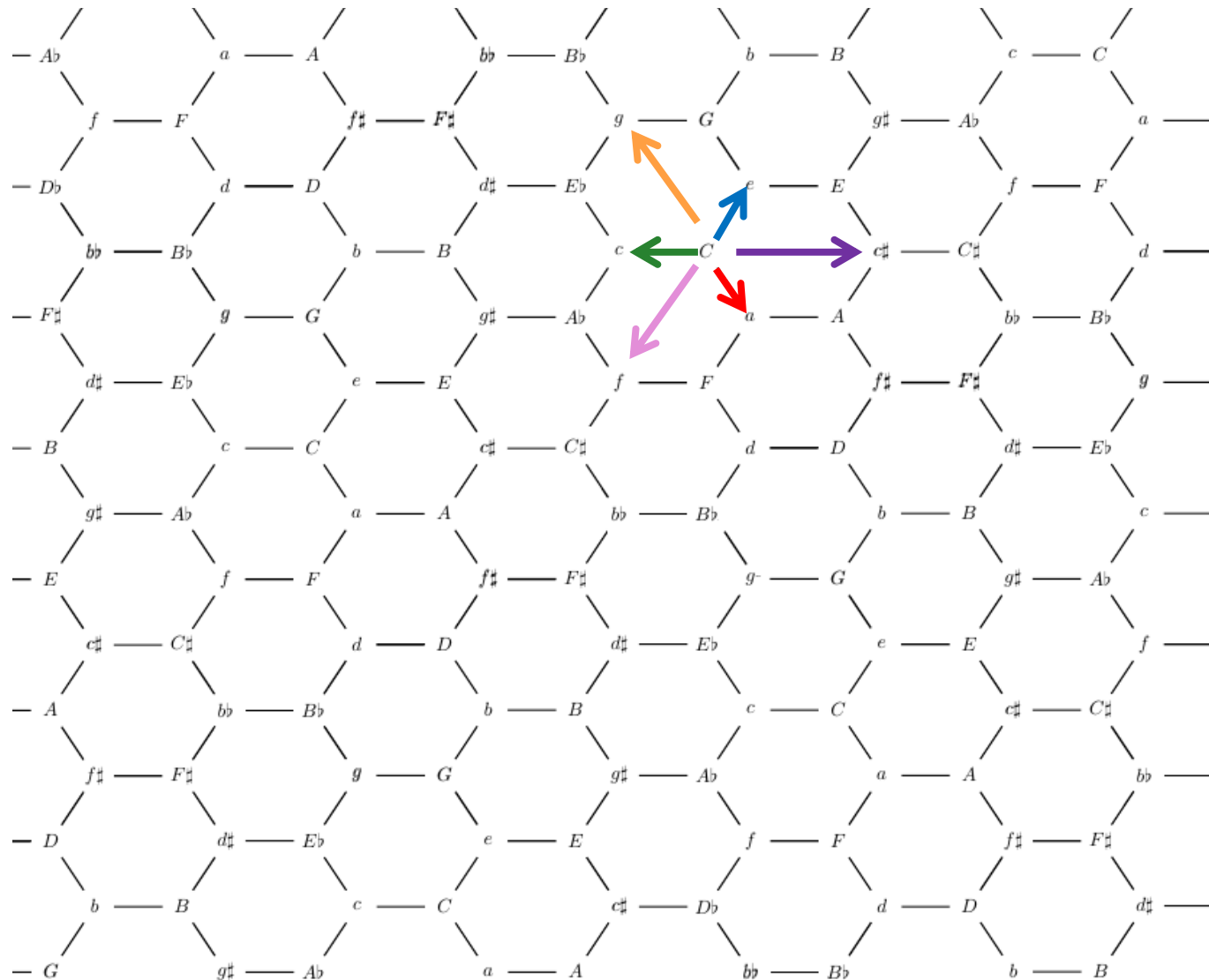


$$S = LPR$$

$$N = RLP$$

$$F = LRP$$

Boucles harmoniques simples (avec R, P et L) et complexes (avec R, P, L, S, N, F)

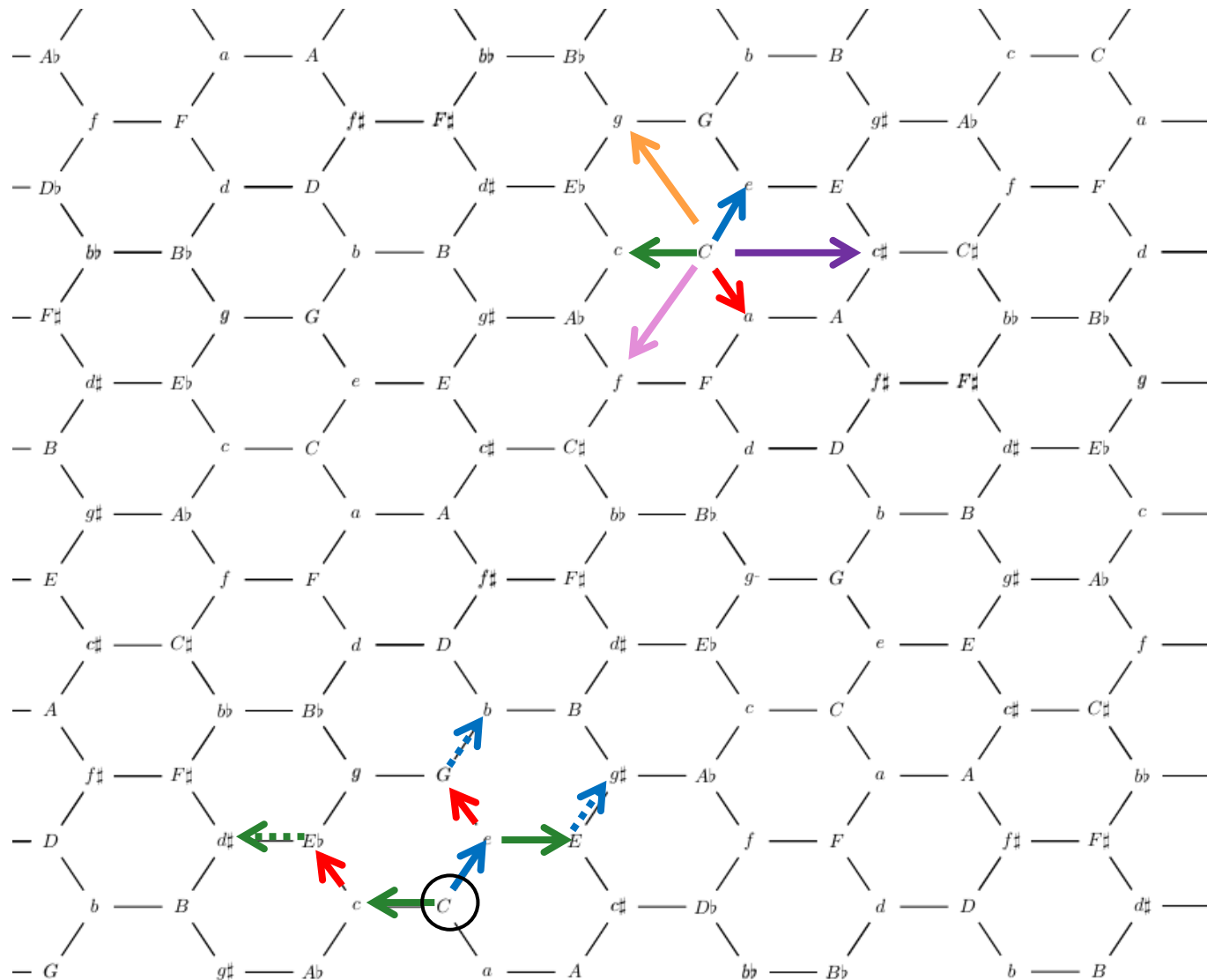


$$S = LPR$$

$$N = RLP$$

$$F = LRP$$

Boucles harmoniques simples (avec R, P et L) et complexes (avec R, P, L, S, N, F)



$$S = LPR$$

$$N = RLP$$

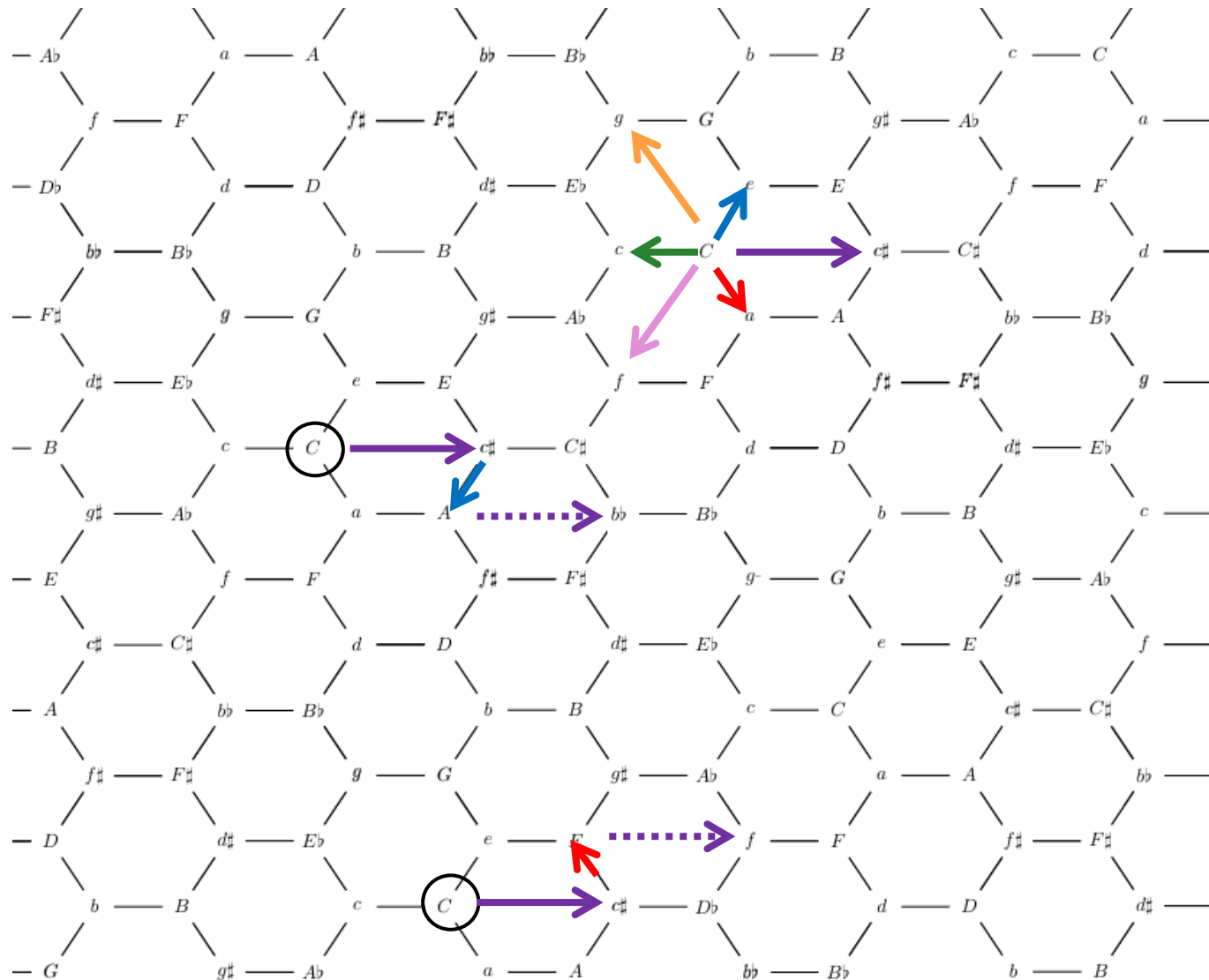
$$F = LRP$$

LPLP...

PRPR...

LRLR...

Boucles harmoniques simples (avec R, P et L) et complexes (avec R, P, L, S, N, F)



$$S = LPR$$

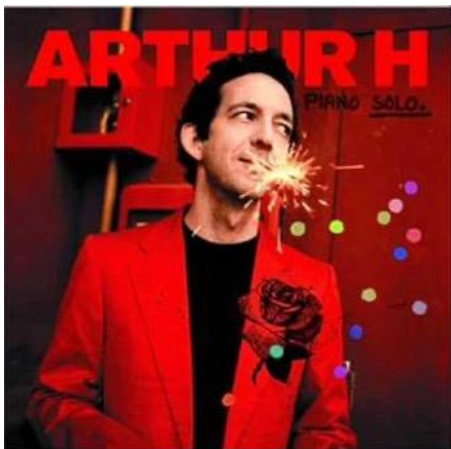
$$N = RLP$$

$$F = LRP$$

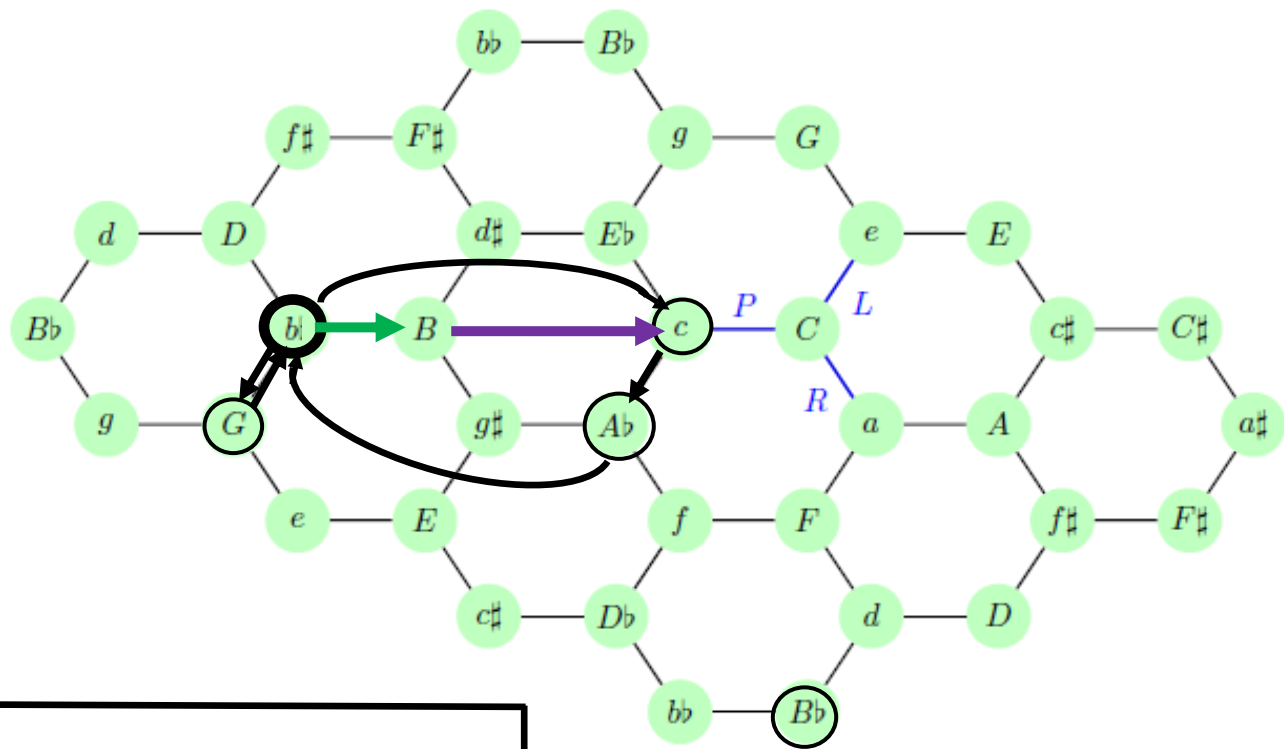
SRSR...

SLSL...

Parcours harmoniques chez Arthur H : le SLIDE



Le Baron noir
(album *Piano solo*, 2002)

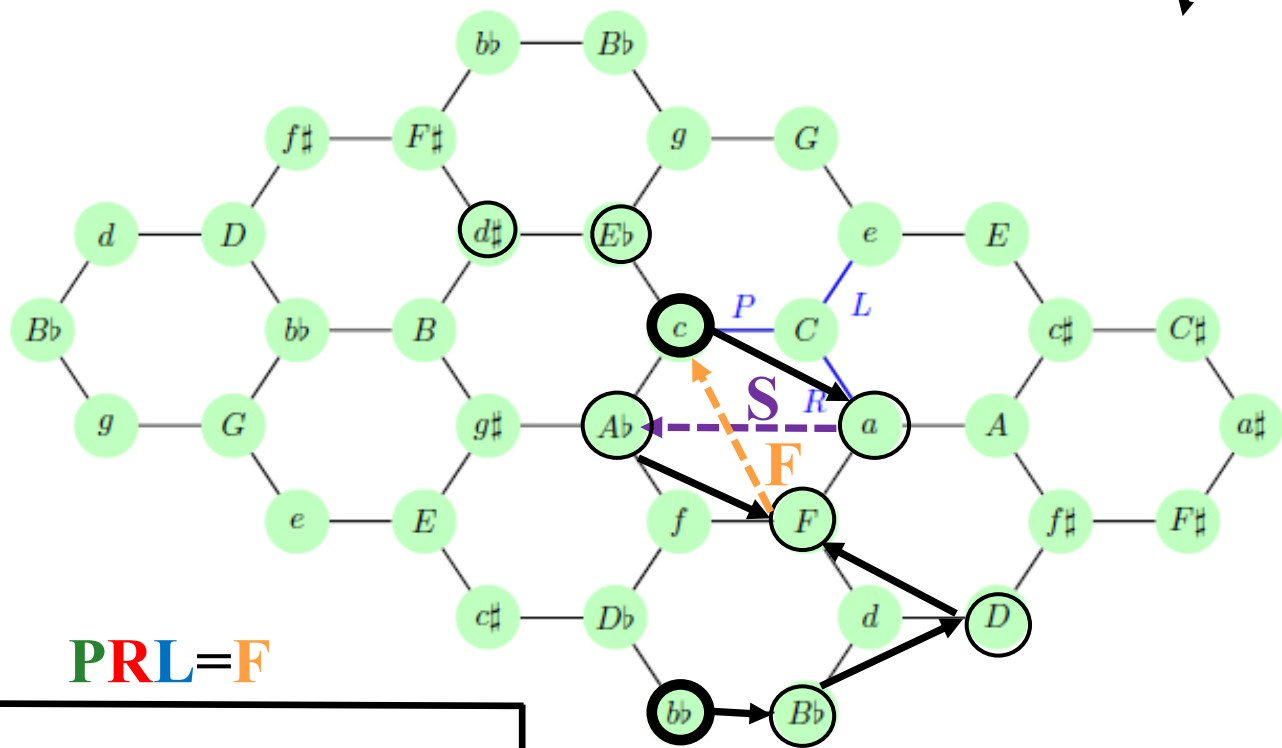


Cycle 1 : $Bm \xrightarrow[\text{PS}]{\text{PLPR}} Cm \xrightarrow{\text{L}} Ab \xrightarrow{\text{PRP}} Bm \xrightarrow{\text{L}} G \xrightarrow{\text{L}} Bm \xrightarrow{\text{L}} G \xrightarrow{\text{L}} Bm$

Autres parcours harmoniques : le FAR FIFTH



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



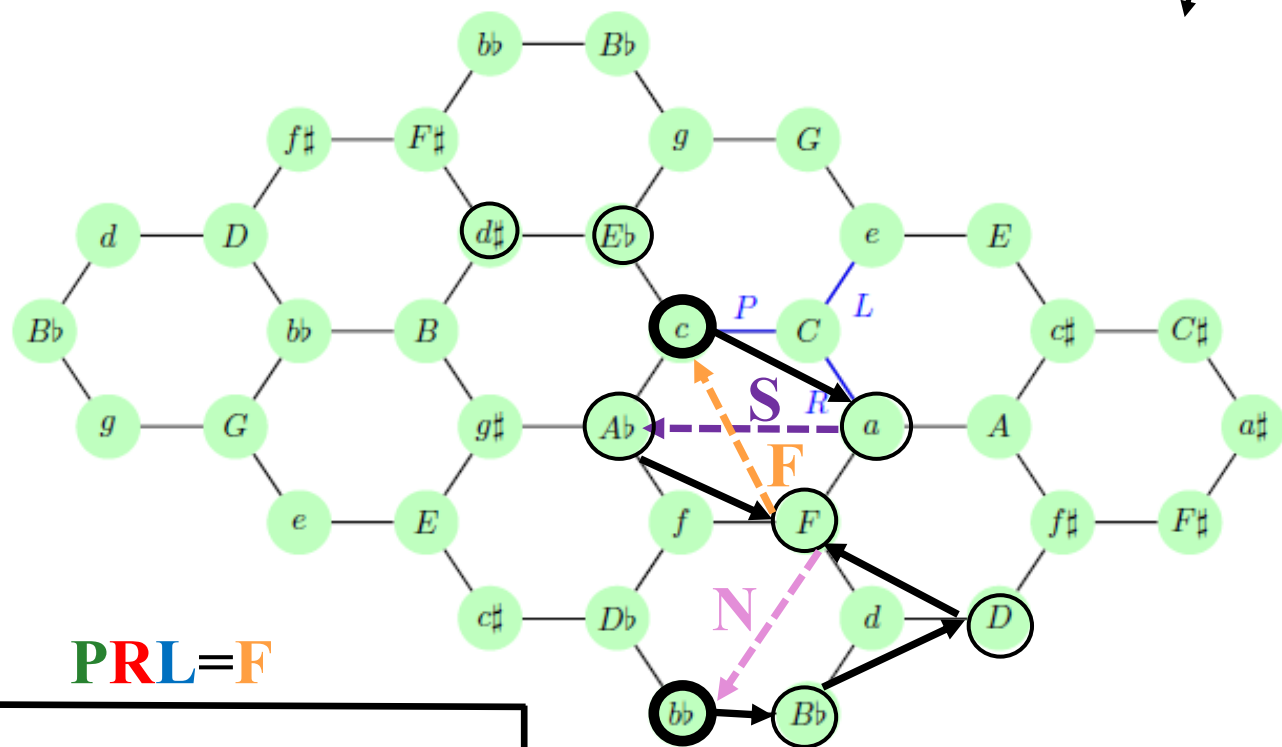
Cycle 1 :



Autres parcours harmoniques : le NEBENVERWANDT



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



PRL=F

Cycle 1 :



Cycle 2 :



PLR=N

Harmonic Progressions

In Paolo Conte

Il Regno del Tango



M.Andreatta G.Baroin
www.MatheMusic.net 2016

Nebenverwandt comme principe modulante

le bateau ivre
un racconto

I. EBA
II. EROICA
III. GIURAMENTO
IV. PRENDI PER GIOCO (GIÀ TARDI)
V. SUPPLICA
VI. CONFIDENZE
VII. FRANGIFLUTTI
VIII. BELLA
IX. PER FAVORE
X. EPILOGO
XI. DORMI STELLA

Edizione e Produzione Musicale
Rivenditori degli Azzardi Avogadro
tel. 06-33 61185428 - IT-39 329 214719
info@sonorichem.it www.andreatta.it

SIRE | **sacem**

Playlist Spotify
« Cours chanson »

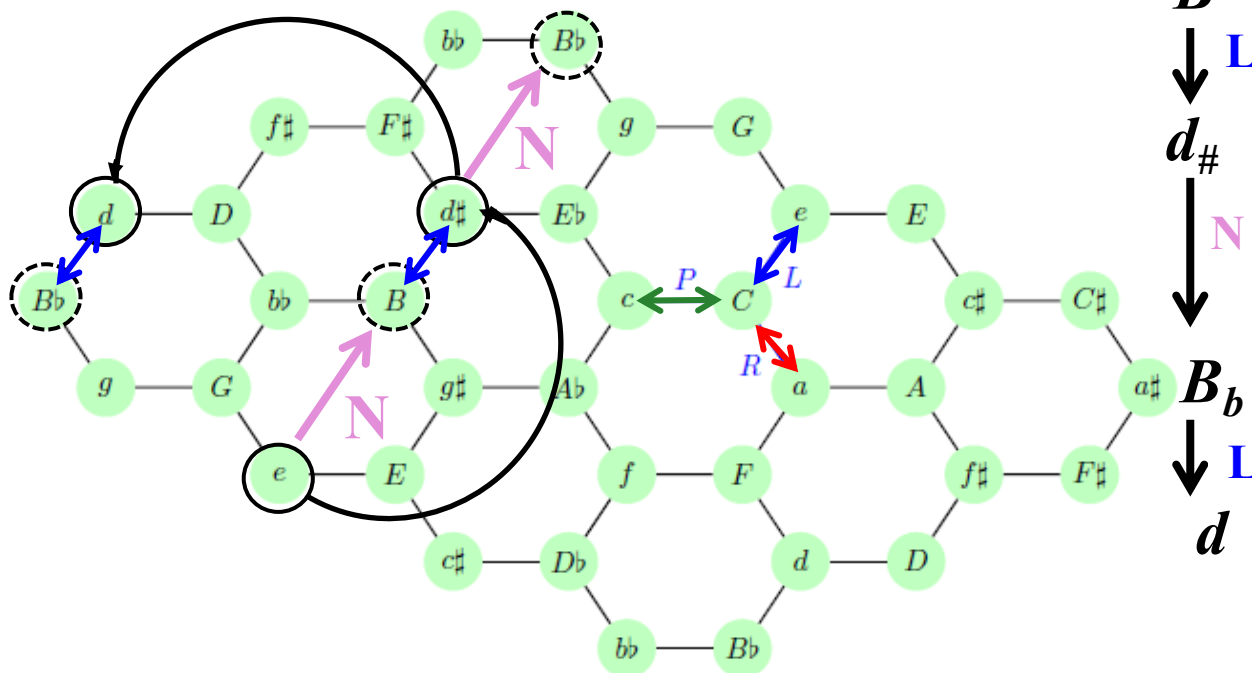
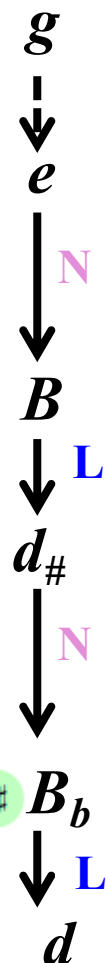
GIURAMENTO (L. Mello / M. Andreatta)

01:29

non ci saranno stelle già sfinite
a raccontare stanche i nostri inizi
non ci saranno immagini sfuocate
dell'alba fatta dolce degli abbracci

non ci saranno frasi come lame
e baci di un raccolto più prezioso
non sagome di vetro a cancellare
la schiuma del tuo volto che compare

nel mio respiro fragile d'argilla
non ci sarà la notte a distanziare
la brace dei tuoi angoli di labbra
la luce che nel tuo danzare brilla



Nebenverwandt comme principe modulante



Playlist Spotify
« Cours chanson »

FRANGIFLUTTI

(L. Mello / M. Andreatta)

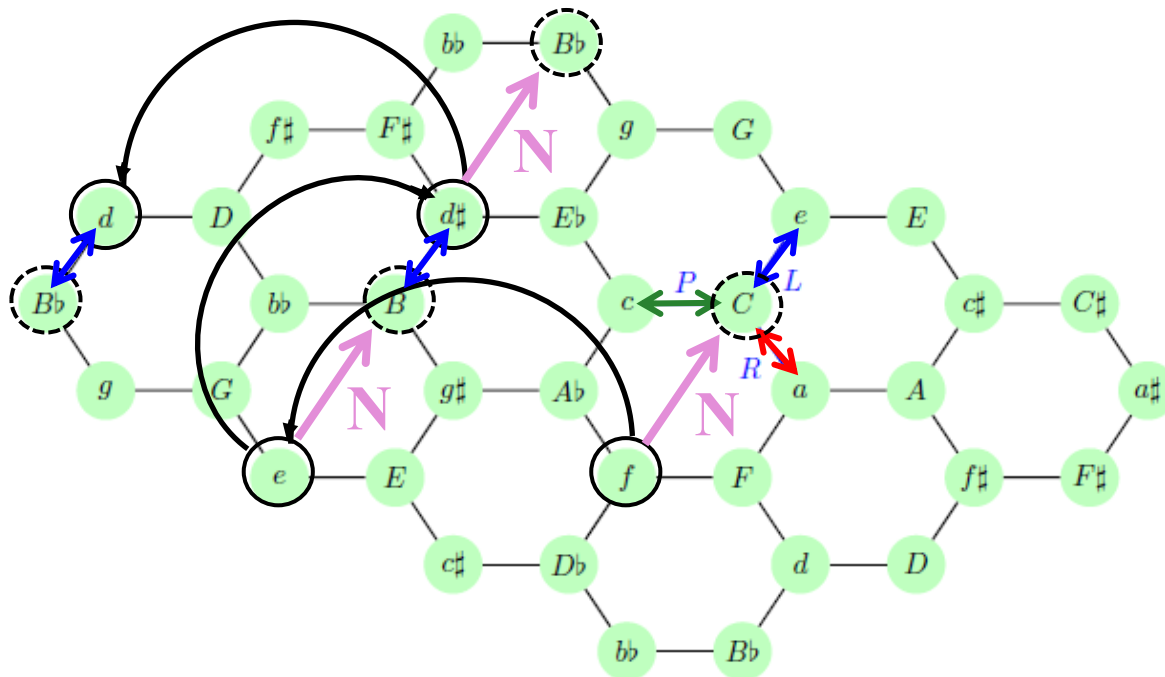
01:29

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.

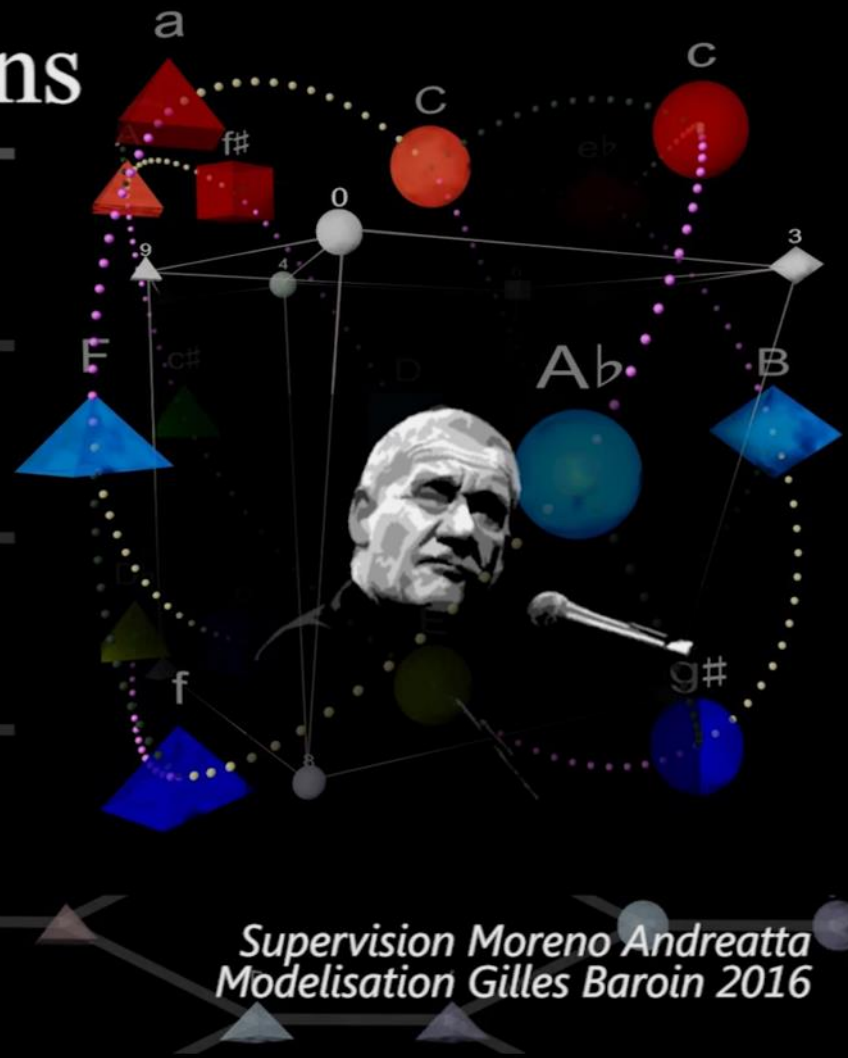
Sai parole da incatenare
sai sorridere per piacere
sai scappare senza tornare
sai ferire e sai far l'amore.



Harmonic Progressions

In Paolo Conte

Madeleine



Le jeu des modulations dans *Madeleine* de Paolo Conte

Preludio *Moderato*

Lab→Réb/Fa→Sib⁷→Mib⁷/Réb

Chorus

Lab Réb/Fa Sib⁷ Mi⁷/Réb Si/Ré# Mi Do# Fa#

Qui, tut - to il meglio è già qui, non ci so - no pa
 Tan - to io ca - pi - sco sol - tan - to si il tat - to del - le tue
 [Ma] qual - che vol - ta è co - che qual - cu - no è tor

Re/La Sol Mi⁷ La⁷ Re Lab⁷ Réb Do⁷ Mib⁷

ro - le per spie ga re ed in - tui - re e ca - pi - re, Ma de - leine, e se mai ri - cor - da - re...
 ma - ni e la can - zo - ne per - du - ta e ri - tro - va - ta, come un' al - tra un' al - tra vi - ta...
 na - to sot - to cer - te ca - rez - ze...

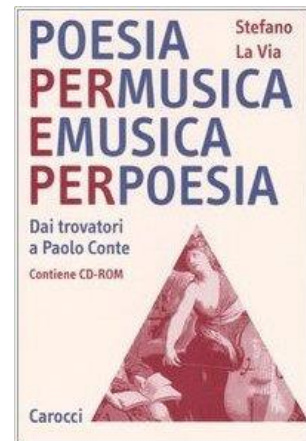
Lab→Réb/Fa→Sib⁷→Mib⁷/Réb

Si/Ré#→Mi→Do#→Fa#

Ré/La→Sol→Mi⁷→La⁷

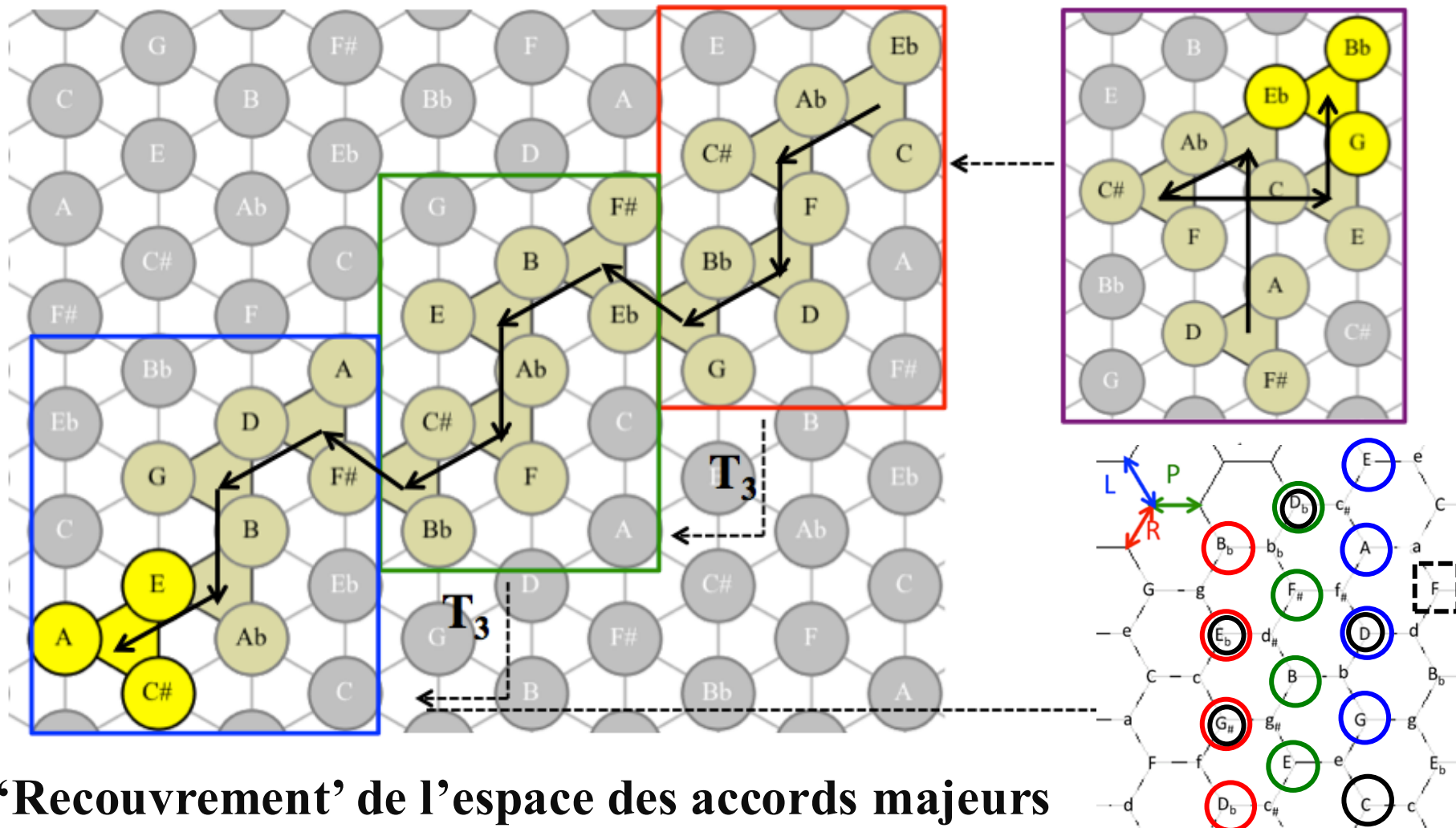
Ré→Lab⁷→Réb→Do⁷→Mib⁷

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



Le jeu des modulations dans *Madeleine* de Paolo Conte

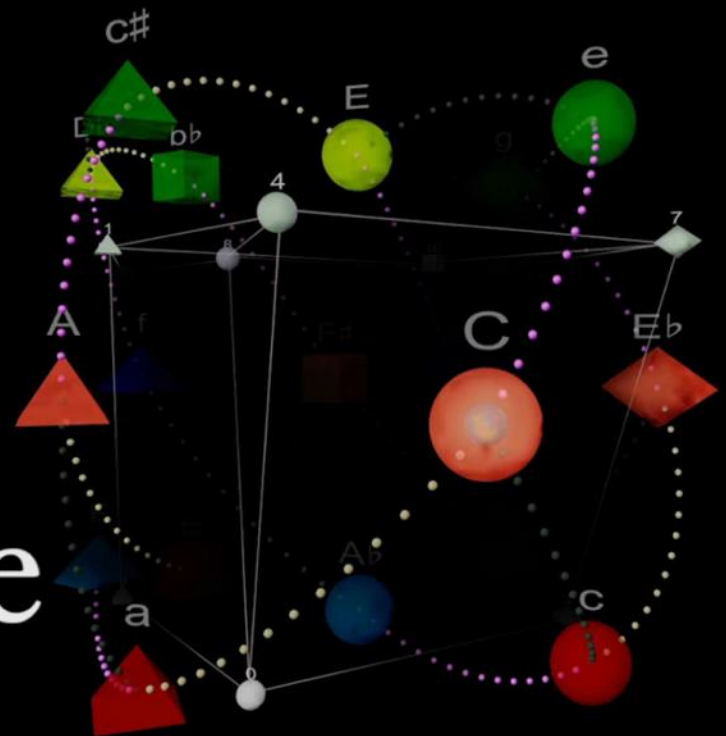
La_b Re_b Si_b Mi_b Si Mi Re_b Fa_# Re Sol Mi La Re La_b Re_b Do Mi_b



‘Recouvrement’ de l’espace des accords majeurs

Beethoven and the Hypersphere

(and the Tonnetz)



Gilles Baroin 2016
www.MatheMusic.net

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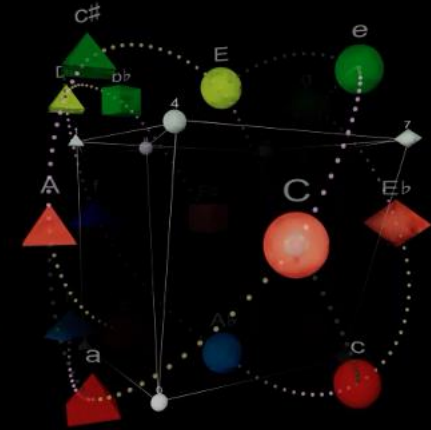


Gilles Baroin

Hamiltonian Song

www.MatheMusic.net

Le Blé en Herbe



Lyrics, music and performance by Polo
Mathemusical supervision by Moreno Andreatta
Hyperspheres and animation by Gilles Baroin, 2016



Polo Lamy



Gilles Baroin

La collection des 28 cycles hamiltoniens « redondants »

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--PRPRRLR
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--PRRLRPR
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--PRLR
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--RPRPRLRP
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--RPRL
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--RPRLRLRP
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



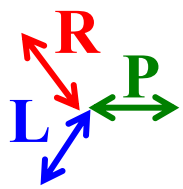
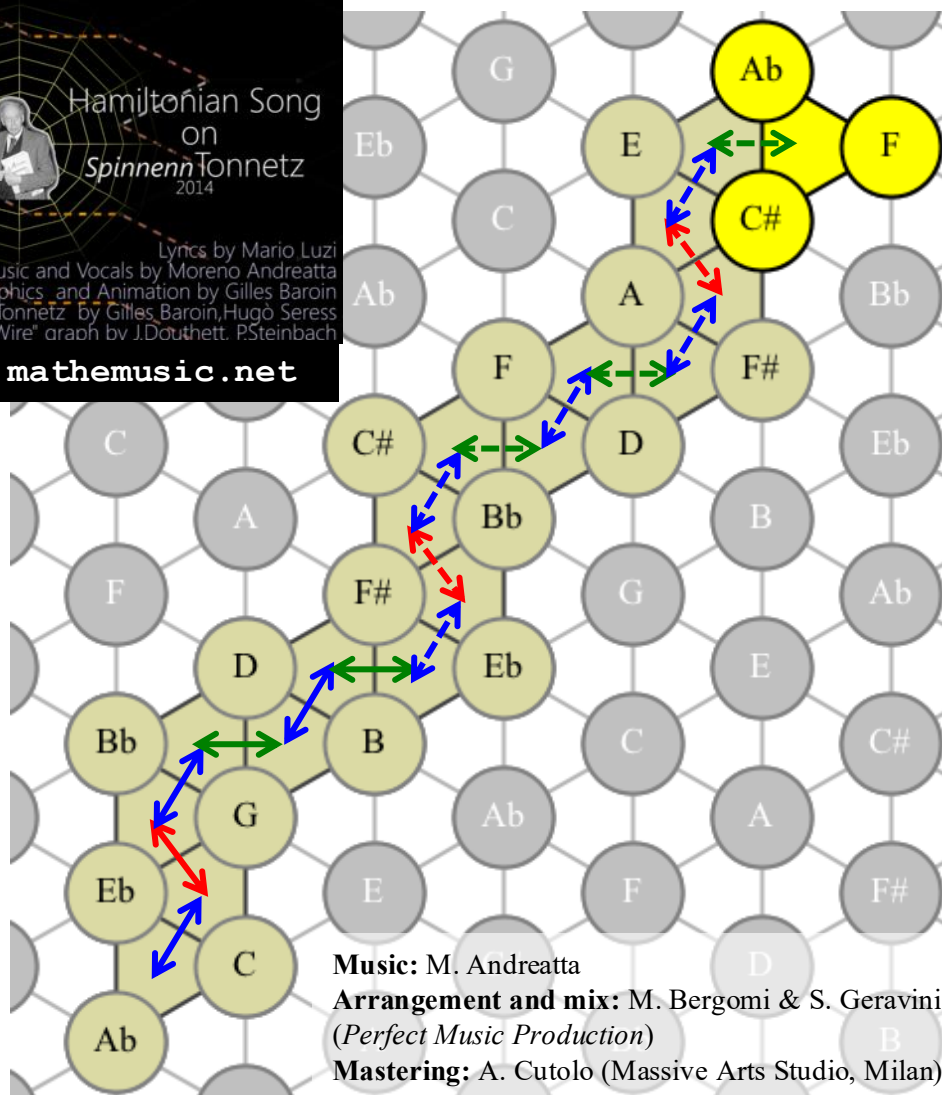
Cycles hamiltoniens avec périodicité interne

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--LRPRRPR
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--LRPRRLR

L P L P L R ...
 P L P L R L ...
 L P L R L P ...
 P L R L P L ...
L R L P L P ...
 R L P L P L ...



<http://www.mathemusic.net>
 min. 1'02"



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

La sera non è più la tua canzone
 (Mario Luzi, 1945, in *Poesie sparse*)

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.

Luzi



Hamiltonian Song
on
Spinnennetz
2014

Lyrics by Mario Luzi
Music and Vocals by Moreno Andreatta
Graphics and Animation by Gilles Baroin
SpinnenNetz by Gilles Baroin, Hugò Seress
Original "Chicken Wire" graph by J.Douthett, P.Steinbach

→ https://www.youtube.com/watch?v=1TlwFLYCYhY&ab_channel=MatheMusic4D

La collection des 28 cycles hamiltoniens « redondants »

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--PRPRRLR
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--PRRLRPR
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--PRLR
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--LRPRRLR
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--RPRPRLRP
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--RPRL
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--RPRLRLRP
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



Le catalogue complet des 124 cycles hamiltoniens

List of 124 Hamiltonian Cycles (Bigo/Andreatta, February 2016)

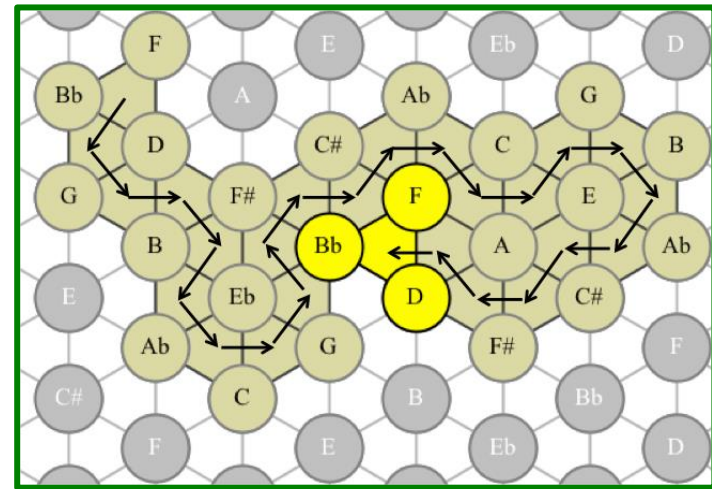
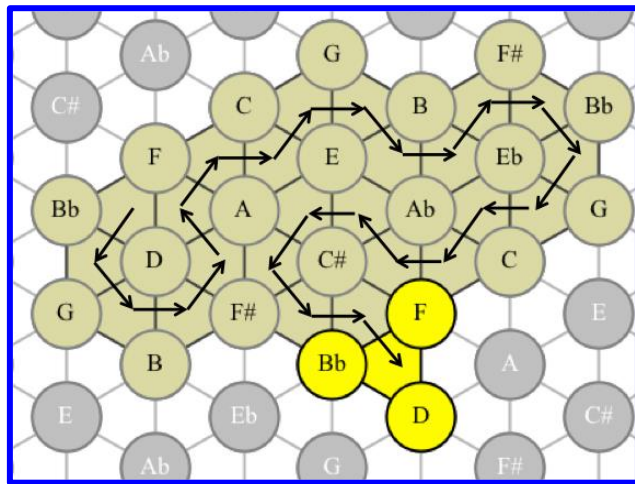
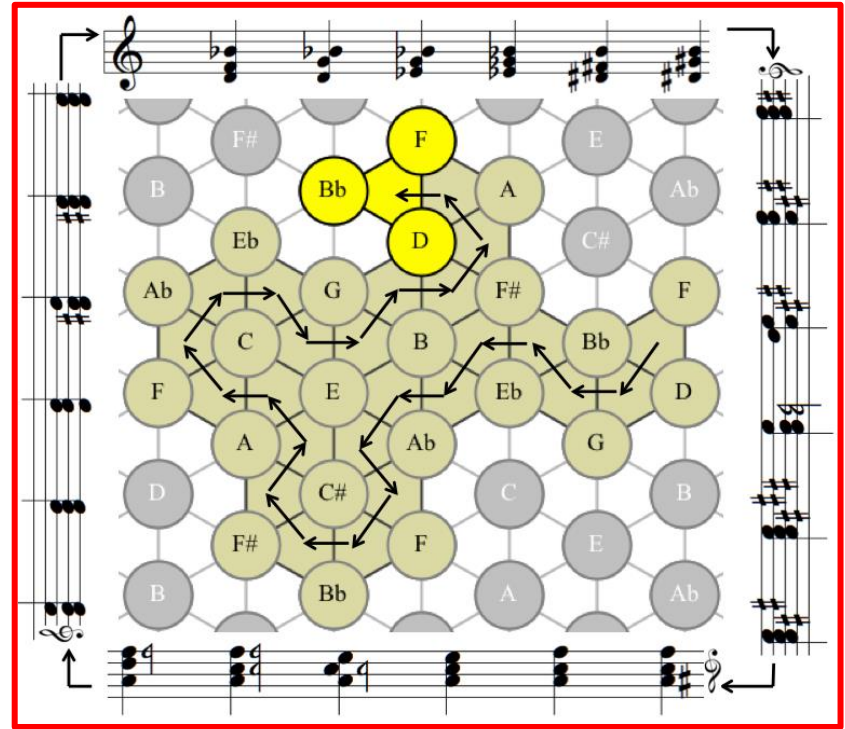
1. C-Cm-Ab-Abm-E-Em-G-Gm-Eb-Ebm-B-Bm-D-Dm-Bb-Bbm-F-F#m-A-C#m-C#-Fm-F-Am--
PLPLPRPLPLPRPLPLPLPLPL
2. C-Cm-Ab-Abm-E-Em-G-Gm-Eb-Ebm-B-Bm-D-F#m-F#-Bbm-Bb-Dm-F-Fm-C#-C#m-A-Am--
PLPLPRPLPLPLPLPLPLPLPL
3. C-Cm-Ab-Abm-E-Em-G-Gm-B-Bm-Eb-Ebm-Bb-Bbm-F-F#m-D-Dm-F-Fm-C#-C#m-A-Am--
PLPLPRPLPLPLPLPLPLPLPL
4. C-Cm-Ab-Abm-E-C#m-C#-Fm-F-Am-A-F#m-F#-Bbm-Bb-Dm-D-Bm-B-Ebm-Eb-Gm-G-Em--
PLPLRPLPLPRPLPLPLPLPL
5. 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
6. C-Cm-Ab-Abm-B-Bm-G-Gm-Eb-Ebm-F-F#m-D-Dm-Bb-Bbm-C#-Fm-F-Am-A-C#m-E-Em--
PLPRPLPLPRPLPLPLPLPL
7. C-Cm-Ab-Abm-B-Bm-G-Gm-Eb-Ebm-F-F#m-Bb-Bm-Dm-D-F#m-A-Am-F-Fm-C#-C#m-E-Em--
PLPRPLPLPLPLPLPLPLPL
8. C-Cm-Ab-Abm-B-Bm-G-Em-E-C#m-A-F#m-D-Dm-Bb-Gm-Eb-Ebm-F-F#m-C#-Fm-F-Am--
PLPRPLPLPLPLPLPLPLPL
9. C-Cm-Ab-Abm-B-Ebm-Eb-Gm-G-Bm-D-Dm-Bb-Bbm-F-F#m-A-Am-F-Fm-C#-C#m-E-Em--
PLPLPLPLPLPLPLPLPLPL
10. C-Cm-Ab-Abm-B-Ebm-Eb-Gm-Bb-Dm-D-Bm-G-Em-E-C#m-A-F#m-F#-Bbm-C#-Fm-F-Am--
PLPLPLPLPLPLPLPLPLPL
11. C-Cm-Ab-Abm-B-Ebm-Eb-Gm-Bb-Dm-F-Fm-C#-Bbm-F-F#m-D-Bm-G-Em-E-C#m-A-Am--
PLPLPLPLPLPLPLPLPLPL
12. C-Cm-Ab-Fm-F-Am-A-C#m-C#-Bbm-Bb-Dm-D-F#m-F#-Ebm-Eb-Gm-G-Bm-B-Abm-E-Em--
PLRPLPLPRPLPLPLPLPLPL
13. C-Cm-Ab-Fm-F-Am-A-F#m-F#-Bbm-C#-C#m-E-Abm-B-Ebm-Eb-Gm-Bb-Dm-D-Bm-G-Em--
PLRPLPRPLPRPLPLPLPLPL
14. C-Cm-Ab-Fm-F-Am-A-F#m-D-Dm-Bb-Gm-Eb-Ebm-F-F#m-C#-C#m-E-Abm-B-Bm-G-Em--
PLRPLPLPLPLPLPLPLPLPL
15. C-Cm-Ab-Fm-F-Dm-Bb-Gm-Eb-Ebm-B-Abm-E-Em-G-Bm-D-F#m-F#-Bbm-C#-C#m-A-Am--
PLRPLRLPLRLPLRLPLRLPL
16. 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
17. C-Cm-Ab-Fm-C#-C#m-A-F#m-F#-Bbm-Bb-Gm-Eb-Ebm-B-Abm-E-Em-G-Bm-D-Dm-F-Am--
PLRLPLRLPLRLPLRLPLRL
18. C-Cm-Ab-Fm-C#-C#m-A-F#m-D-Bm-B-Abm-E-Em-G-Gm-Eb-Ebm-F-F#m-Bb-Dm-F-Am--
PLRLPLRLPLRLPLRLPLRL
19. C-Cm-Ab-Fm-C#-C#m-E-Abm-B-Bm-D-F#m-A-Am-F-Dm-Bb-Bbm-F-F#m-Ebm-Eb-Gm-G-Em--
PLRLPLRLPLRLPLRLPLRL
20. C-Cm-Ab-Fm-C#-C#m-E-Abm-B-Ebm-Eb-Gm-Bb-Bbm-F-F#m-A-Am-F-Dm-D-Bm-G-Em--
PLRLPLRLPLRLPLRLPLRL
21. C-Cm-Ab-Fm-C#-Bbm-Bb-Dm-F-Am-A-C#m-E-Abm-B-Bm-D-F#m-F#-Ebm-Eb-Gm-G-Em--
PLRLPLRLPLRLPLRLPLRL
22. C-Cm-Ab-Fm-C#-Bbm-Bb-Gm-Eb-Ebm-F-F#m-D-Dm-F-Am-A-C#m-E-Abm-B-Bm-G-Em--
PLRLPLRLPLRLPLRLPLRL
23. C-Cm-Eb-Ebm-B-Bm-G-Gm-Bb-Bbm-F-F#m-D-Dm-F-Am-A-C#m-C#-Fm-Ab-Abm-E-Em--
PRPLPLPRPLPLPLPLPLPL
24. C-Cm-Eb-Ebm-B-Bm-G-Gm-Bb-Dm-D-F#m-F#-Bbm-C#-C#m-A-Am-F-Fm-Ab-Abm-E-Em--
PRPLPLPLPLPLPLPLPLPL
25. C-Cm-Eb-Ebm-B-Bm-D-F#m-F#-Bbm-C#-Fm-Ab-Abm-E-C#m-A-Am-F-Dm-Bb-Gm-G-Em--
PRPLPLPLRLPLRLPLRLPL
26. C-Cm-Eb-Ebm-B-Abm-Ab-Fm-C#-Bbm-F-F#m-D-Bm-G-Gm-Bb-Dm-F-Am-A-C#m-E-Em--
PRPLPLRLPLRLPLRLPLRL
27. 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--
PRPRPLRL
28. C-Cm-Eb-Ebm-F-F#m-Bbm-C#-C#m-E-Em-G-Gm-Bb-Dm-F-Fm-Ab-Abm-B-Bm-D-F#m-A-Am--
PRPLRLPR
29. C-Cm-Eb-Ebm-F-F#m-Bbm-C#-Fm-Ab-Abm-B-Bm-D-F#m-A-C#m-E-Em-G-Gm-Bb-Dm-F-Am--
PRPLRLRL
30. C-Cm-Eb-Gm-G-Bm-B-Ebm-F-F#m-D-Dm-Bb-Bbm-C#-C#m-A-Am-F-Fm-Ab-Abm-E-Em--
PRLPLPLPLPLPLPLPLPLPL
31. C-Cm-Eb-Gm-G-Bm-D-F#m-F#-Ebm-B-Abm-Ab-Fm-C#-Bbm-Bb-Dm-F-Am-A-C#m-E-Em--
PRLPLRLPLRLPLRLPLRLPL
32. C-Cm-Eb-Gm-G-Bm-D-F#m-A-Am-F-Dm-Bb-Bbm-F-F#m-Ebm-B-Abm-Ab-Fm-C#-C#m-E-Em--
PRLPLRLPLRLPLRLPLRLPL
33. C-Cm-Eb-Gm-G-Em-E-Abm-Ab-Fm-C#-C#m-A-F#m-D-Bm-B-Ebm-F-F#m-Bb-Dm-F-Am--
PRLPLRLPLRLPLRLPLRLPL
34. C-Cm-Eb-Gm-Bb-Bbm-F-F#m-Ebm-B-Bm-G-Em-E-Abm-Ab-Fm-C#-C#m-A-F#m-D-Dm-F-Am--
PRLPLRLPLRLPLRLPLRLPL
35. 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--
PRLPRPR
36. C-Cm-Eb-Gm-Bb-Bbm-C#-Fm-Ab-Abm-E-C#m-A-Am-F-Dm-D-F#m-F#-Ebm-B-Bm-G-Em--
PRLPRPLRLPLRLPLRLPLRL
37. 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--
PRLR
38. C-Cm-Eb-Gm-Bb-Dm-D-F#m-A-Am-F-Fm-Ab-Abm-E-C#m-C#-Bbm-F-F#m-Ebm-B-Bm-G-Em--
PRLPLPLPLPLPLPLPLPLPL
39. C-Cm-Eb-Gm-Bb-Dm-D-F#m-A-C#m-C#-Bbm-F-F#m-Ebm-B-Bm-G-Em-E-Abm-Ab-Fm-F-Am--
PRLPLPLPLPLPLPLPLPLPL
40. C-Cm-Eb-Gm-Bb-Dm-F-Fm-Ab-Abm-B-Ebm-F-F#m-C#-C#m-E-Em-G-Bm-D-F#m-A-Am--
PRLRLRPR
41. C-Em-E-Abm-Ab-Cm-Eb-Ebm-B-Bm-G-Gm-Bb-Bbm-F-F#m-D-Dm-F-Fm-C#-C#m-A-Am--
LPLPLPLPLPLPLPLPLPLPL
42. C-Em-E-Abm-Ab-Cm-Eb-Gm-G-Bm-B-Ebm-F-F#m-Bb-Dm-D-F#m-A-C#m-C#-Fm-F-Am--
LPLPL
43. C-Em-E-Abm-Ab-Fm-F-Am-A-C#m-C#-Bbm-Bb-Dm-D-F#m-F#-Ebm-B-Bm-G-Em-Cm--
LPLPRPLPLPRPLPLPLPLPL
44. C-Em-E-Abm-Ab-Fm-F-Am-A-C#m-C#-Bbm-F-F#m-D-Dm-Bb-Gm-G-Bm-B-Ebm-Eb-Cm--
LPLPRPLPLPLPLPLPLPLPL
45. C-Em-E-Abm-Ab-Fm-C#-C#m-A-Am-F-Dm-D-F#m-F#-Bbm-Bb-Gm-G-Bm-B-Ebm-Eb-Cm--
LPLPLPLPLPLPLPLPLPLPL
46. C-Em-E-Abm-B-Bm-G-Gm-Eb-Ebm-F-F#m-D-Dm-Bb-Bbm-C#-C#m-A-Am-F-Fm-Ab-Cm--
LPLRPLPLPRPLPLPLPLPL
47. C-Em-E-Abm-B-Bm-G-Gm-Bb-Bbm-F-F#m-Ebm-Eb-Cm-Ab-Fm-C#-C#m-A-F#m-D-Dm-F-Am--
LPLPLPLPRPLPLRLPLRLPL
48. C-Em-E-Abm-B-Bm-G-Gm-Bb-Dm-D-F#m-A-C#m-C#-Bbm-F-F#m-Ebm-Eb-Cm-Ab-Fm-F-Am--
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49. 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--
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50. C-Em-E-Abm-B-Ebm-Eb-Cm-Ab-Fm-F-Dm-Bb-Gm-G-Bm-D-F#m-F#-Bbm-C#-C#m-A-Am--
LPLRLPLRLPLRLPLRLPL
51. C-Em-E-Abm-B-Ebm-Eb-Cm-Ab-Fm-C#-C#m-A-F#m-F#-Bbm-Bb-Gm-G-Bm-D-Dm-F-Am--
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52. C-Em-E-Abm-B-Ebm-F-F#m-D-Bm-G-Gm-Eb-Cm-Ab-Fm-F-Dm-Bb-Bbm-C#-C#m-A-Am--
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53. C-Em-E-Abm-B-Ebm-F-F#m-A-C#m-C#-Bbm-Bb-Dm-D-Bm-G-Gm-Eb-Cm-Ab-Fm-F-Am--
LPLRLPLRLPLRLPLRLPL

Le catalogue complet des 124 cycles hamiltoniens

54. C-Em-E-C#m-C#-Fm-F-Am-A-F#m-F#-Bbm-Bb-Dm-D-Bm-G-Gm-Eb-Ebm-B-Abm-Ab-Cm--LPRPLPRPLPRPLPRPLPRPLPR
55. C-Em-E-C#m-C#-Fm-F-Am-A-F#m-D-Dm-Bb-Bbm-F#-Ebm-Eb-Gm-G-Bm-B-Abm-Ab-Cm--LPRPLPRPLPRPLPRPLPRPLPR
56. C-Em-E-C#m-C#-Fm-F-Dm-Bb-Bbm-F#-Ebm-B-Abm-Ab-Cm-Eb-Gm-G-Bm-D-F#m-A-Am--LPRPLPRPLRRLRRLRRLRRLR
57. C-Em-E-C#m-C#-Fm-Ab-Abm-B-Ebm-F#-Bbm-Bb-Dm-F-Am-A-F#m-D-Bm-G-Gm-Eb-Cm--LPRPLPRRLRRLRRLRRLRPLR
58. C-Em-E-C#m-A-Am-F-Fm-C#-Bbm-Bb-Dm-D-F#m-F#-Ebm-Eb-Gm-G-Bm-B-Abm-Ab-Cm--LPRLPLRPLRPLRPLRPLRPLR
59. C-Em-E-C#m-A-Am-F-Dm-Bb-Bbm-C#-Fm-Ab-Abm-B-Ebm-F#-F#m-D-Bm-G-Gm-Eb-Cm--LPRLRRLRPLRPLRPLRPLRPLR
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61. C-Em-E-C#m-A-F#m-F#-Ebm-B-Abm-Ab-Cm-Eb-Gm-G-Bm-D-Dm-Bb-Bbm-C#-Fm-F-Am--LPRLRPLRPLRPLRPLRPLRPLR
62. C-Em-E-C#m-A-F#m-D-Dm-Bb-Gm-G-Bm-B-Abm-Ab-Cm-Eb-Ebm-F#-Bbm-C#-Fm-F-Am--LPRLRPLRPLRPLRPLRPLRPLR
63. C-Em-G-Gm-Eb-Ebm-B-Bm-D-Dm-Bb-Bbm-F#-F#m-A-Am-F-Fm-C#-C#m-E-Abm-Ab-Cm--LRPLPLRPLRPLRPLRPLRPLR
64. C-Em-G-Gm-Eb-Ebm-F#-F#m-D-Bm-B-Abm-E-C#m-A-Am-F-Dm-Bb-Bbm-C#-Fm-Ab-Cm--LRPLRPLRPLRPLRPLRPLRPLR
65. C-Em-G-Gm-Eb-Ebm-F#-Bbm-Bb-Dm-F-Am-A-F#m-D-Bm-B-Abm-E-C#m-C#-Fm-Ab-Cm--LRPLRPLRPLRPLRPLRPLRPLR
66. C-Em-G-Gm-Eb-Cm-Ab-Abm-E-C#m-C#-Fm-F-Dm-Bb-Bbm-F#-Ebm-B-Bm-D-F#m-A-Am--LRPLRPLRPLRPLRPLRPLRPLR
67. C-Em-G-Gm-Eb-Cm-Ab-Abm-E-C#m-A-F#m-F#-Ebm-B-Bm-D-Dm-Bb-Bbm-C#-Fm-F-Am--LRPLRPLRPLRPLRPLRPLRPLR
68. 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
69. 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
70. C-Em-G-Gm-Bb-Dm-D-Bm-B-Ebm-Eb-Cm-Ab-Abm-E-C#m-A-F#m-F#-Bbm-C#-Fm-F-Am--LRPRLRPLRPLRPLRPLRPLRPLR
71. C-Em-G-Gm-Bb-Dm-F-Fm-C#-Bbm-F#-F#m-D-Bm-B-Ebm-Eb-Cm-Ab-Abm-E-C#m-A-Am--LRPRLRPLRPLRPLRPLRPLRPLR
72. 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
73. C-Em-G-Gm-Bb-Dm-F-Am-A-C#m-E-Abm-Ab-Fm-C#-Bbm-F#-F#m-D-Bm-B-Ebm-Eb-Cm--LRPLRPLRPLRPLRPLRPLRPLR
74. C-Em-G-Gm-B-Ebm-Eb-Gm-Bb-Dm-D-F#m-F#-Bbm-C#-Fm-F-Am-A-C#m-E-Abm-Ab-Cm--LRLPLP
75. C-Em-G-Gm-B-Ebm-F#-F#m-D-Dm-F-Fm-C#-Bbm-Bb-Gm-Eb-Cm-Ab-Abm-E-C#m-A-Am--LRLPLRPLRPLRPLRPLRPLRPLR
76. C-Em-G-Gm-B-Ebm-F#-F#m-D-Dm-F-Am-A-C#m-E-Abm-Ab-Fm-C#-Bbm-Bb-Gm-Eb-Cm--LRLPLRPLRPLRPLRPLRPLRPLR
77. C-Em-G-Gm-B-Ebm-F#-Bbm-Bb-Gm-Eb-Cm-Ab-Abm-E-C#m-C#-Fm-F-Dm-D-F#m-A-Am--LRLPLRPLRPLRPLRPLRPLRPLR
78. C-Em-G-Gm-B-Ebm-F#-Bbm-C#-C#m-E-Abm-Ab-Fm-F-Am-A-F#m-D-Dm-Bb-Gm-Eb-Cm--LRLPLRPLRPLRPLRPLRPLRPLR
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83. C-Em-G-Gm-D-Dm-F-Am-A-F#m-F#-Bbm-Bb-Gm-Eb-Ebm-B-Abm-E-C#m-C#-Fm-Ab-Cm--LRLRPLRPLRPLRPLRPLRPLRPLR
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85. C-Am-A-C#m-C#-Fm-F-Dm-D-F#m-F#-Bbm-Bb-Gm-G-Bm-B-Ebm-Eb-Cm-Ab-Abm-E-Em--RPLRPLRPLRPLRPLRPLRPLRPLR
86. C-Am-A-C#m-C#-Fm-F-Dm-D-F#m-F#-Bbm-Bb-Gm-Eb-Ebm-B-Bm-G-Em-E-Abm-Ab-Cm--RPLRPLRPLRPLRPLRPLRPLR
87. C-Am-A-C#m-C#-Fm-F-Dm-Bb-Bbm-F#-F#m-D-Bm-B-Ebm-Eb-Gm-G-Em-E-Abm-Ab-Cm--RPLRPLRPLRPLRPLRPLRPLR
88. C-Am-A-C#m-C#-Bbm-Bb-Dm-F-Fm-Ab-Cm-Eb-Gm-G-Bm-D-F#m-F#-Ebm-B-Abm-E-Em--RPLRPLRPLRPLRPLRPLRPLR
89. C-Am-A-C#m-C#-Bbm-F#-F#m-D-Bm-G-Gm-Bb-Dm-F-Fm-Ab-Cm-Eb-Ebm-B-Abm-E-Em--RPLRPLRPLRPLRPLRPLRPLR
90. C-Am-A-C#m-C#-Bbm-F#-F#m-D-Bm-G-Em-E-Abm-B-Ebm-Eb-Gm-Bb-Dm-F-Fm-Ab-Cm--RPLRPLRPLRPLRPLRPLRPLR
91. C-Am-A-C#m-E-Em-G-Bm-D-F#m-F#-Bbm-C#-Fm-F-Dm-Bb-Gm-Eb-Ebm-B-Abm-Ab-Cm--RPLRPLRPLRPLRPLRPLRPLR
92. C-Am-A-C#m-E-Abm-Ab-Cm-Eb-Ebm-B-Bm-D-F#m-F#-Bbm-C#-Fm-F-Dm-Bb-Gm-G-Em--RPLRPLRPLRPLRPLRPLRPLR
93. C-Am-A-C#m-E-Abm-Ab-Cm-Eb-Gm-Bb-Bbm-C#-Fm-F-Dm-D-F#m-F#-Ebm-B-Bm-G-Em--RPLRPLRPLRPLRPLRPLRPLR
94. 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--RPRPRPLR
95. 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--RPRRPLR
96. 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--RPRRPLR
97. C-Am-A-F#m-D-Dm-F-Fm-C#-C#m-E-Abm-Ab-Cm-Eb-Gm-Bb-Bbm-F#-Ebm-B-Bm-G-Em--RPLRPLRPLRPLRPLRPLRPLR
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101. C-Am-A-F#m-D-Bm-G-Gm-Eb-Cm-Ab-Abm-B-Ebm-F#-Bbm-Bb-Dm-F-Fm-C#-C#m-E-Em--RPRLRPLRPLRPLRPLRPLRPLR
102. 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--RPRLRPLR
103. C-Am-F-Fm-C#-C#m-A-F#m-F#-Bbm-Bb-Dm-D-Bm-B-Ebm-Eb-Gm-G-Em-E-Abm-Ab-Cm--RLPLRPLRPLRPLRPLRPLRPLR
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107. C-Am-F-Fm-C#-Bbm-F#-F#m-A-C#m-E-Em-G-Bm-D-Dm-Bb-Gm-Eb-Ebm-B-Abm-Ab-Cm--RLPLRPLRPLRPLRPLRPLRPLR

Le catalogue complet des 124 cycles hamiltoniens

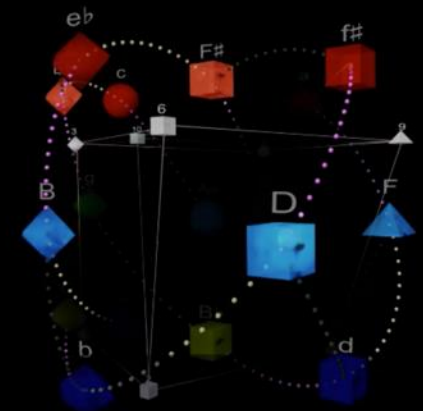
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124. C-Am-F-Dm-Bb-Gm-Eb-Cm-Ab-Fm-C#-Bbm-F#-Ebm-B-Abm-E-C#m-A-F#m-D-Bm-G-Em-RL



Aprile

Hamiltonian Song

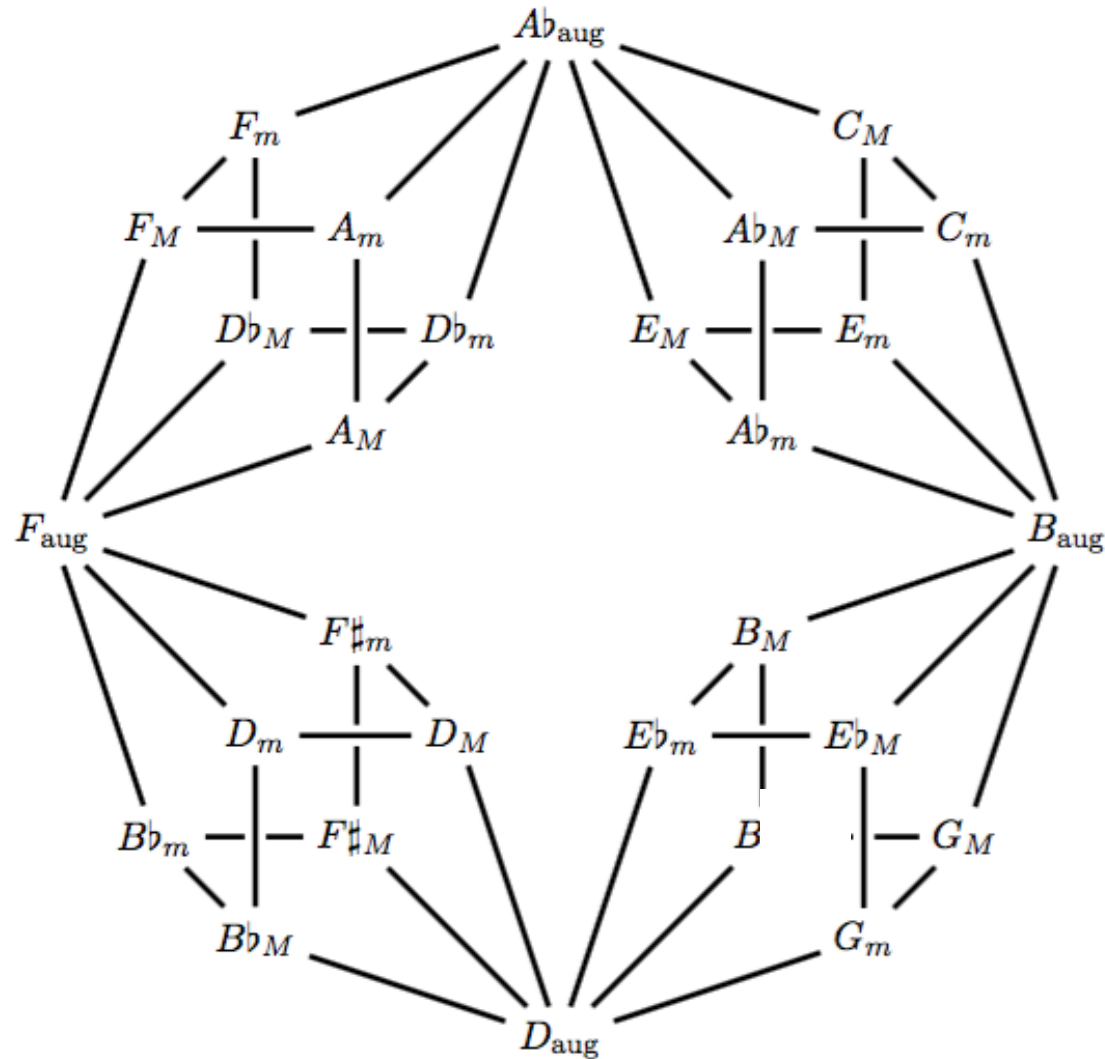
Mathemusical
2D & 4D Visualizations



G. D'Annunzio
(1863-1938)

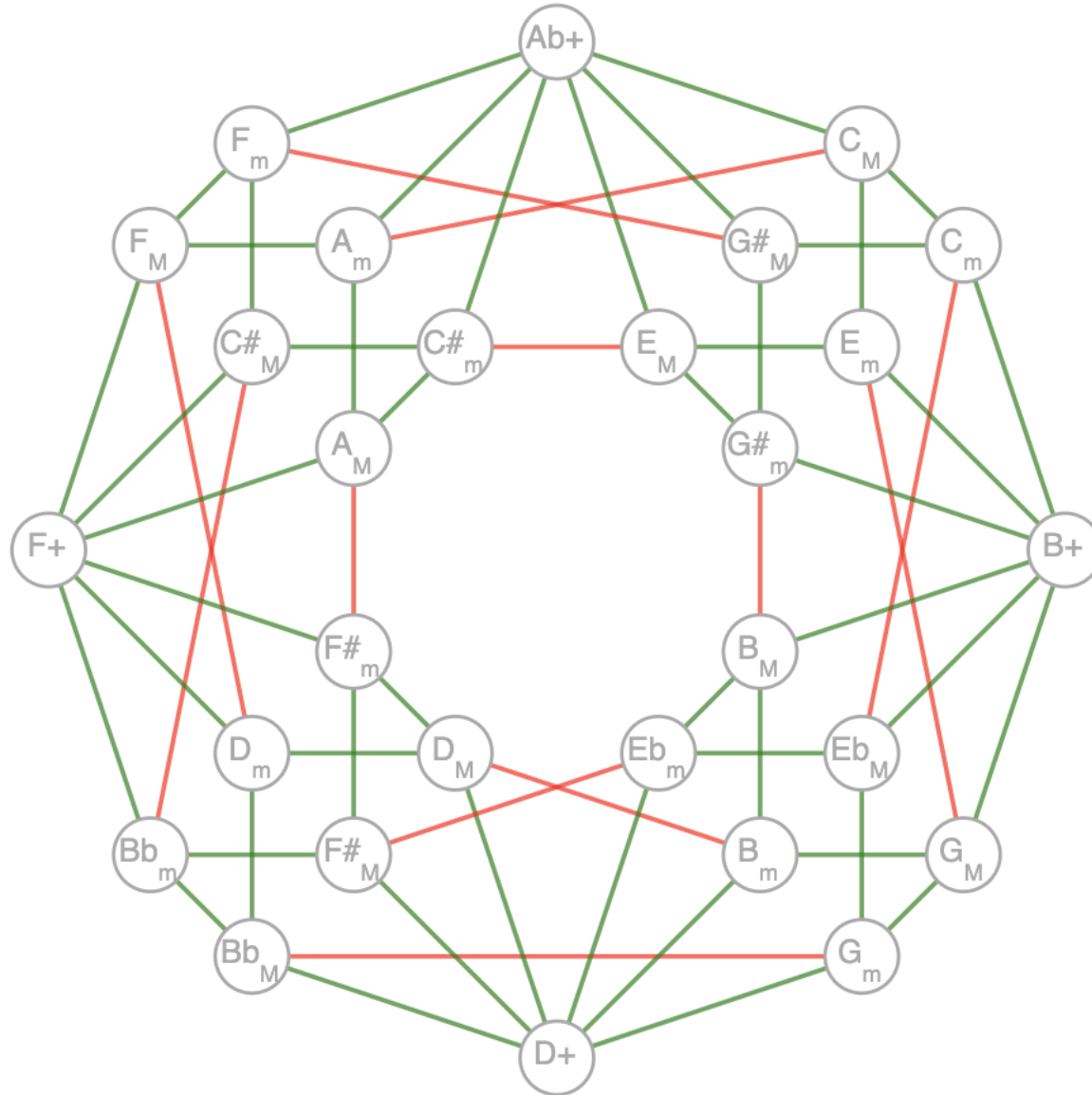
Composition, Performance: Moreno Andreatta
Hyperspheres & Animations: Gilles Baroin
Spinnen-Tonnetz: Hugò Seress & G.B
Lyrics by Gabriele D'Annunzio
www.MatheMusic.net

Le Cube Dance des accords majeurs, mineurs et augmentés



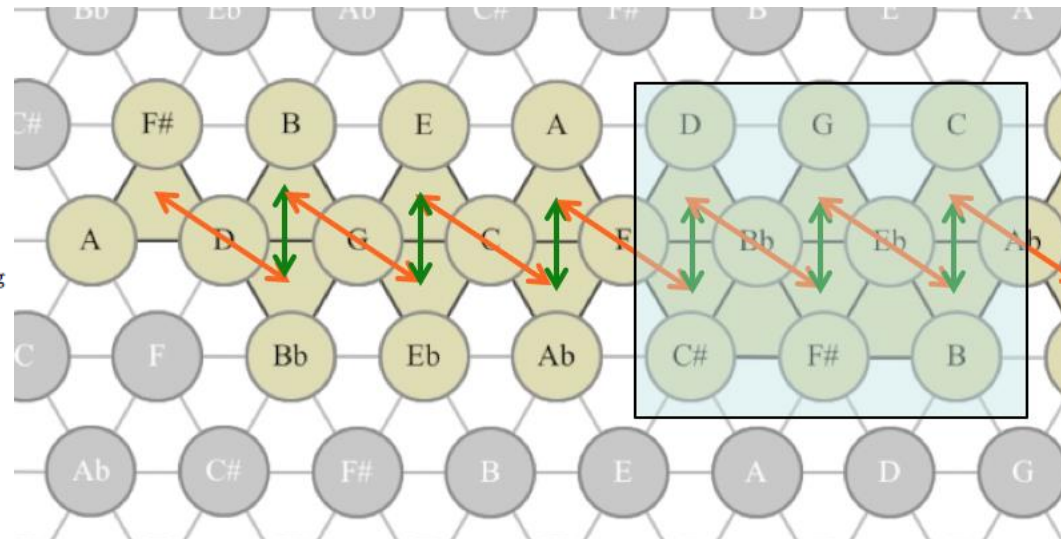
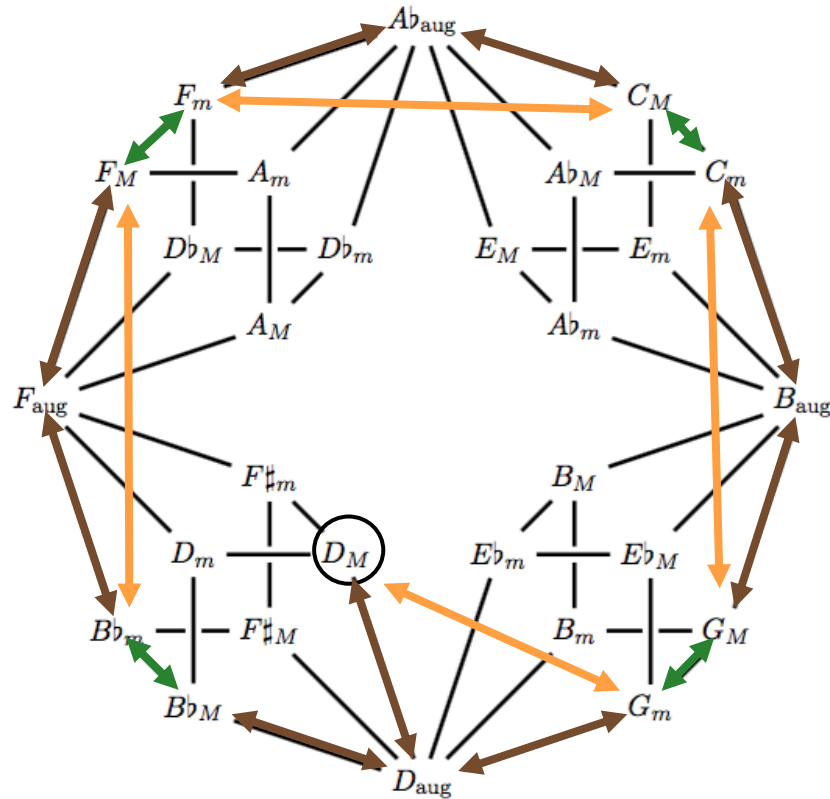
J. Douthett, P. Steinbach, Parsimonious Graphs: A Study in Parsimony, Contextual Transformation, and Modes of Limited Transposition, *Journal of Music Theory*, 42/2, 1998.

Modèles computationnels : le « Cube Dance » interactif



➔ https://alexpof.github.io/interactive_mathmusic/Pmn_graphs/pmn_graphs.html

« Take a bow » dans le Cube Dance



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 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.

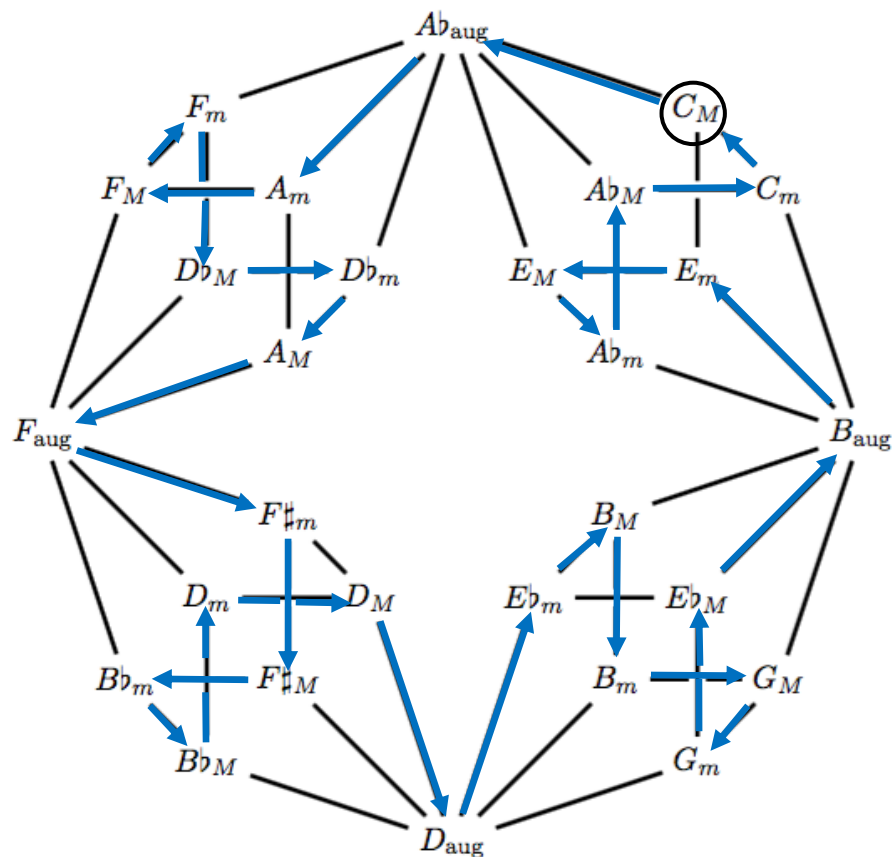
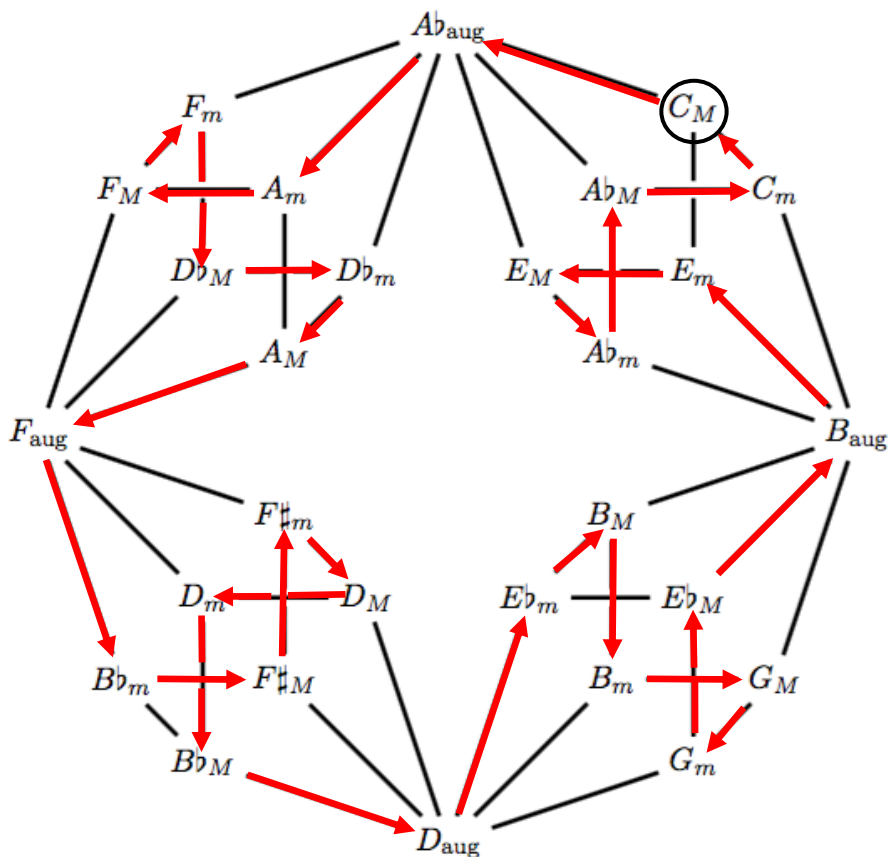


Le rêve du canonnier

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)



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

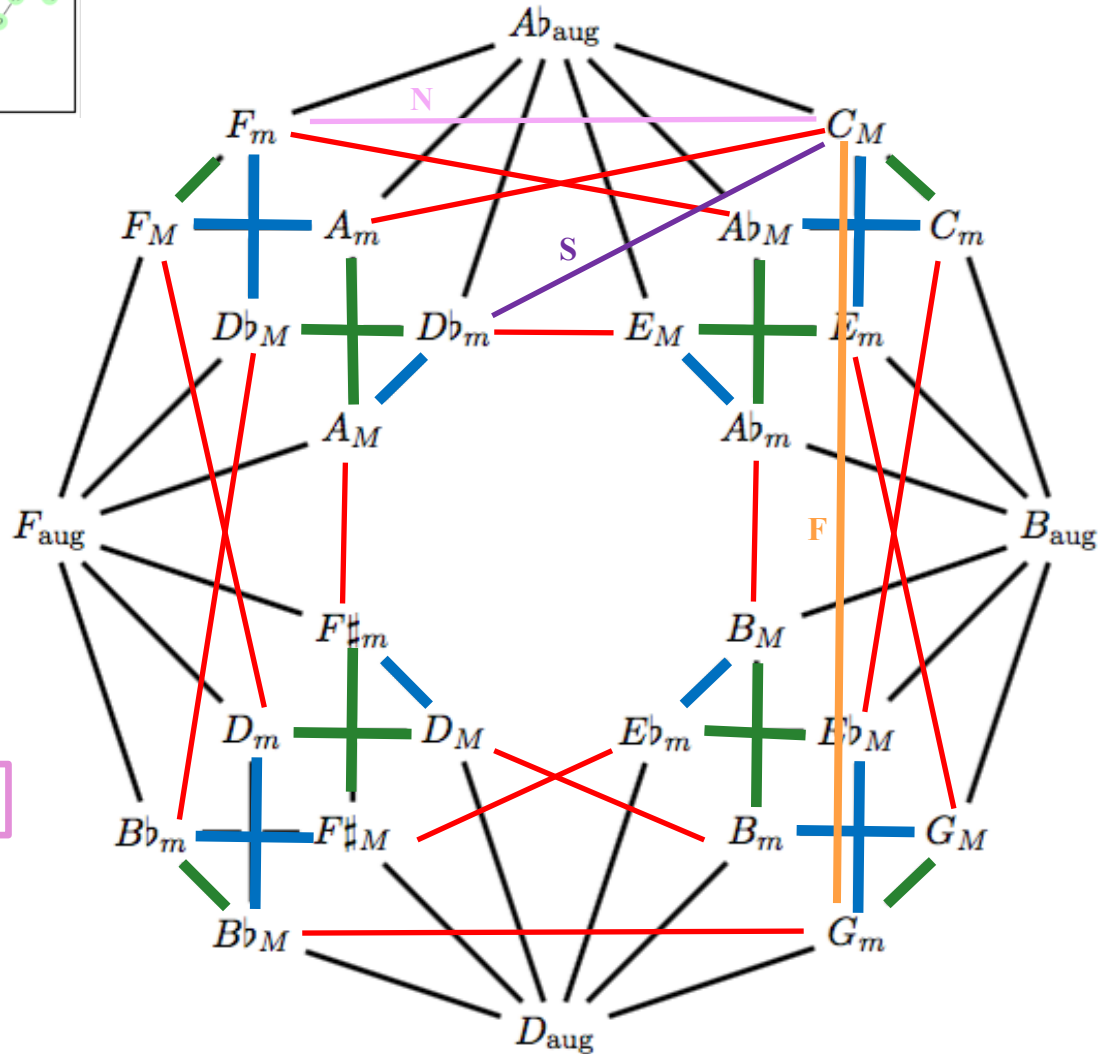
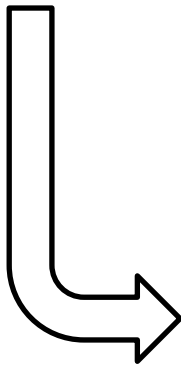
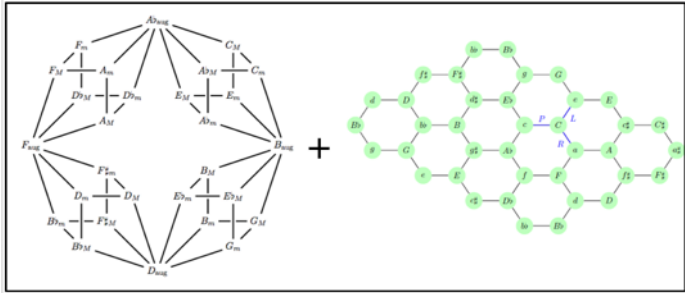
$C \rightarrow C+ \rightarrow Am \rightarrow F \rightarrow Fm \rightarrow C\# \rightarrow C\#m \rightarrow A \rightarrow F+ \rightarrow Bbm \rightarrow F\# \rightarrow F\#m \rightarrow D \rightarrow Dm \rightarrow Bb \rightarrow D+ \rightarrow Ebm \rightarrow B \rightarrow Bm \rightarrow G \rightarrow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

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

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



Autres transformations dans le Cube Dance



LPR = S = SLIDE

RLP = N = NEBENVERWANDT

PRL = F = FAR FIFTH