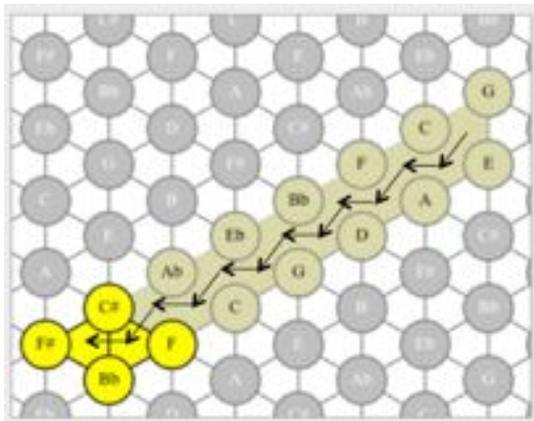
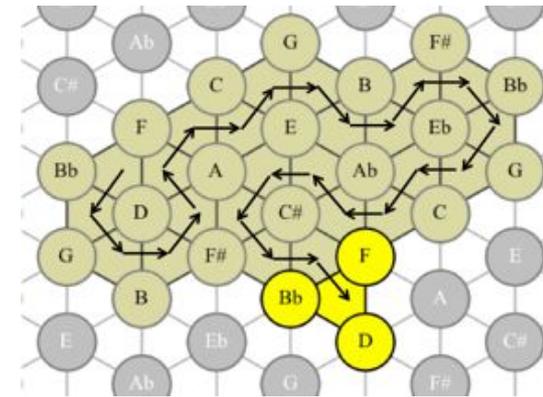


# Formalisations, représentations et modélisations en musicologie computationnelle : un voyage entre musique savante et musiques actuelles



Atheneum  
24 mars 2016  
15h45-16h30



Moreno Andreatta  
Equipe Représentations Musicales  
IRCAM / CNRS UMR 9912 / UPMC  
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# La sera non è più la tua canzone : chanson hamiltonienne 'redondante'

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.

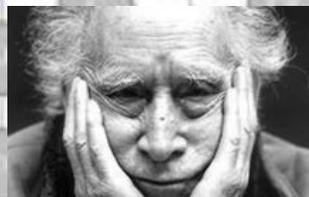
*Le soir n'est plus ta chanson,  
c'est ce rochet d'ombre transpercé  
par les lumières et les voix sans fin,  
la paix d'une chose déjà pensée.*

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

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

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

(tr. Antonia Soulez, philosophe et poète)



M. Luzi (1914-2005)

**Luzi**  
Hamiltonian Song  
on  
Spinnennetz  
2014  
Lyrics by Mario Luzi  
Music and Vocals by Moreno Andreatta  
Graphics and Animation by Gilles Baroin  
SpinnenTonnetz by Gilles Baroin, Hugò Seress  
Original "Chicken Wire" graph by J.Douthett, P.Steinbach

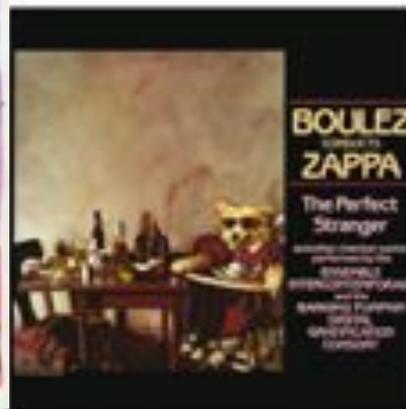
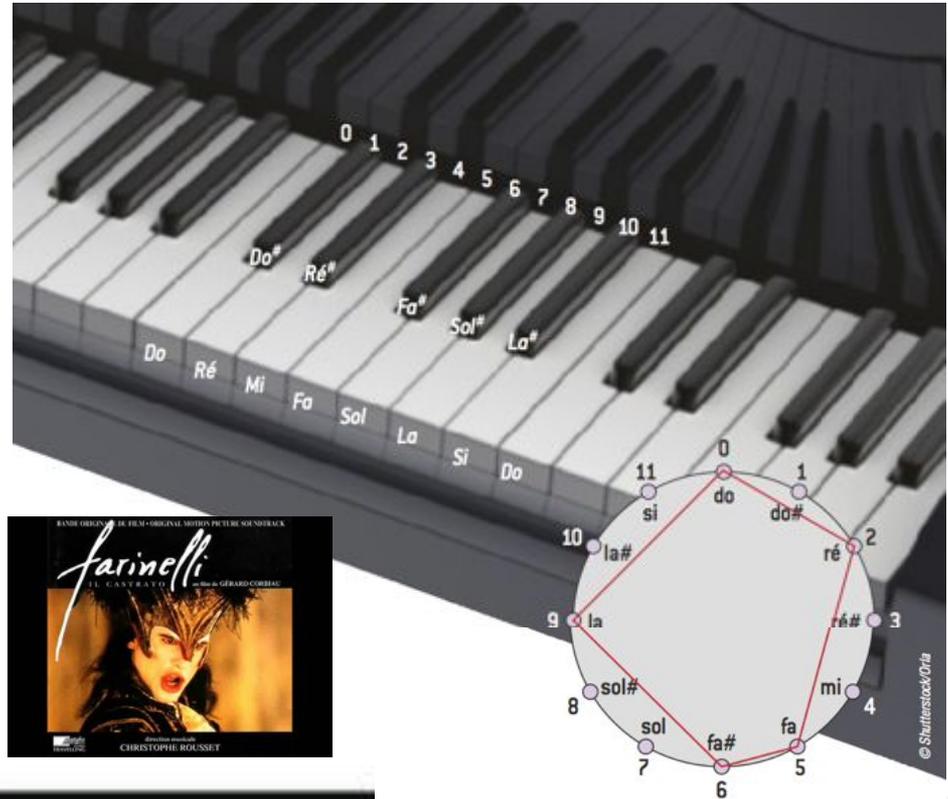
**Musique :** M. Andreatta  
**Arrangements et mixage :** M. Bergomi &  
S. Geravini  
(Perfect Music Production)  
**Mastering :** A. Cutolo (Massive Arts  
Studio, Milan)



# ... entre musique savante et *popular music*



MusiqueLab 2

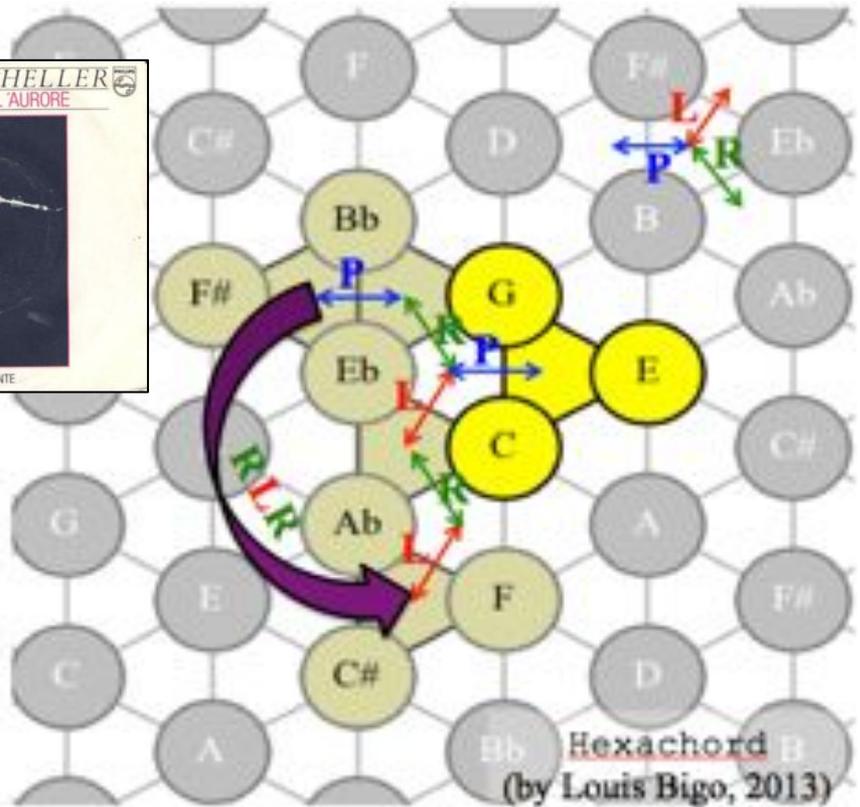
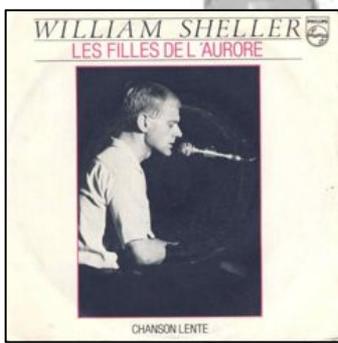


OMAX (logiciel d'improvisation)

# Les musiques actuelles : pop, rock, chanson, improvisation



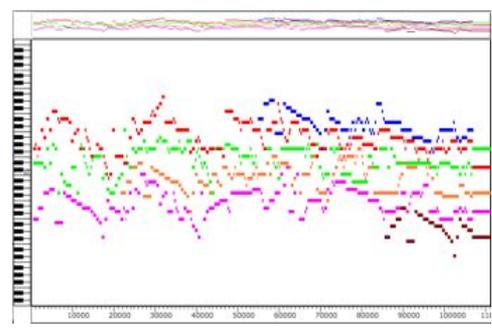
MusiqueLab 2



OMAX



Orig.



Var. 1

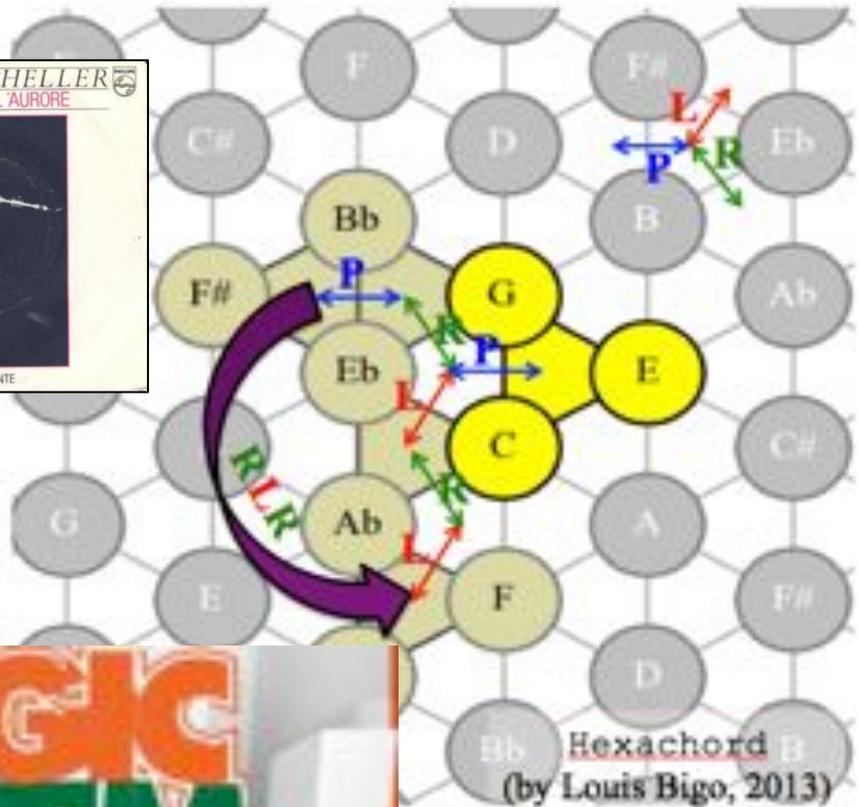
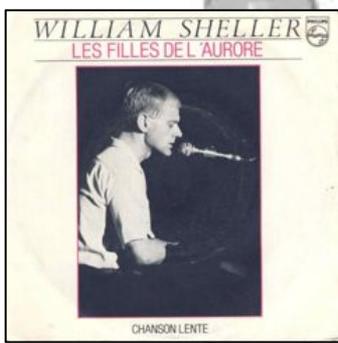


Var. 2

# Les musiques actuelles : pop, rock, chanson, improvisation



MusiqueLab 2



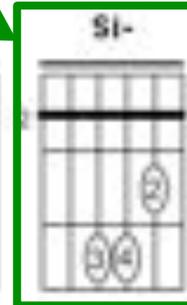
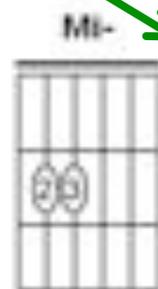
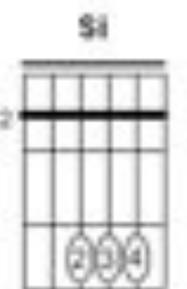
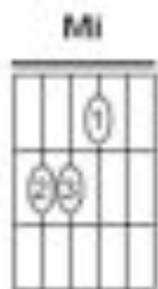
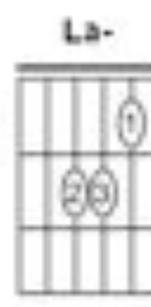
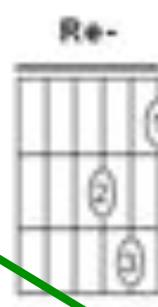
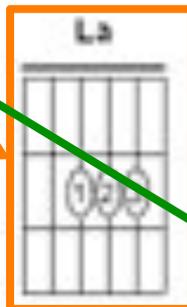
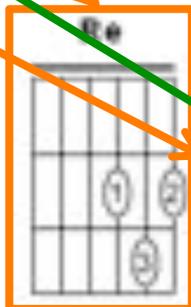
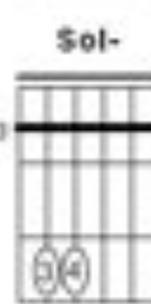
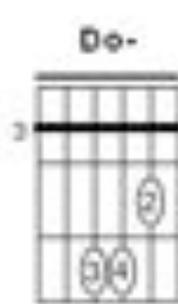
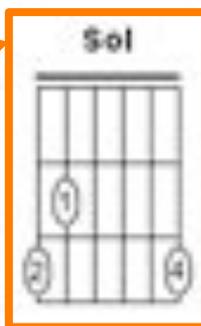
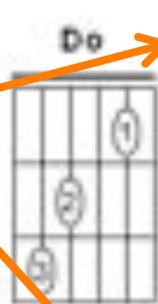
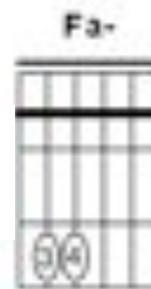
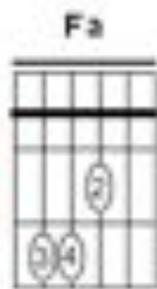
OMAX





**ACCORDS MAJEURS**

**ACCORDS MINEURS**



**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 ...



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**La** **Si-**

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**Sol**

Feel the magic in the air ...

The diagram shows a grid of guitar chord diagrams for major and minor chords. Major chords (Fa, Do, Re, Mi) are highlighted with orange boxes, and minor chords (Fa-, Do-, Re-, Mi-, Si-) are highlighted with green boxes. Arrows point from the chord diagrams to musical staves showing the notes: Sol (G), Ré (D), La (A), and Si- (B).



**ACCORDS MAJEURS**

**ACCORDS MINEURS**

**MAGIC IN THE AIR**

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

**La** **Si-**  
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(x4 avec toutes les voix)

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 Comme d'habitude on est calés

**La** **Si-**  
 Comme toujours ça va aller

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

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

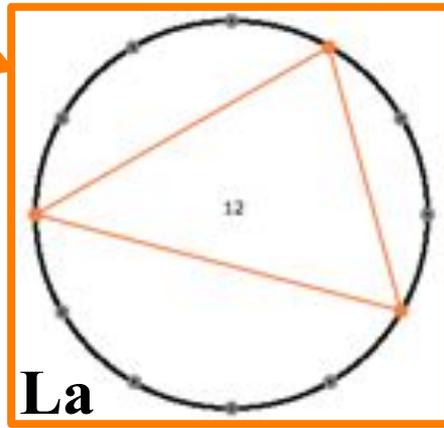
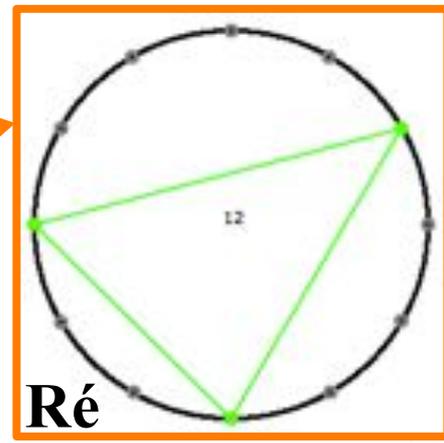
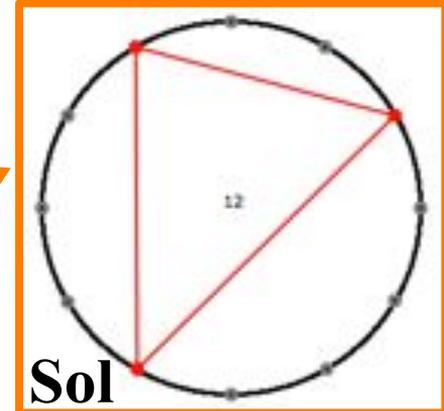
**La** **Si-**  
 Oublie tes soucis Viens faire la folie

**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 ...

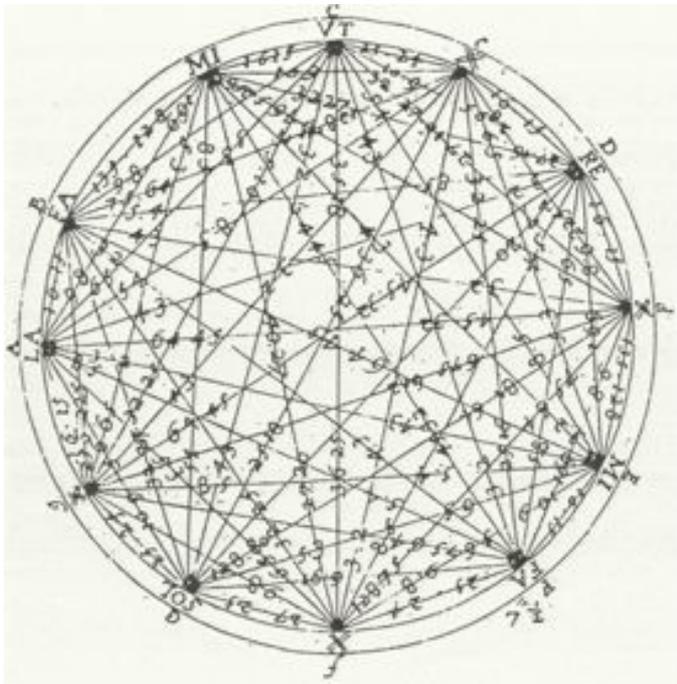
	<b>Fa</b> 	<b>Fa-</b> 
<b>Do</b> 	<b>Sol</b> 	<b>Do-</b> 
<b>Re</b> 	<b>La</b> 	<b>Re-</b> 
<b>Mi</b> 	<b>Si</b> 	<b>Mi-</b> 
		<b>Si-</b> 



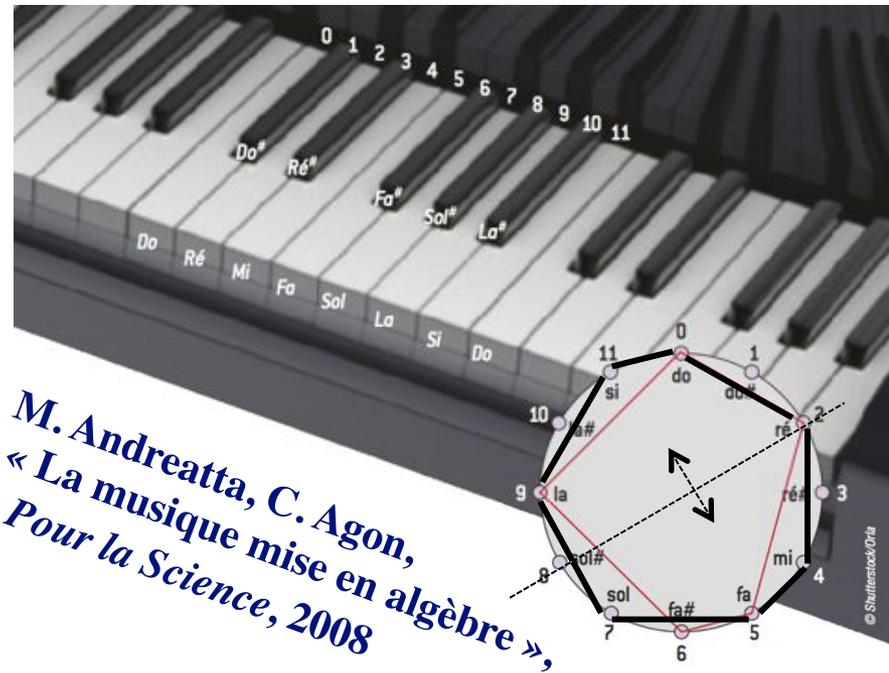
# La représentation circulaire et ses *mappings*



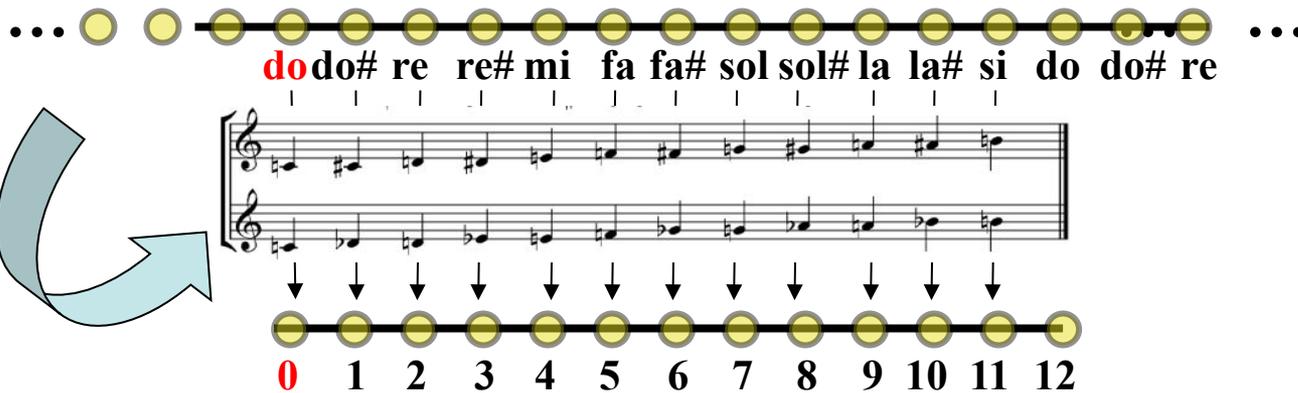
Marin Mersenne



*Harmonicorum Libri XII*, 1648



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



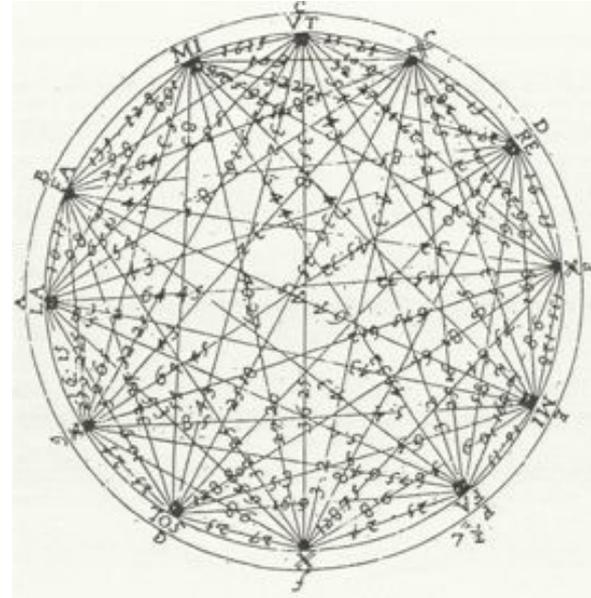
# Mersenne et la naissance de la combinatoire musicale

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

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

*Tabula Combinationis ab 1 ad 22.*

I	1
II	2
III	6
IV	24
V	110
VI	710
VII	3040
VIII	40310
IX	361880
X	3618800
XI	39916800
XII	479001600
XIII	6127010800
XIV	87178120000
XV	1307674368000
XVI	20922789888000
XVII	315687418096000
XVIII	6402373705718000
XIX	12164100408811000
XX	2432901008176640000
XXI	5090948871709440000
XXII	11400072777607480000



*abcd*  
*abdc*  
*acbd*  
*acdb*  
*adbc*  
*adcb*  
...

*Varietas, seu Combinatio quatuor notarum.*

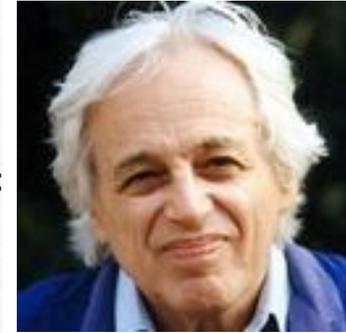
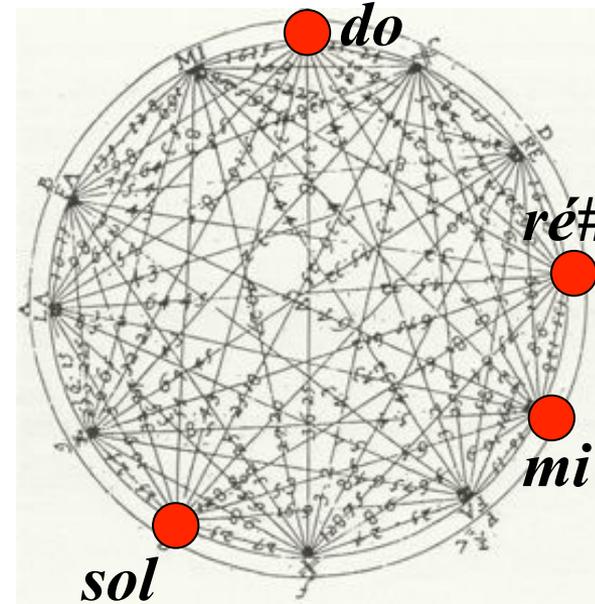
# Mersenne et la naissance de la combinatoire musicale

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

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Tabula Combinationis ab 1 ad 22.

I	1
II	2
III	6
IV	24
V	110
VI	710
VII	5040
VIII	40310
IX	361880
X	3618800
XI	39916800
XII	479001600
XIII	6127010800
XIV	87178120000
XV	1307674368000
XVI	20922789888000
XVII	315687418096000
XVIII	6402373705718000
XIX	12164100408810000
XX	2432901008176640000
XXI	5090948871709440000
XXII	11400072777607480000



*Six Bagatelles*  
(G. Ligeti, 1953)



Varietas, seu Combinatio quatuor notarum.

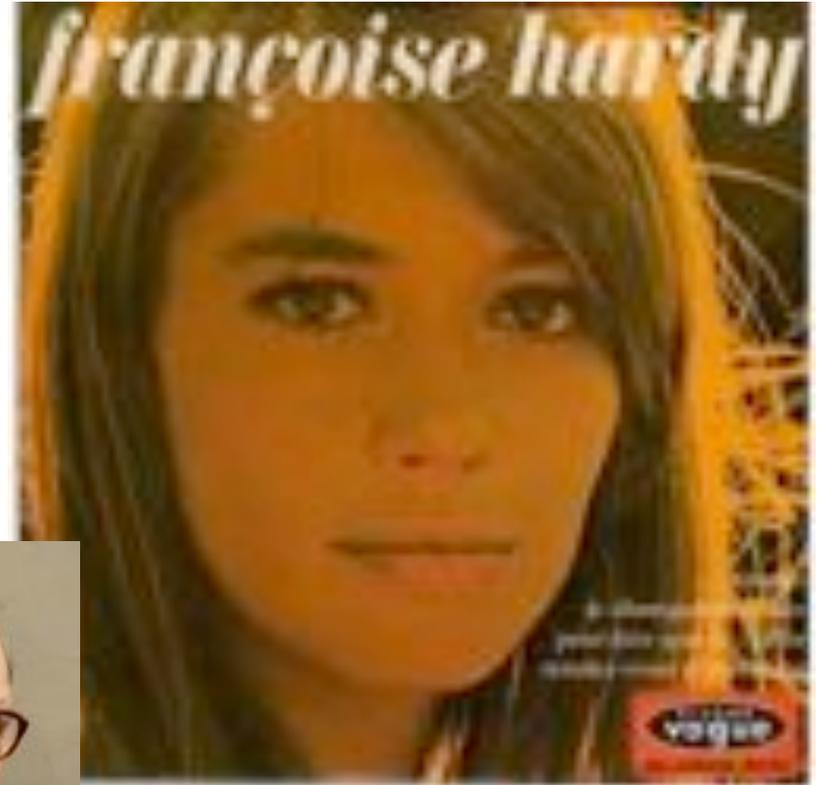
# Démarches permutationnelles en chanson

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*Se telefonando*, 1966 (Maurizio Costanzo/  
Ennio Morricone). Voix : Mina

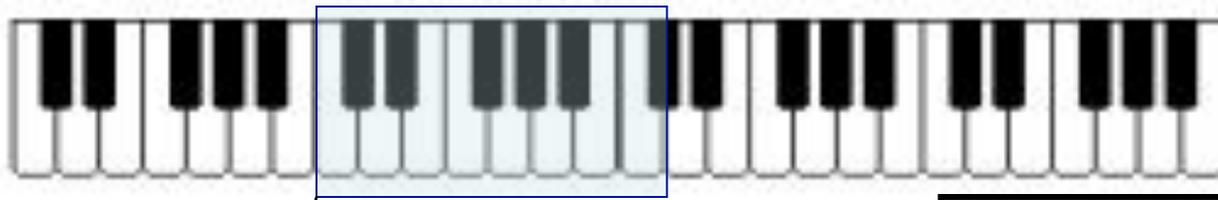


*Je changerais d'avis*, 1966 (Françoise  
Hardy/Ennio Morricone)



**Ennio Morricone**

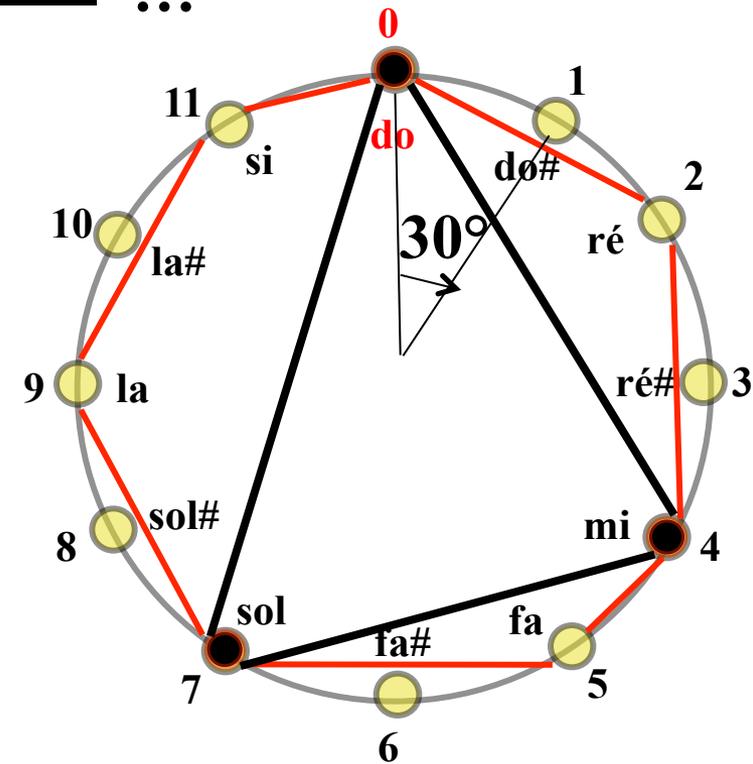
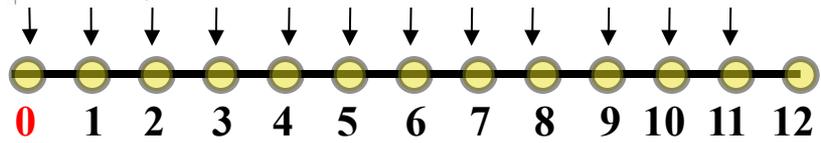
# Les transpositions sont des additions...



$$\text{Do maj} = \{0, 2, 4, 5, 7, 9, 11\} + 1$$

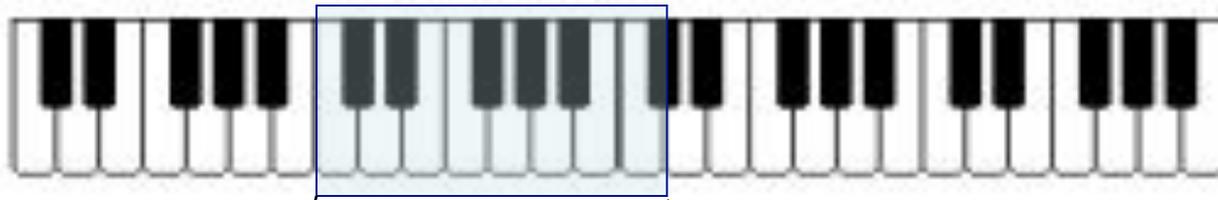


do do# ré ré# mi fa fa# sol sol# la la# si do



... ou des rotations !

# Les transpositions sont des additions...

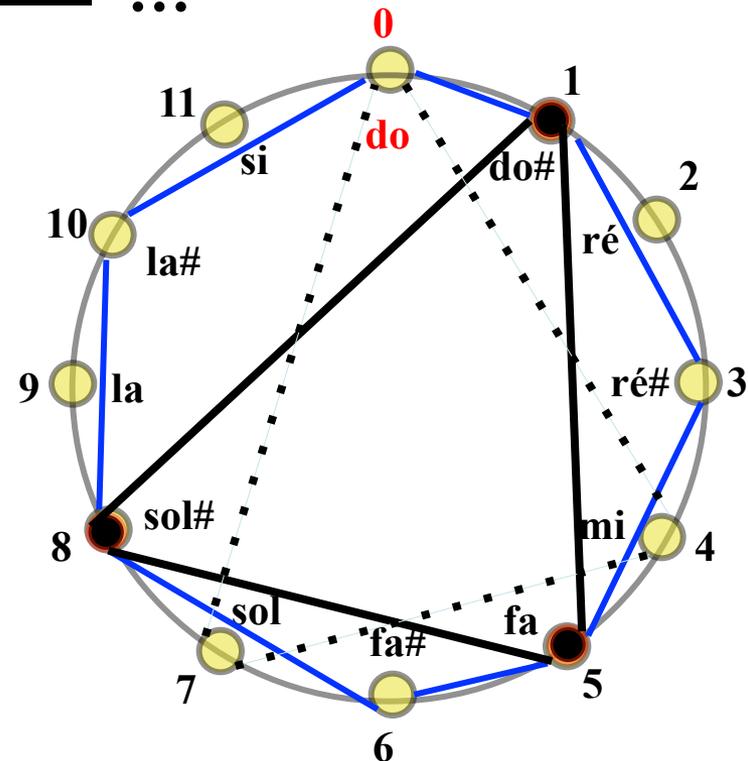


$$Do\# \text{ maj} = \{1, 3, 5, 6, 8, 10, 0\}$$

... do do# ré ré# mi fa fa# sol sol# la la# si do ...



0 1 2 3 4 5 6 7 8 9 10 11 12

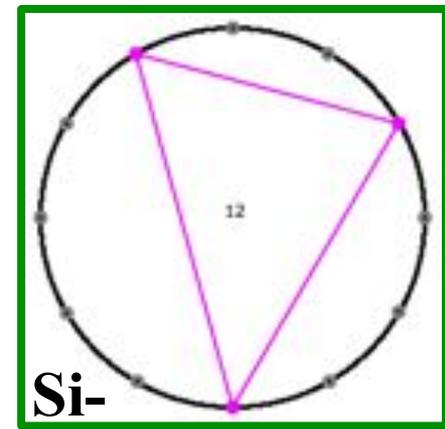
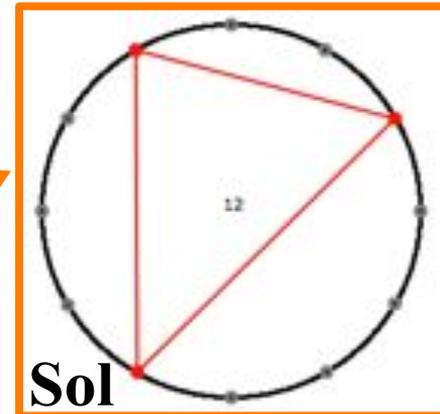


... ou des rotations !



**ACCORDS MAJEURS**

**ACCORDS MINEURS**



**MAGIC IN THE AIR**

**Sol**

**Ré**  
**Si-**

Feel the magic in the air, Allez, allez, allez  
**La**  
 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

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

**Sol**  
 Feel the magic in the air ...

	<b>Fa</b>		<b>Fa-</b>
<b>Do</b>	<b>Sol</b>	<b>Do-</b>	<b>Sol-</b>
<b>Re</b>	<b>La</b>	<b>Re-</b>	<b>La-</b>
<b>Mi</b>	<b>Si</b>	<b>Mi-</b>	<b>Si-</b>



**ACCORDS MAJEURS**

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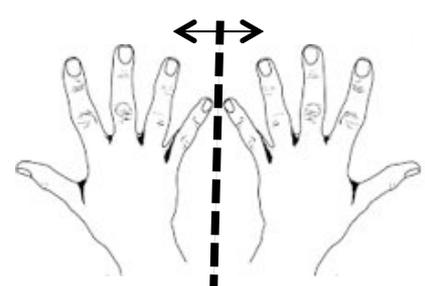
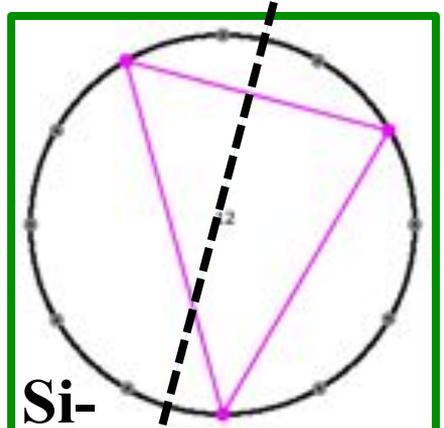
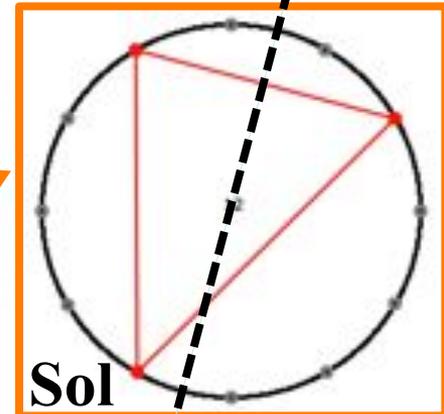
**La** **Si-**  
 Oublie tes soucis Viens faire la folie

**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 ...

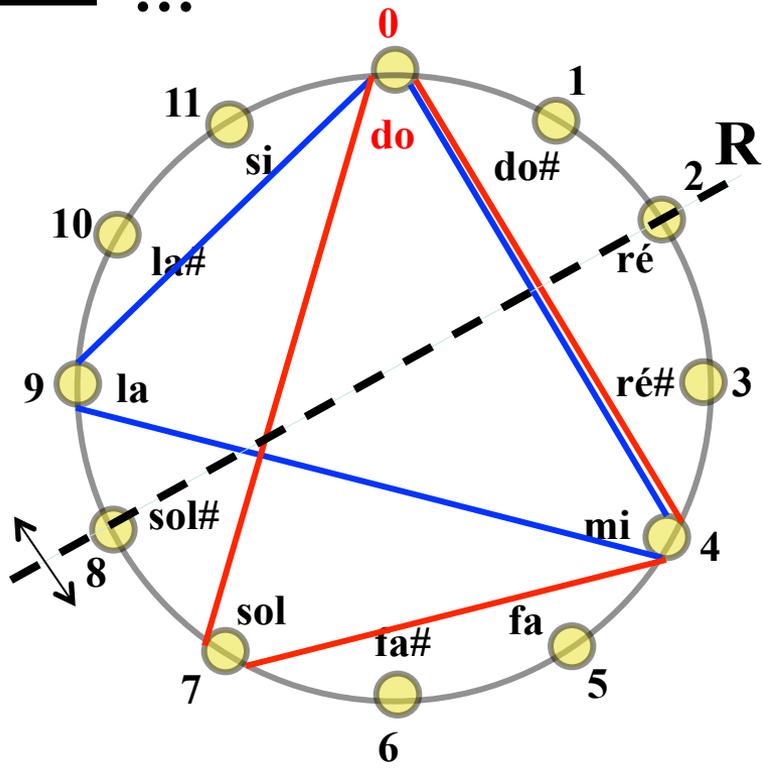
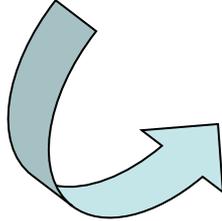
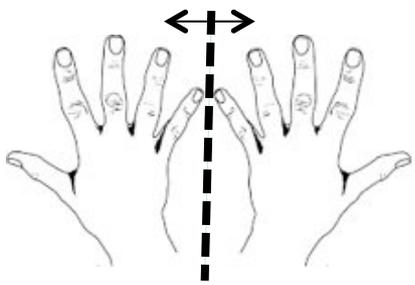
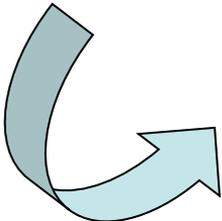
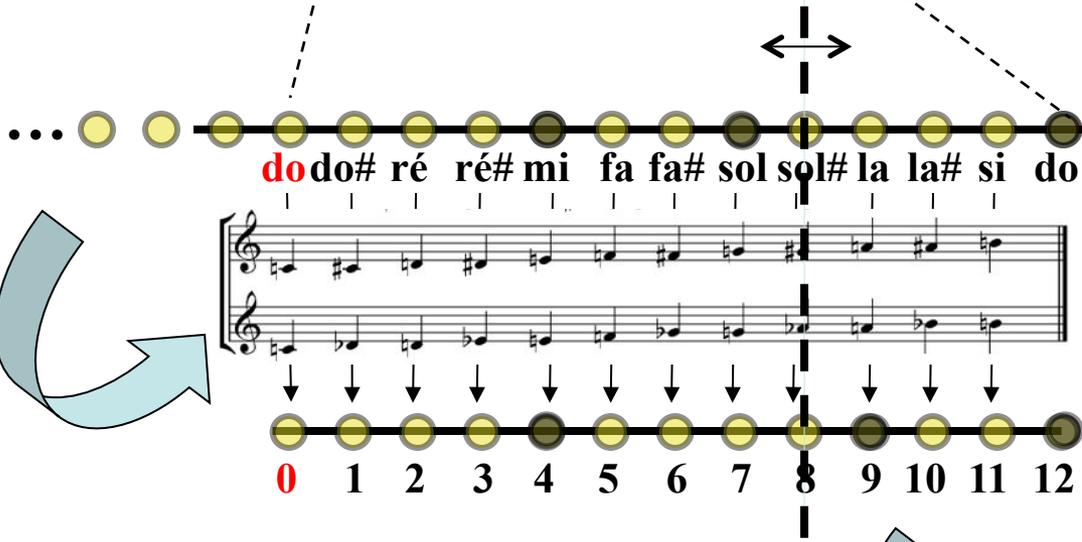
	<b>Fa</b>		<b>Fa-</b>
<b>Do</b>	<b>Sol</b>	<b>Do-</b>	<b>Sol-</b>
<b>Re</b>	<b>La</b>	<b>Re-</b>	<b>La-</b>
<b>Mi</b>	<b>Si</b>	<b>Mi-</b>	<b>Si-</b>



# Les inversions sont des symétries axiales



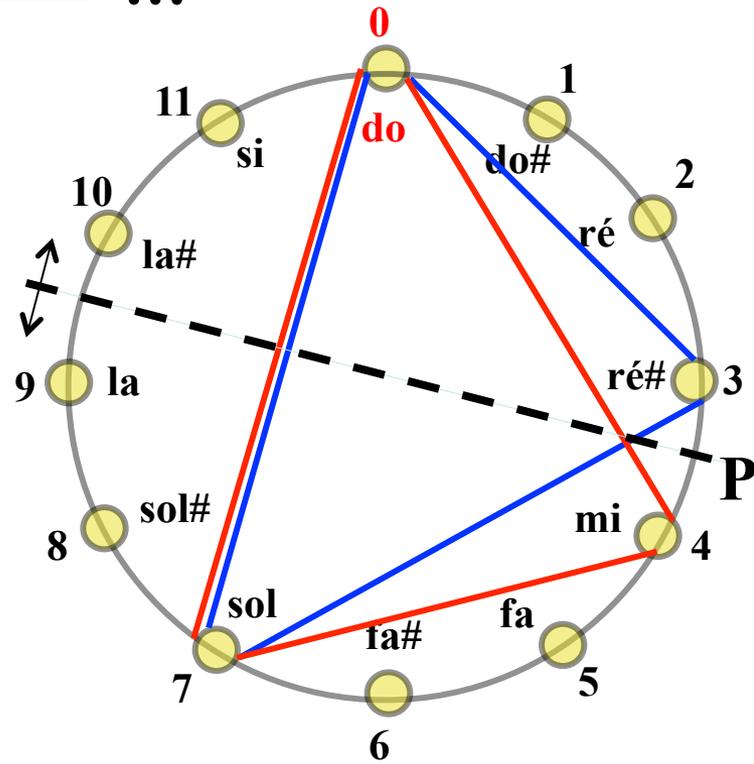
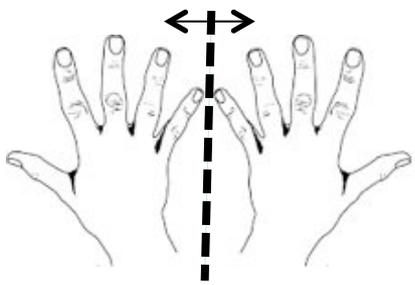
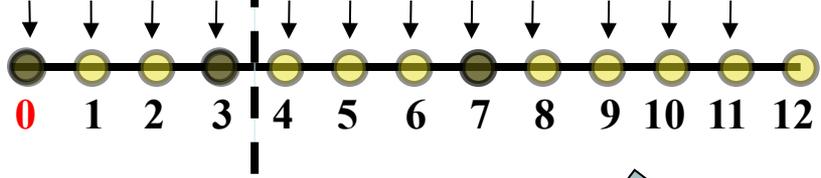
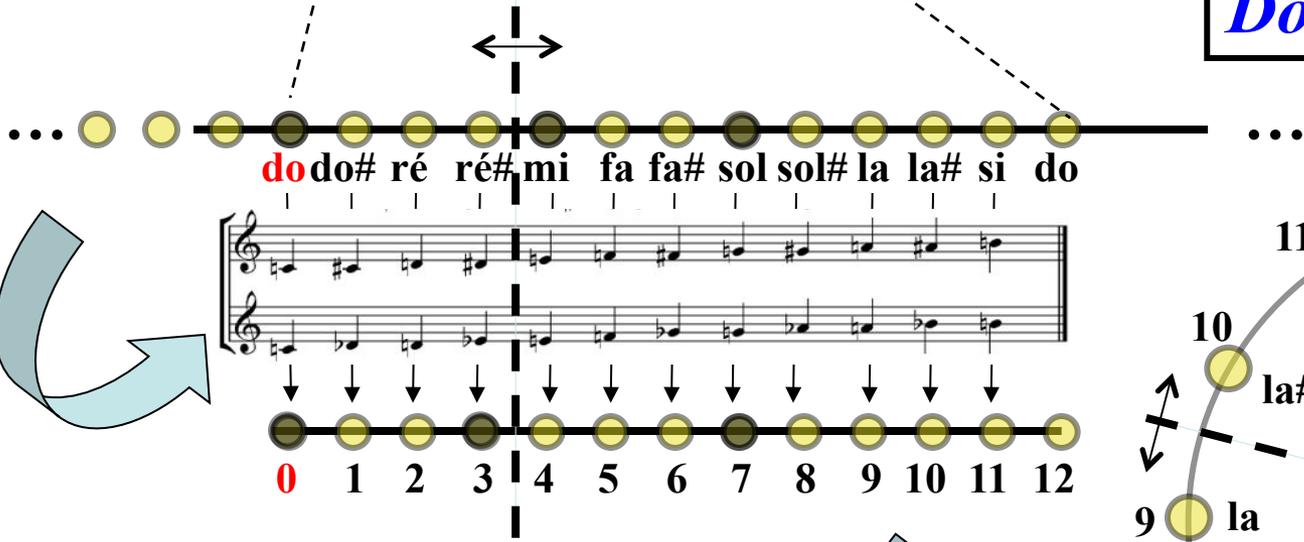
*Do maj* = {0,4,7}  
*La min* = {0,4,9}



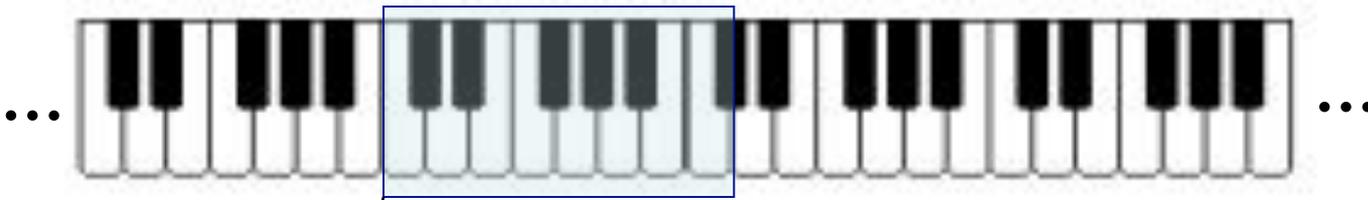
# Les inversions sont des symétries axiales



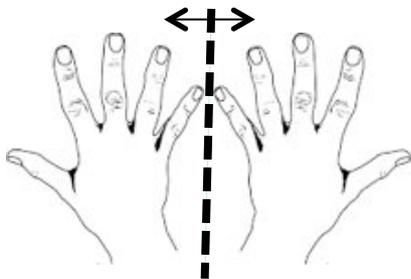
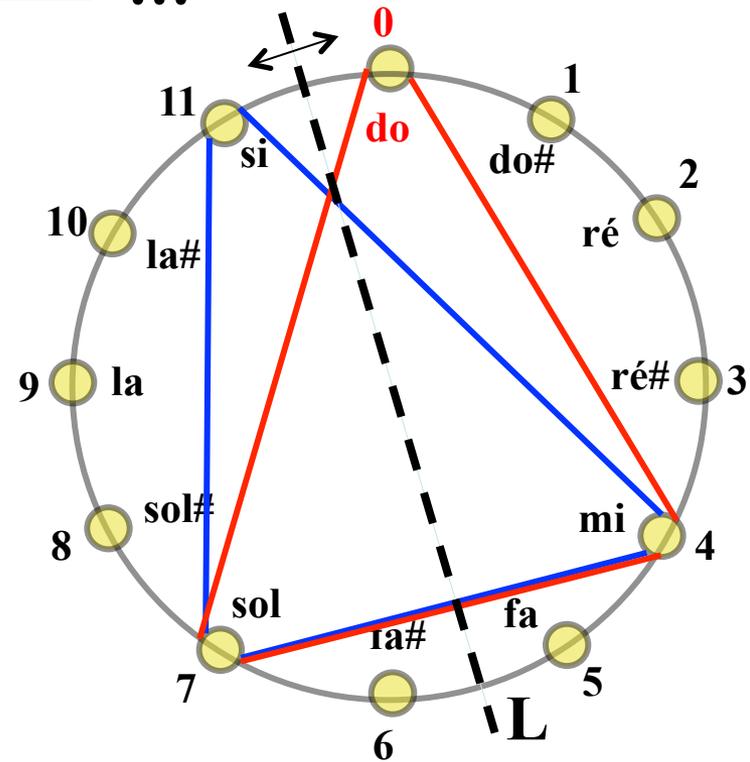
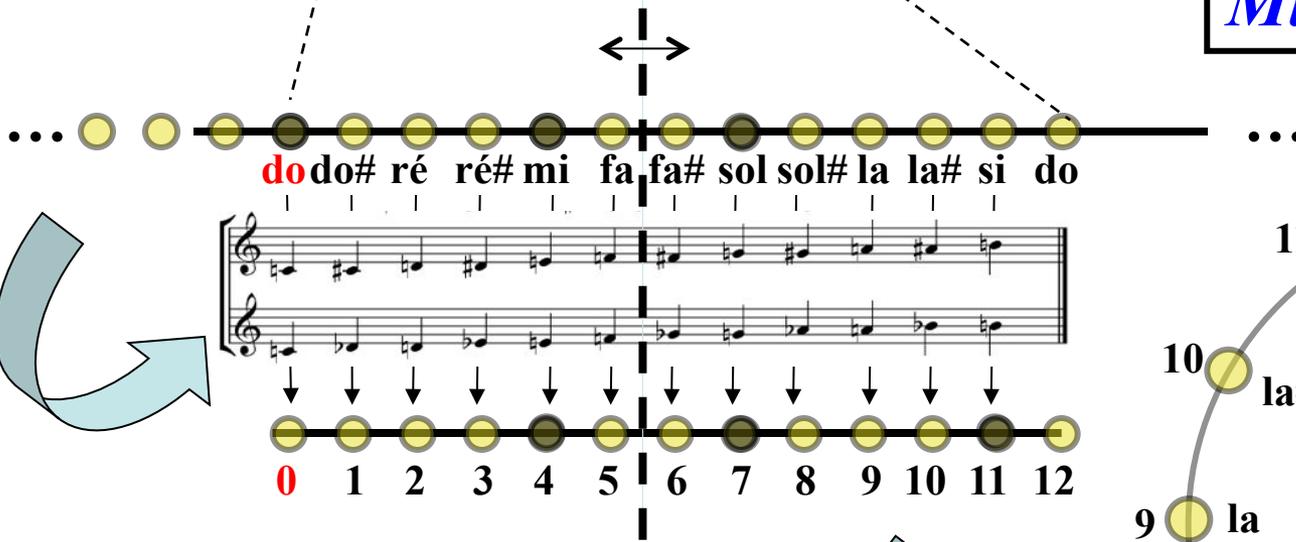
**Do maj** = {0,4,7}  
**Do min** = {0,3,7}



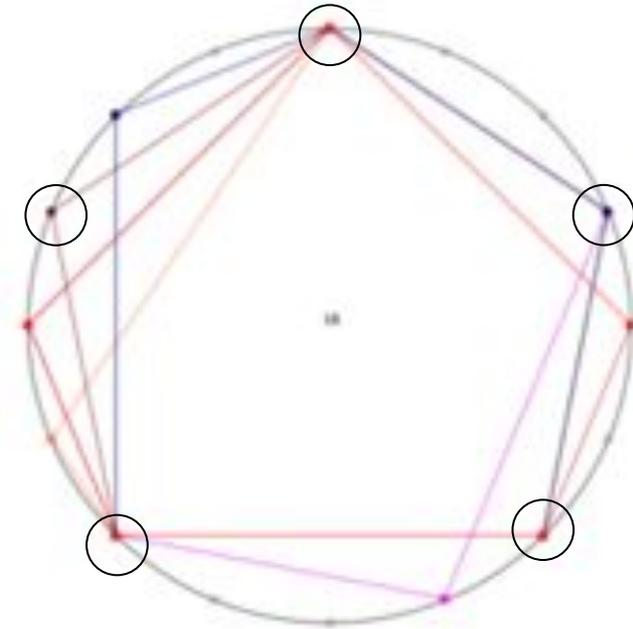
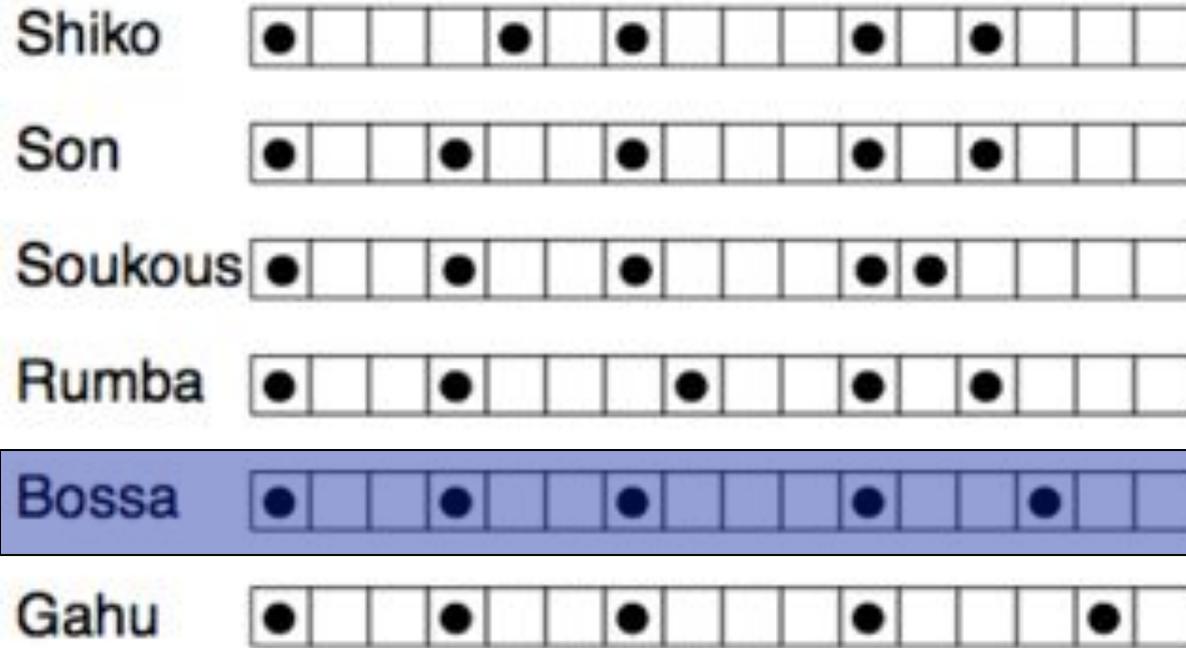
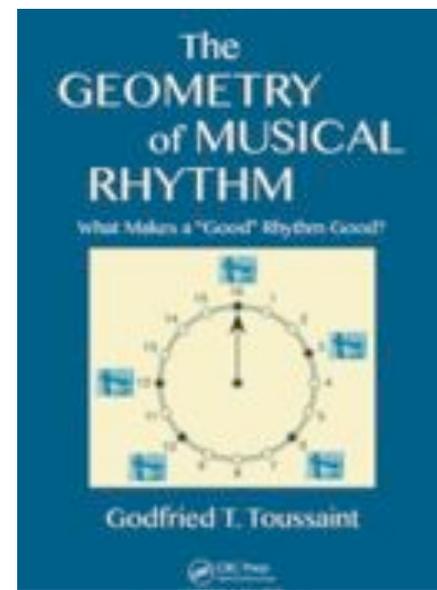
# Les inversions sont des symétries axiales



**Do maj** = {0,4,7}  
**Mi min** = {4,7,11}



# La géométrie du rythme musical



→ Quel est le rythme le plus régulier ?



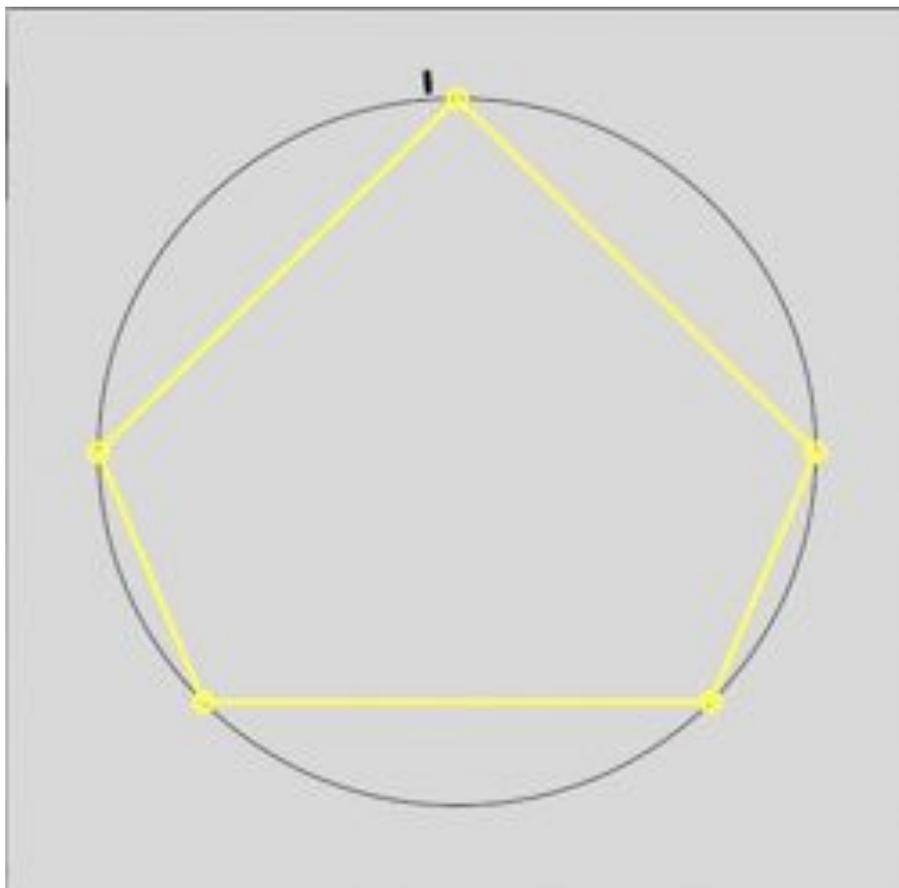
Mercredi 27.01.16 - HEMU - *Les rythmes non-euclidiens*

Par Malcom Braff (CH) / Salle BCV concert Hall

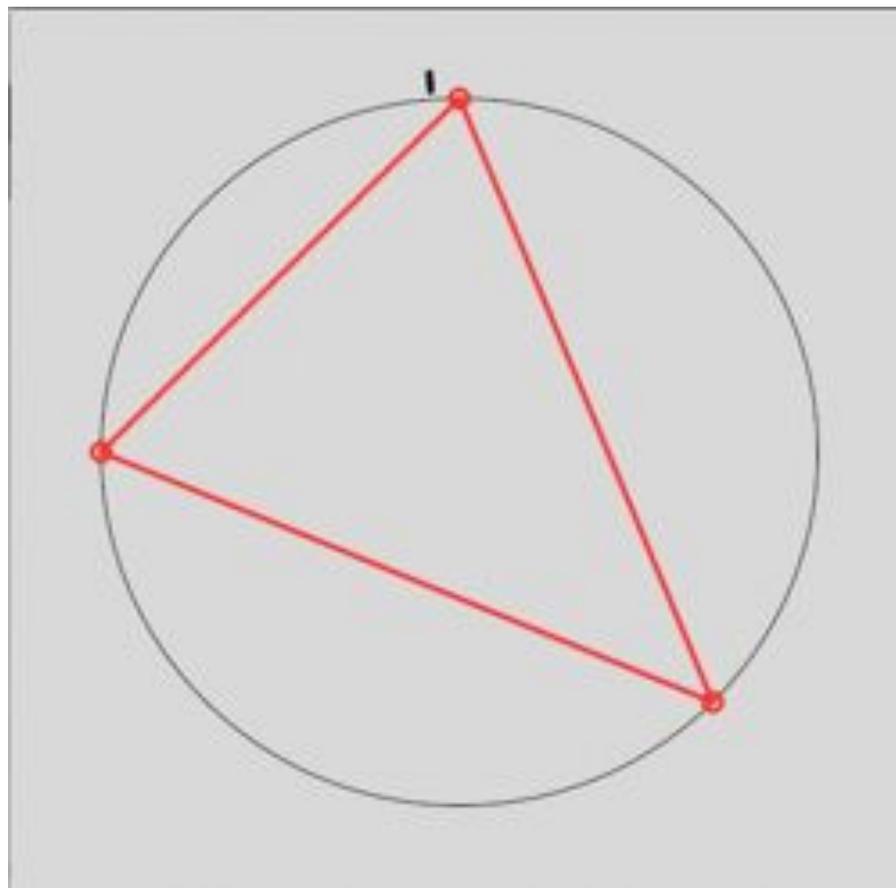
10h-12h30 / 13h30-16h

# Rythmes afro-cubains

## *El cinquillo*



## *El trecillo*



# Le « cercle rythmique » et ses rotations

## CLAPPING MUSIC

FOR TWO PERFORMERS

① J. 1114-168

CLAP 1  
CLAP 2

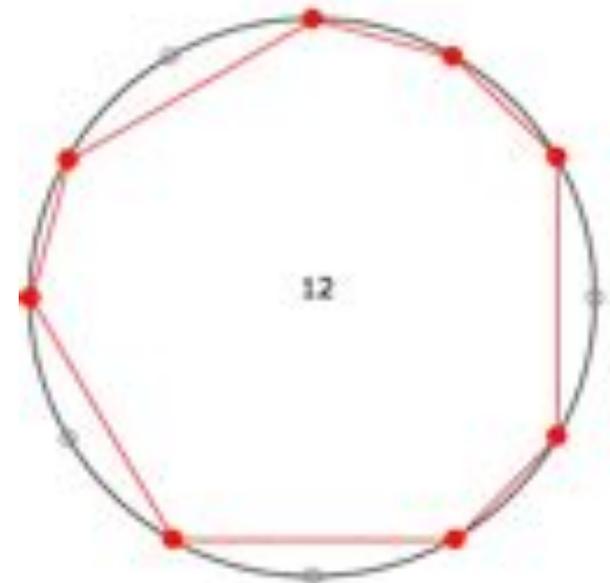
Repeat back ①, then end

The performers begin and end with both performers in unison at bar ①. The number of repeats of each bar should be fixed at twelve repeats per bar. Since the first performer's part does not change, it is up to the second performer to move from one bar to the next. The second performer should try to keep his or her clapping where it is written, i.e. on the first beat of each measure (not on the first beat of the group of four claps), so that his clapping always falls on a new beat of the bar's underlying pattern.

The choice of a particular clapping sound, i.e. with cupped or flat hands is left up to the performers, whichever sound is chosen, both performers should try to get the same one so that their two parts will blend to produce one overall rhythmic pattern.

**Clapping Music de Steve Reich (1972)**

Steve Reich 11/72  
revised 1/77



# Le « cercle rythmique » et ses rotations

## CLAPPING MUSIC

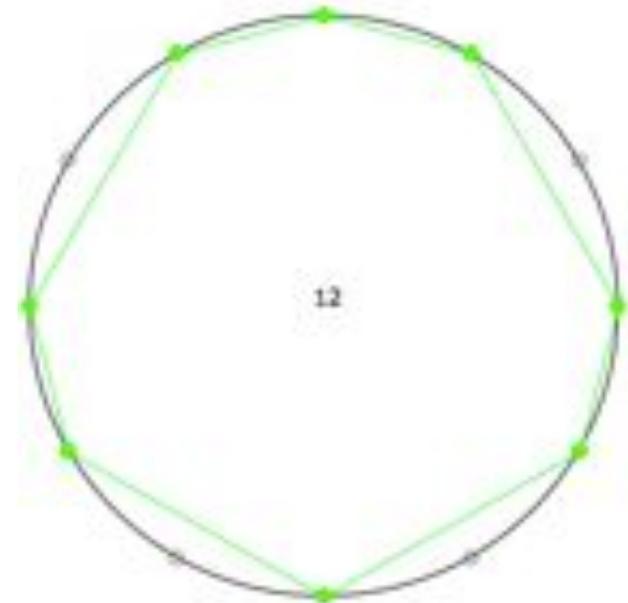
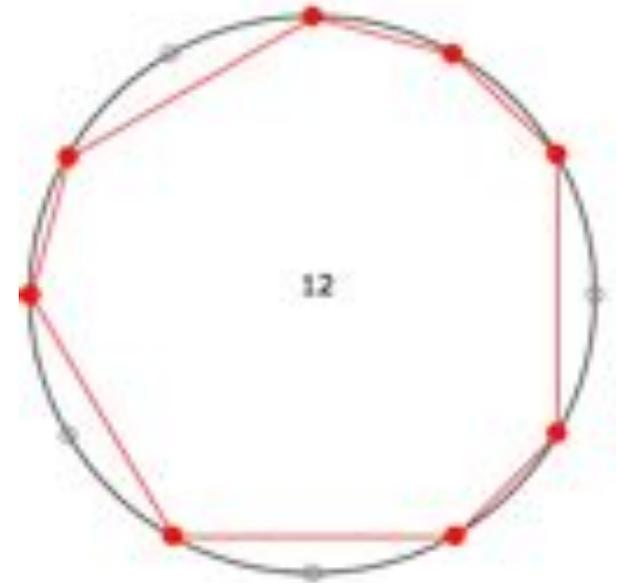
FOR TWO PERFORMERS

Handwritten musical notation for two clappers, labeled CLAP 1 and CLAP 2. The notation consists of rhythmic patterns on a staff. A red box highlights the first measure of CLAP 1, and a green box highlights the first measure of CLAP 2. The notation is numbered 1 through 12. The text "Repeat bar 12, then end" is written at the bottom right of the notation.

The performers begin and end with both performers in unison at bar ①. The number of repeats of each bar should be fixed at twelve repeats per bar. Since the first performer's part does not change, it is up to the second performer to move from one bar to the next. The second performer should try to keep his or her clapping where it is written, i.e. on the first beat of each measure (not on the first beat of the group of three claps), so that his clapping always falls on a new beat of his or her underlying pattern.

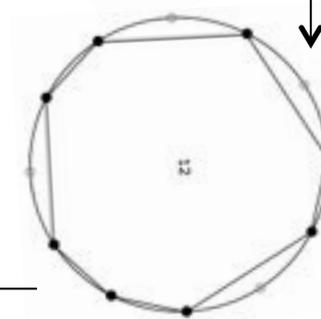
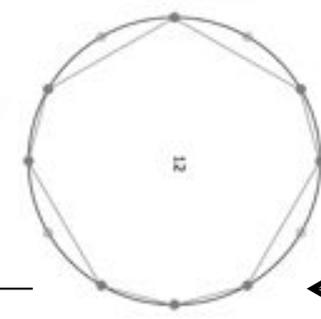
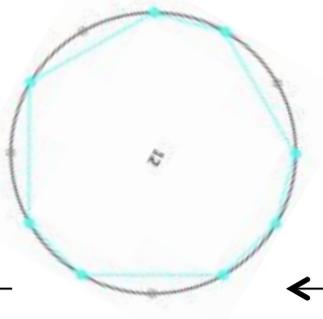
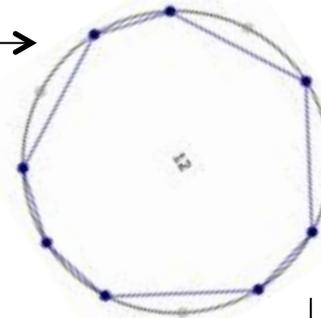
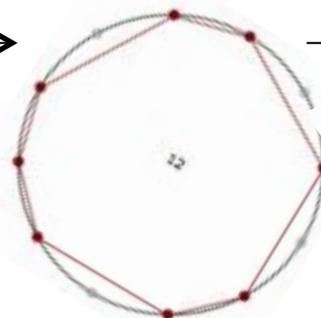
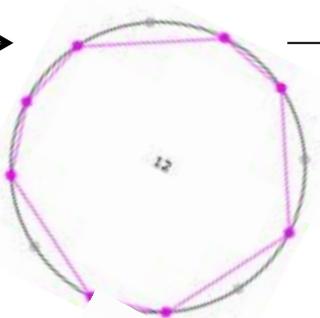
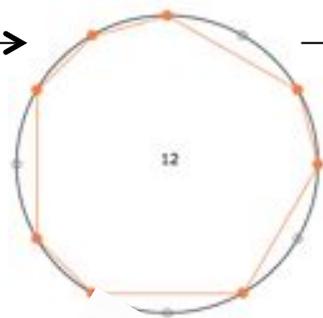
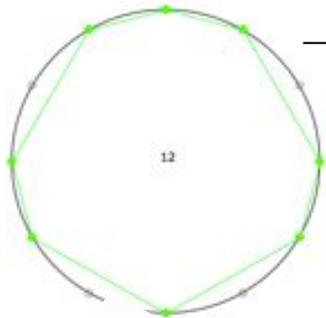
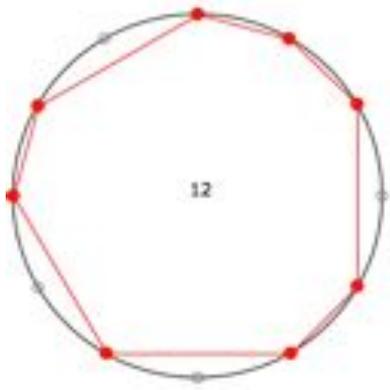
The choice of a particular clapping sound, i.e. with cupped or flat hands is left up to the performers, whichever sound is chosen, both performers should try to get the same one so that their two parts will blend to produce one exact sounding pattern.

Howarth 12/72  
revised 1/77



# Le « cercle rythmique » et ses rotations

Handwritten musical notation for two claps, labeled CLAP 1 and CLAP 2. The notation is organized into three columns, each with a red box above it. The first column is also highlighted with a green box below it. The notation consists of rhythmic patterns on a staff, with some notes circled in red. The text "J: 105-148" is visible at the top left of the notation.



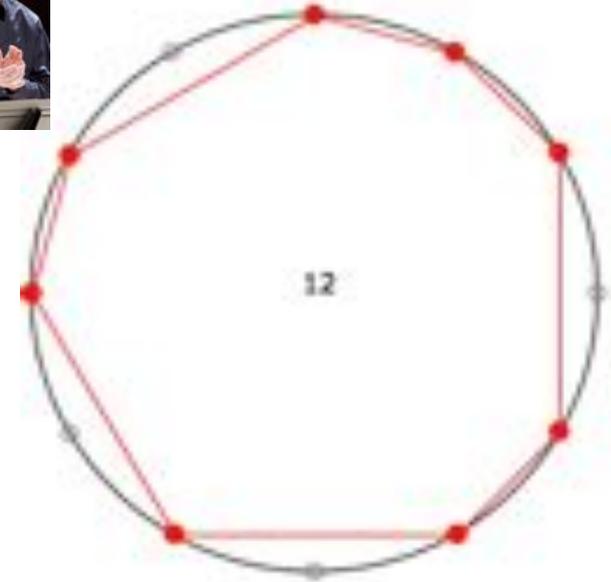
# Le « cercle rythmique » et ses rotations

## CLAPPING MUSIC

FOR TWO PERFORMERS



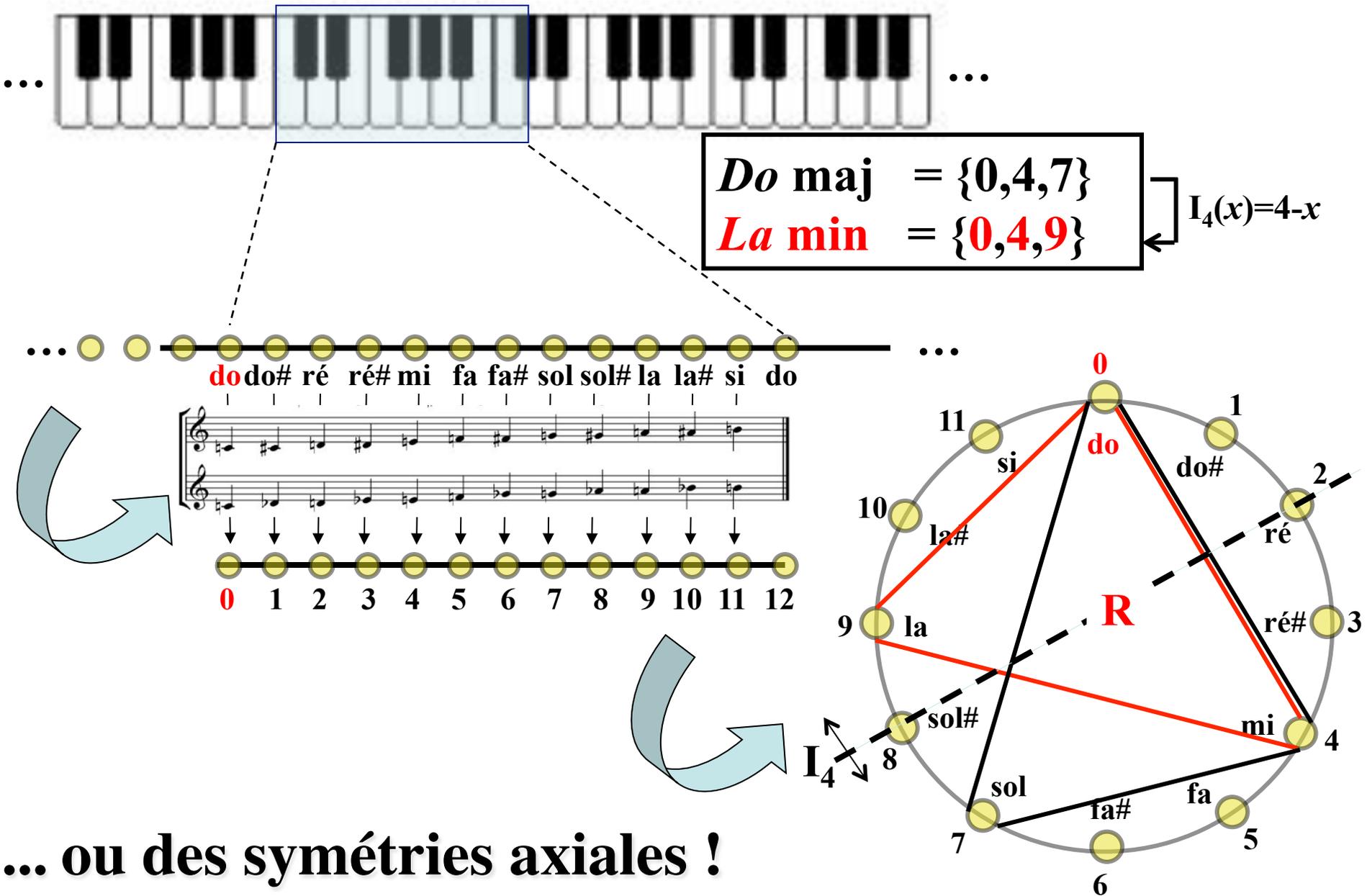
Handwritten musical score for two performers, labeled "CLAP 1" and "CLAP 2". The score consists of three systems of two staves each. The first system is highlighted with colored boxes: a red box around the first measure, a green box around the second measure, and an orange box around the third measure. The score includes circled measure numbers (1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12) and a circled "f" at the beginning of the first system. The text "Repeat bar 12, then end" is written at the bottom right of the score.



The performers begin and end with both performers in unison at bar ①. The number of repeats of each bar should be fixed at twelve repeats per bar. Since the first performer part does not change, it is up to the second performer to move from one bar to the next. The second performer should try to keep his or her downbeat where it is written, i.e. on the first beat of each measure (not on the first beat of the group of three claps), so that his or her downbeat always falls on a new beat of the bar's underlying pattern.

The choice of a particular clapping sound, i.e. with cupped or flat hands is left up to the performers, whichever sound is chosen, both performers should try to get the same one so that their two parts will blend to produce one overall sounding pattern.

# Les inversions sont des soustractions...



# Les inversions sont des soustractions...

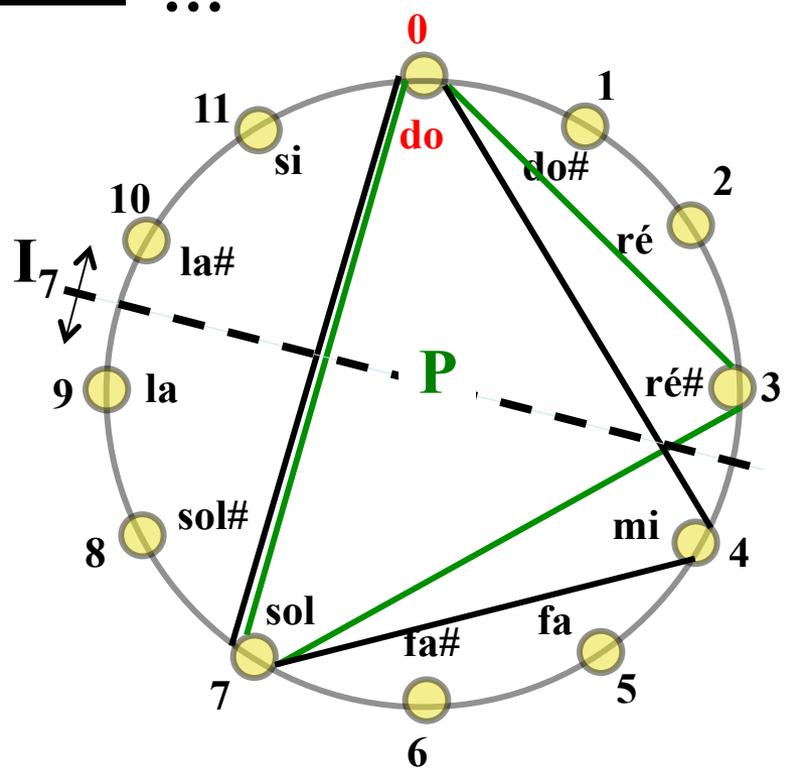
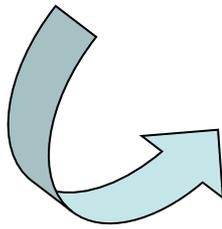
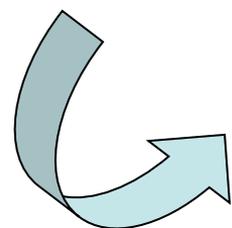
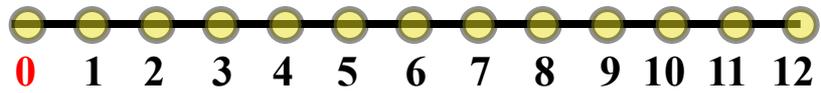


*Do* maj = {0,4,7}  
*Do* min = {0,3,7}

$I_7(x) = 7 - x$



do do# ré ré# mi fa fa# sol sol# la la# si do



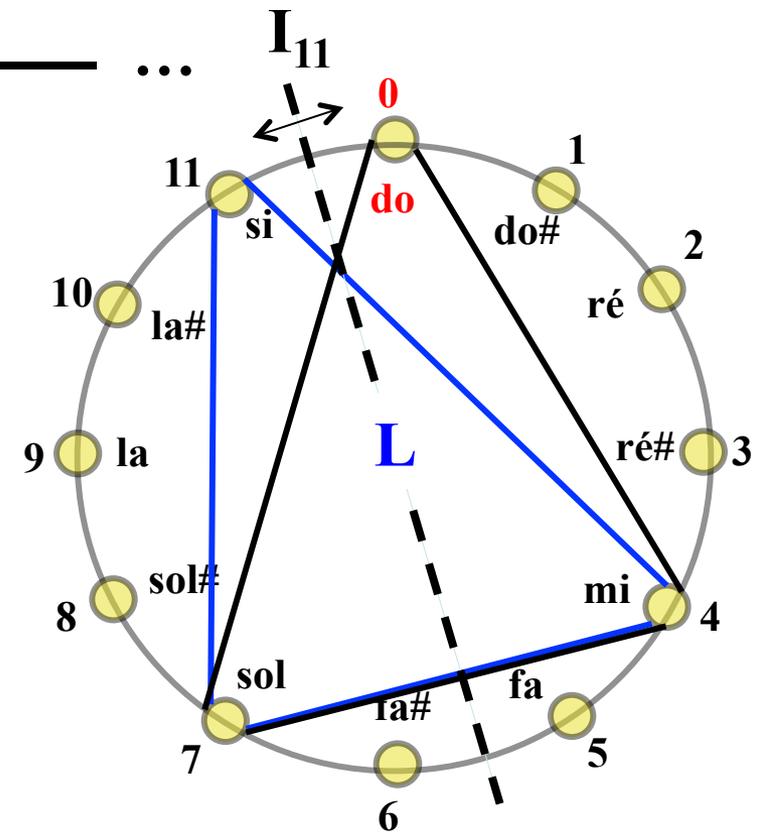
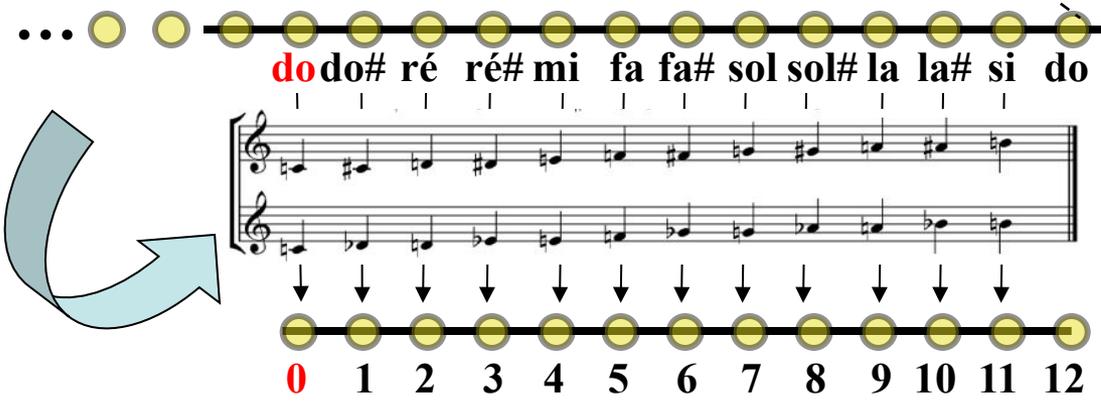
... ou des symétries axiales !

# Les inversions sont des soustractions...



*Do* maj = {0,4,7}  
*Mi* min = {4,7,11}

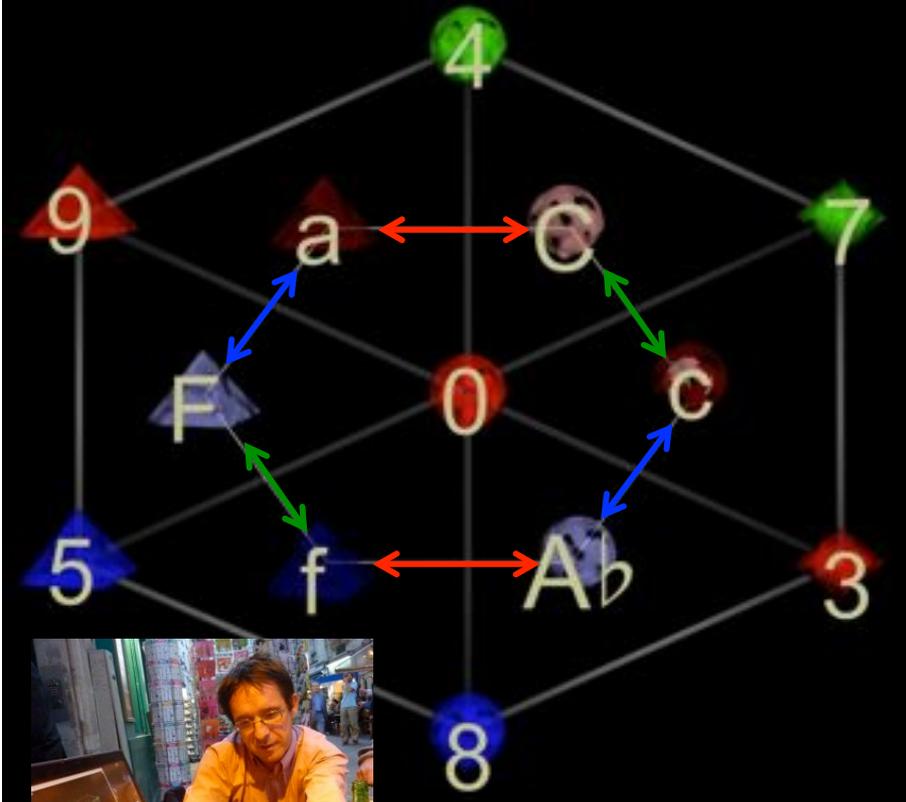
$I_{11}(x) = 11 - x$



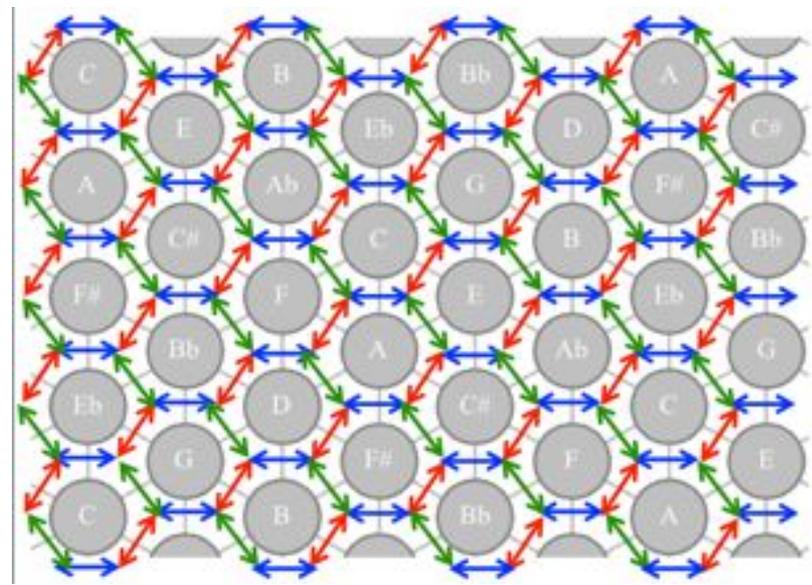
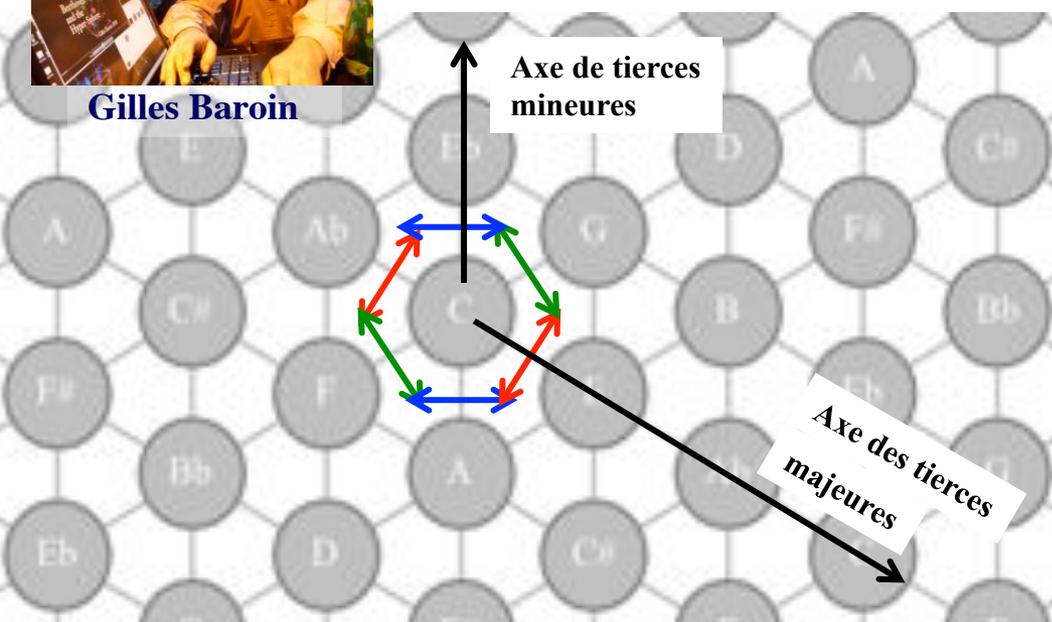
... ou des symétries axiales !



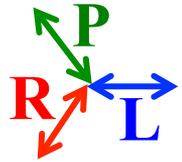
# Le Tonnetz... ...un jeu d'enfants !



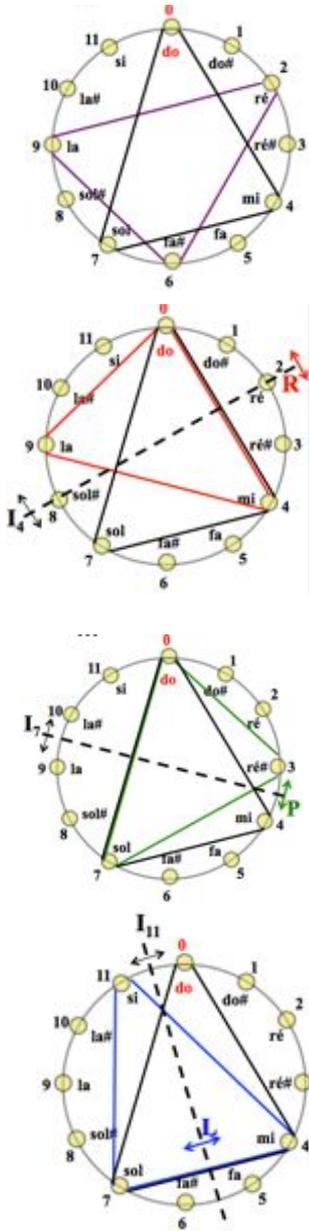
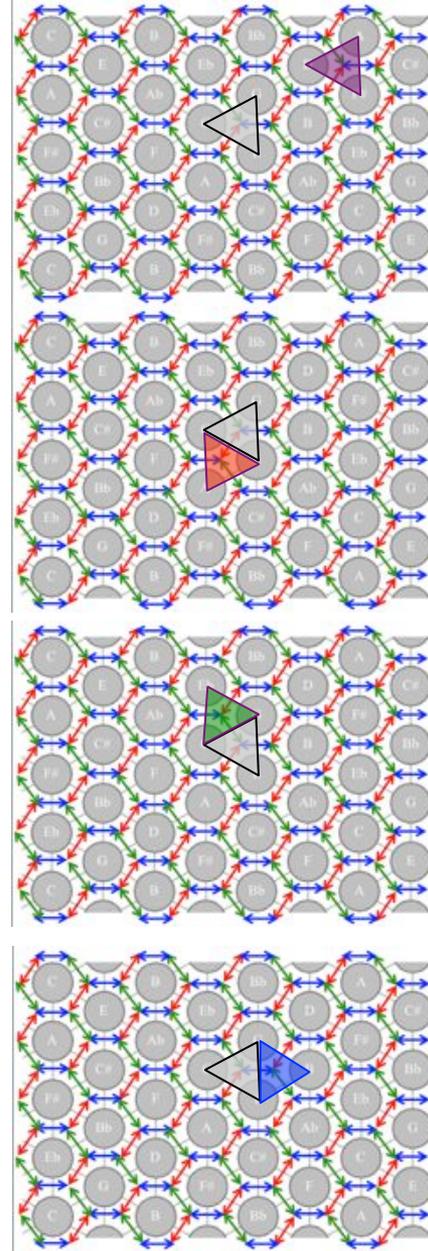
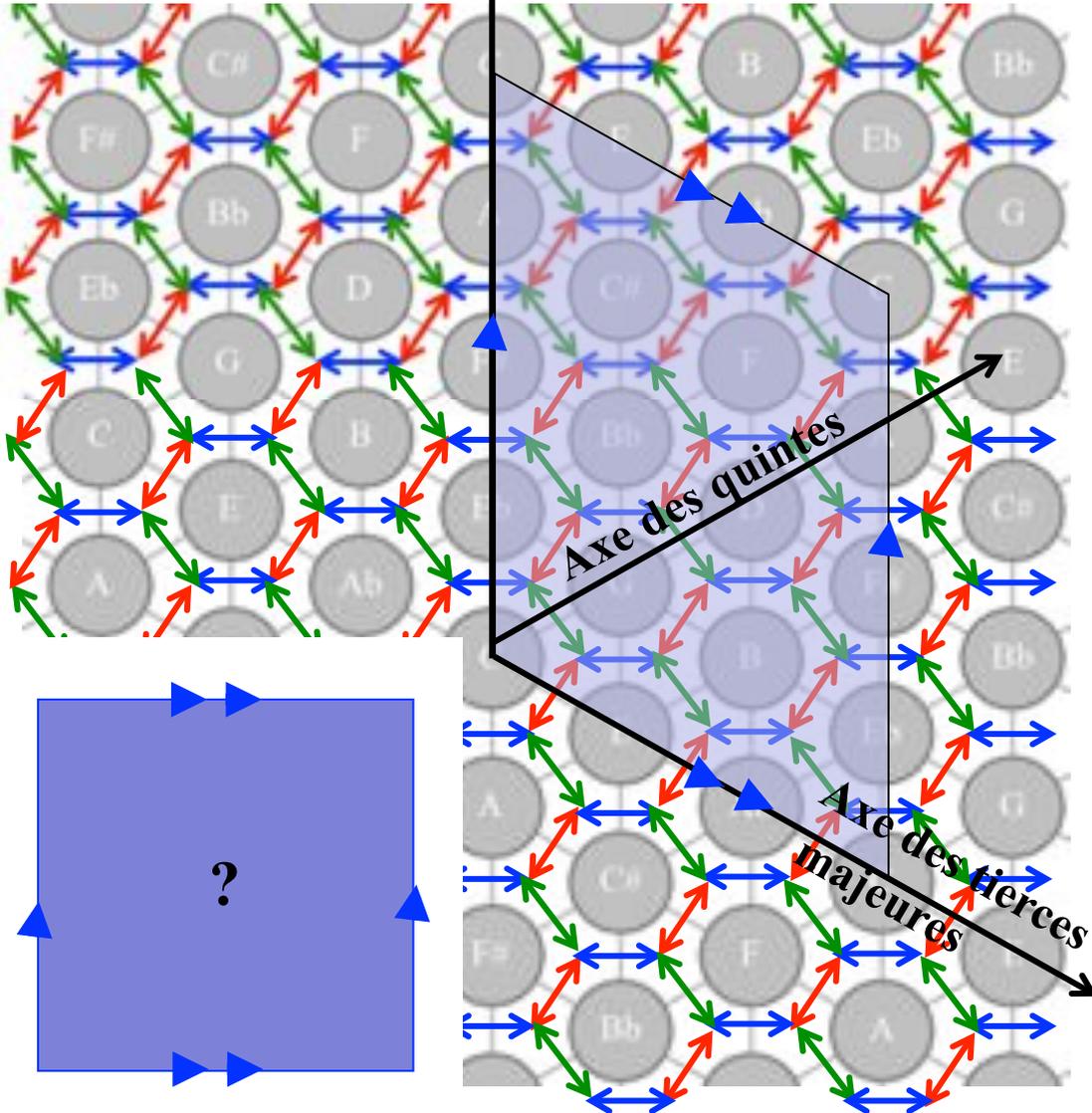
Gilles Baroin



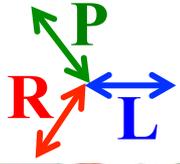
# Le Tonnetz et ses symétries



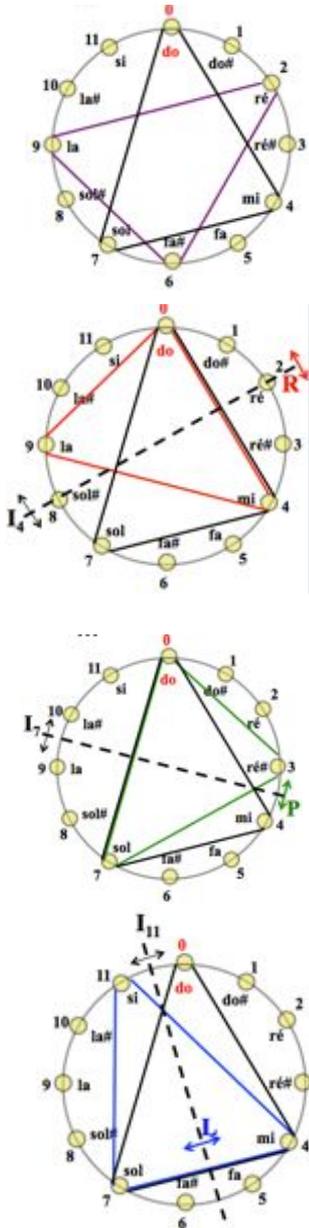
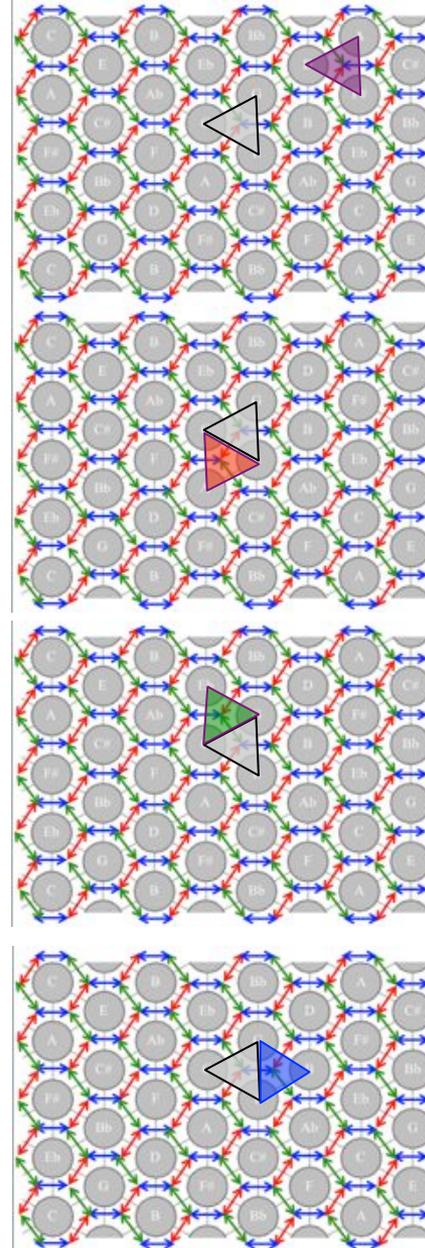
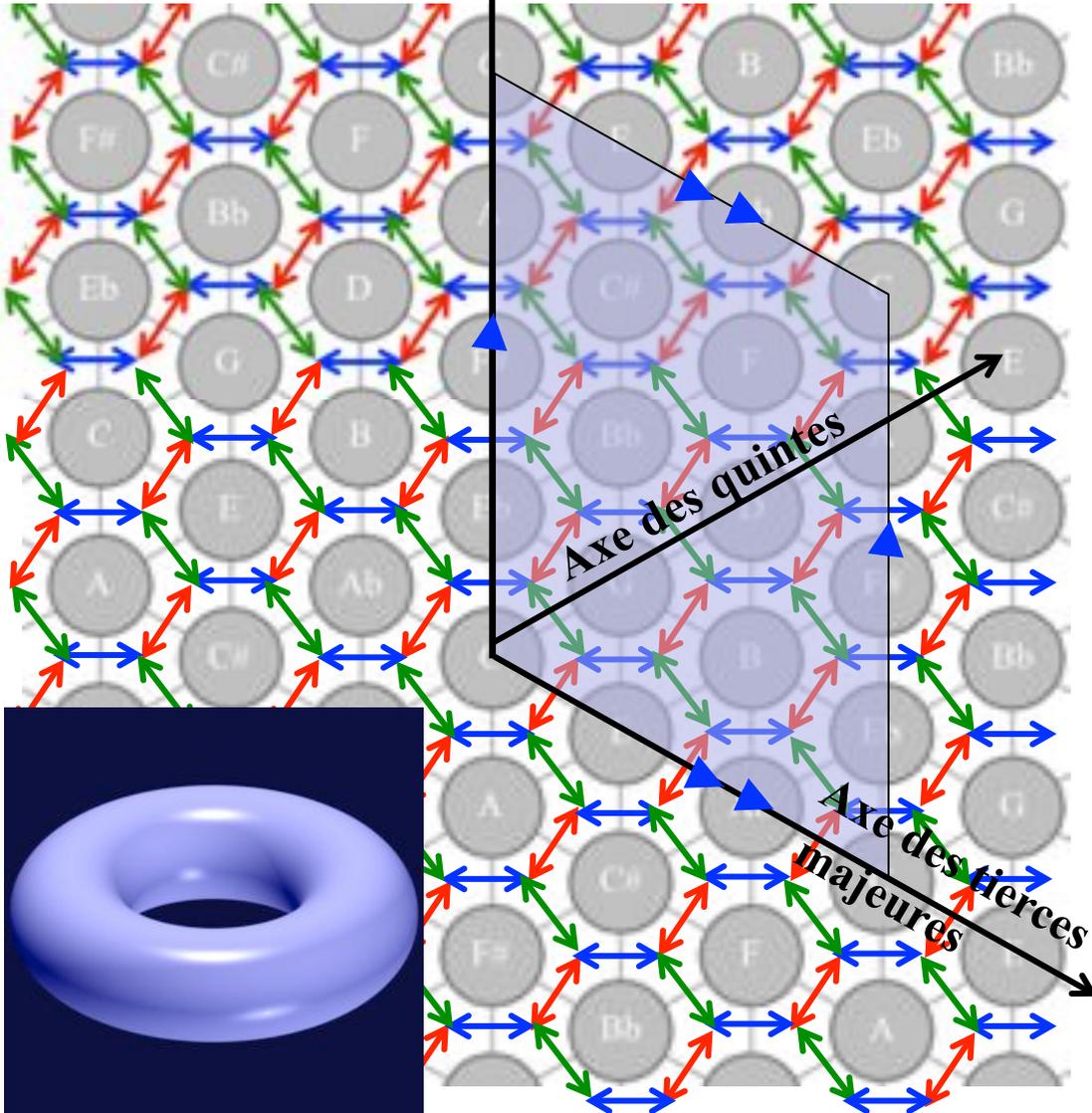
Axe de tierces mineures



# Le Tonnetz et ses symétries



Axe de tierces mineures



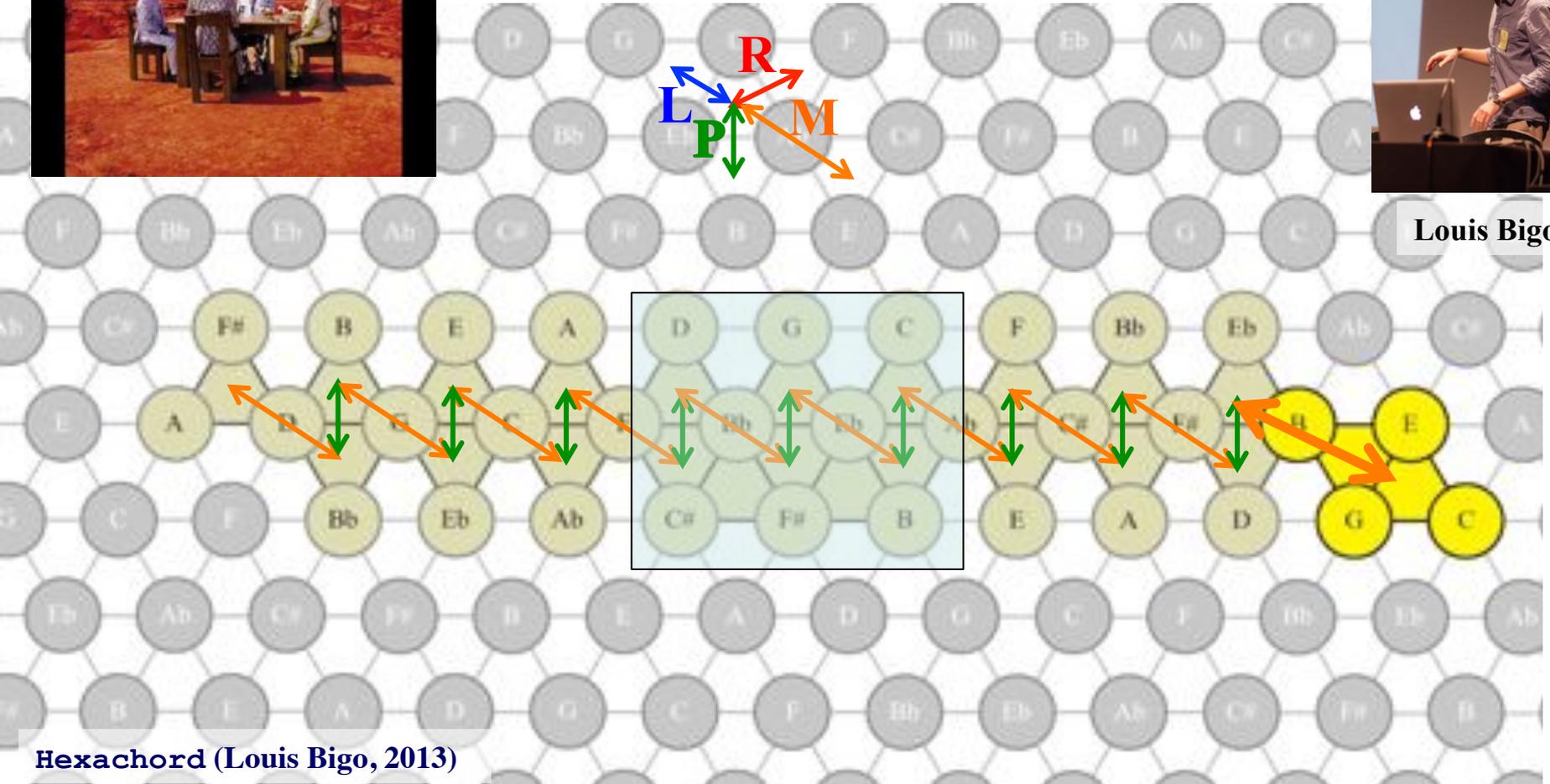
# Symétries et procédés algorithmiques chez *Muse*



« Take a bow » (*Black Holes and Revelations*, 2006)



Louis Bigo



Hexachord (Louis Bigo, 2013)

→  
temps (logique)



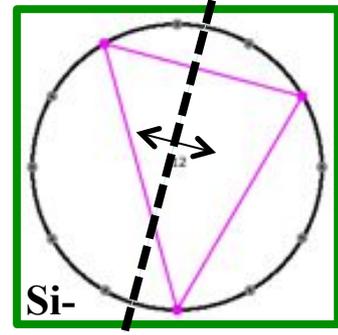
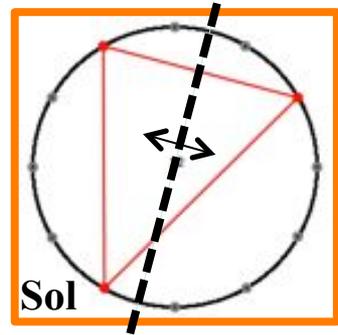
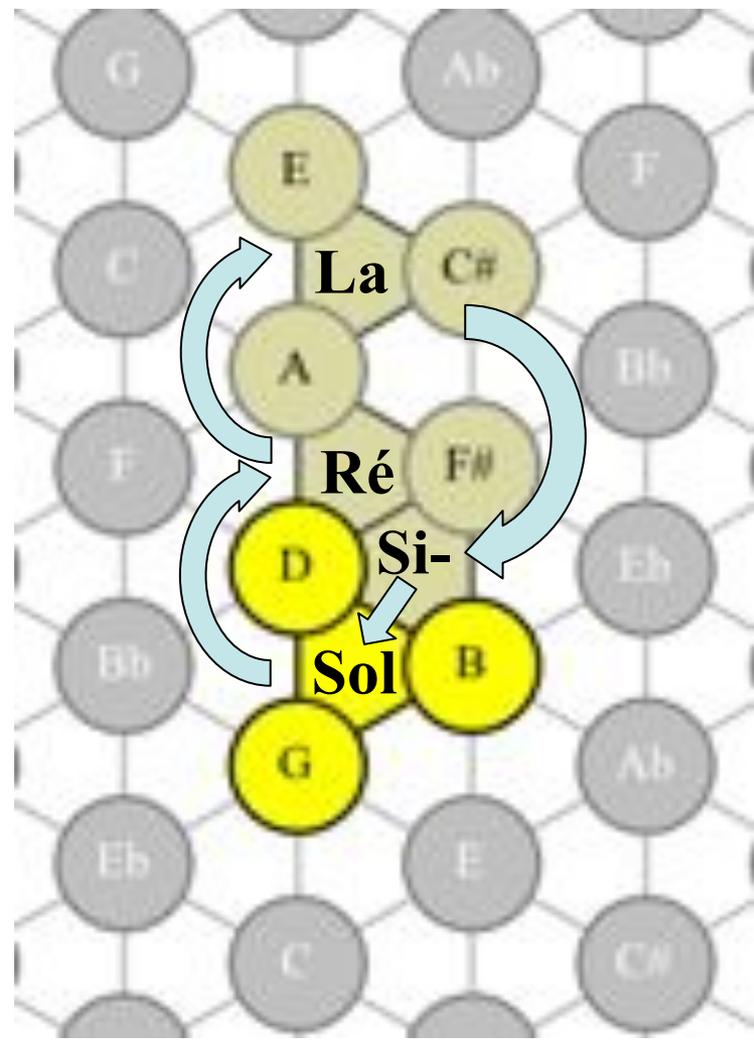
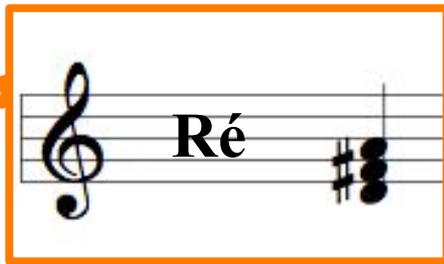
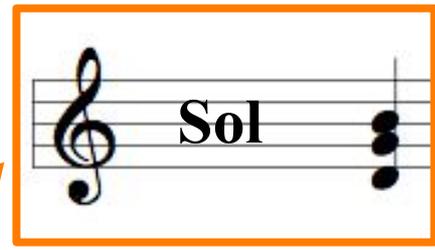
**MAGIC IN THE AIR**

**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 ...







# Harmonies géométriques dans « Madeleine » (Paolo Conte)

**Prélude** *Modérato*

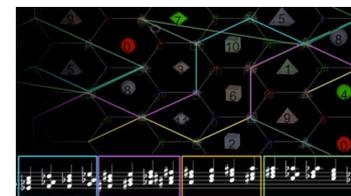
**Chorus**

Lab → Réb/Fa → Sib<sup>7</sup> → Mib<sup>7</sup>/Réb

Si/Ré# → Mi → Do# → Fa#

Ré/La → Sol → Mi<sup>7</sup> → La<sup>7</sup>

Ré → Lab<sup>7</sup> → Réb → Do<sup>7</sup> → Mib



[www.mathemusic.net](http://www.mathemusic.net)

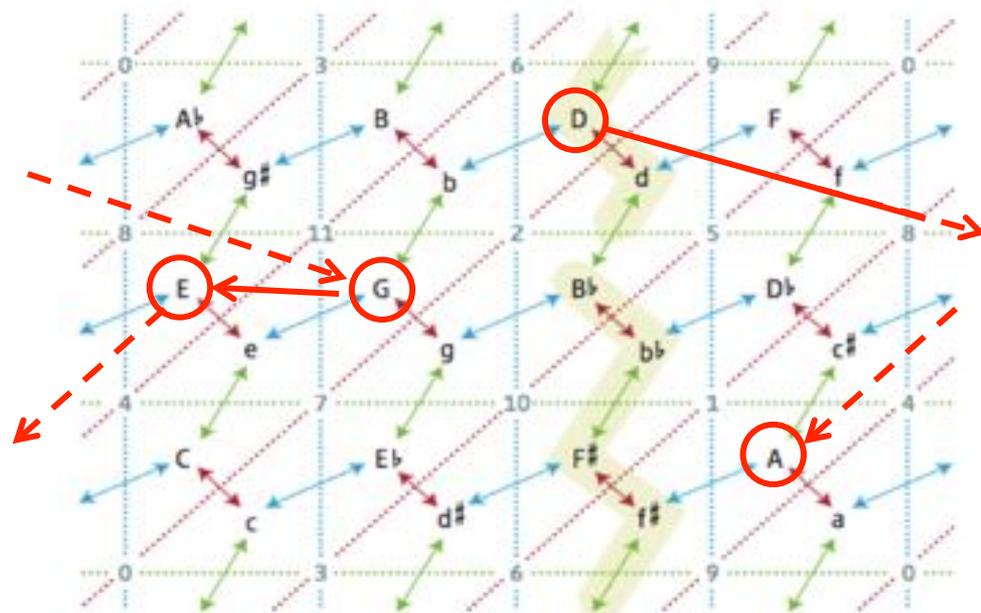
S. La Via, *Poesia per musica e musica per poesia. Dai trovatori a Paolo Conte*, Carocci, 2006

→ Lab → Réb/Fa → Sib<sup>7</sup> → Mib<sup>7</sup>/Réb

→ Si/Ré# → Mi → Do# → Fa#

→ Ré/La → Sol → Mi<sup>7</sup> → La<sup>7</sup>

→ Ré → Lab<sup>7</sup> → Réb → Do<sup>7</sup> → Mib



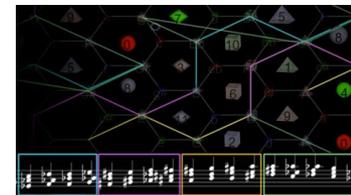
# Harmonies géométriques dans « Madeleine » (Paolo Conte)

**Principale** *Modérato*

**Chorus** *Lab* → *Réb/Fa* → *Sib<sup>7</sup>* → *Mib<sup>7</sup>/Réb*

*Sol* → *Mi* → *La<sup>7</sup>* → *Réb*

*Ré* → *Lab<sup>7</sup>* → *Réb* → *Do<sup>7</sup>* → *Mib*



[www.mathemusic.net](http://www.mathemusic.net)

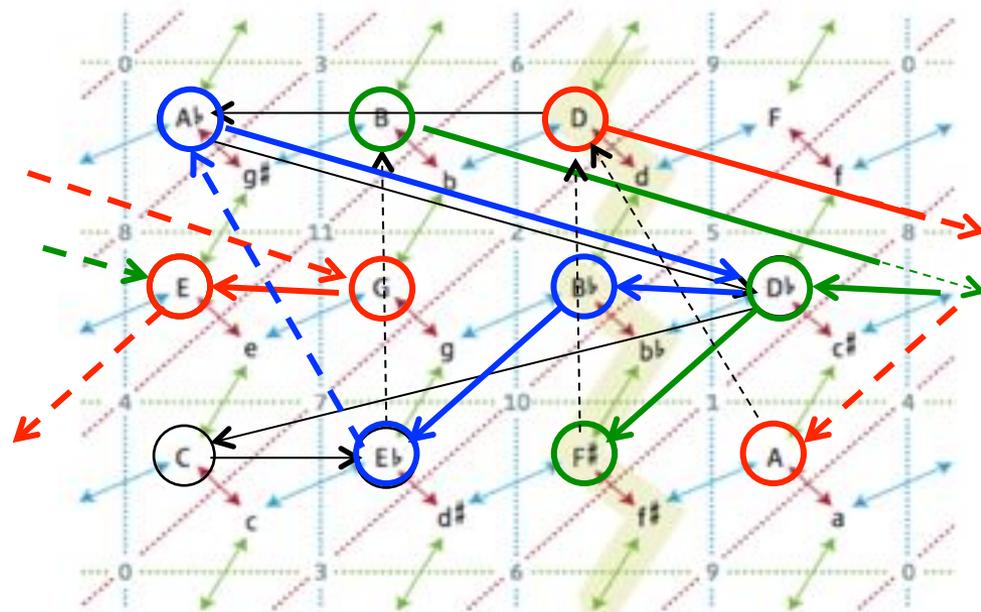
*S. La Via, Poesia per musica e musica per poesia. Dai trovatori a Paolo Conte, Carocci, 2006*

→ **Lab** → **Réb/Fa** → **Sib<sup>7</sup>** → **Mib<sup>7</sup>/Réb**

→ **Si/Ré#** → **Mi** → **Do#** → **Fa#**

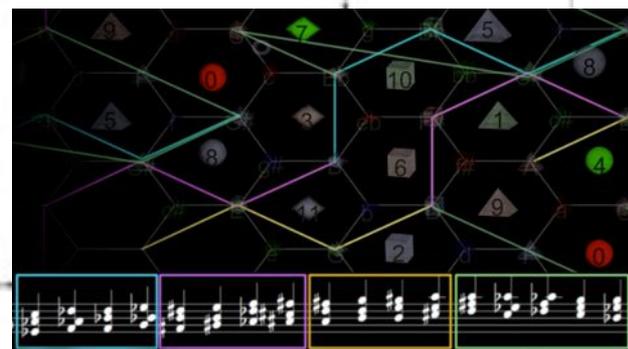
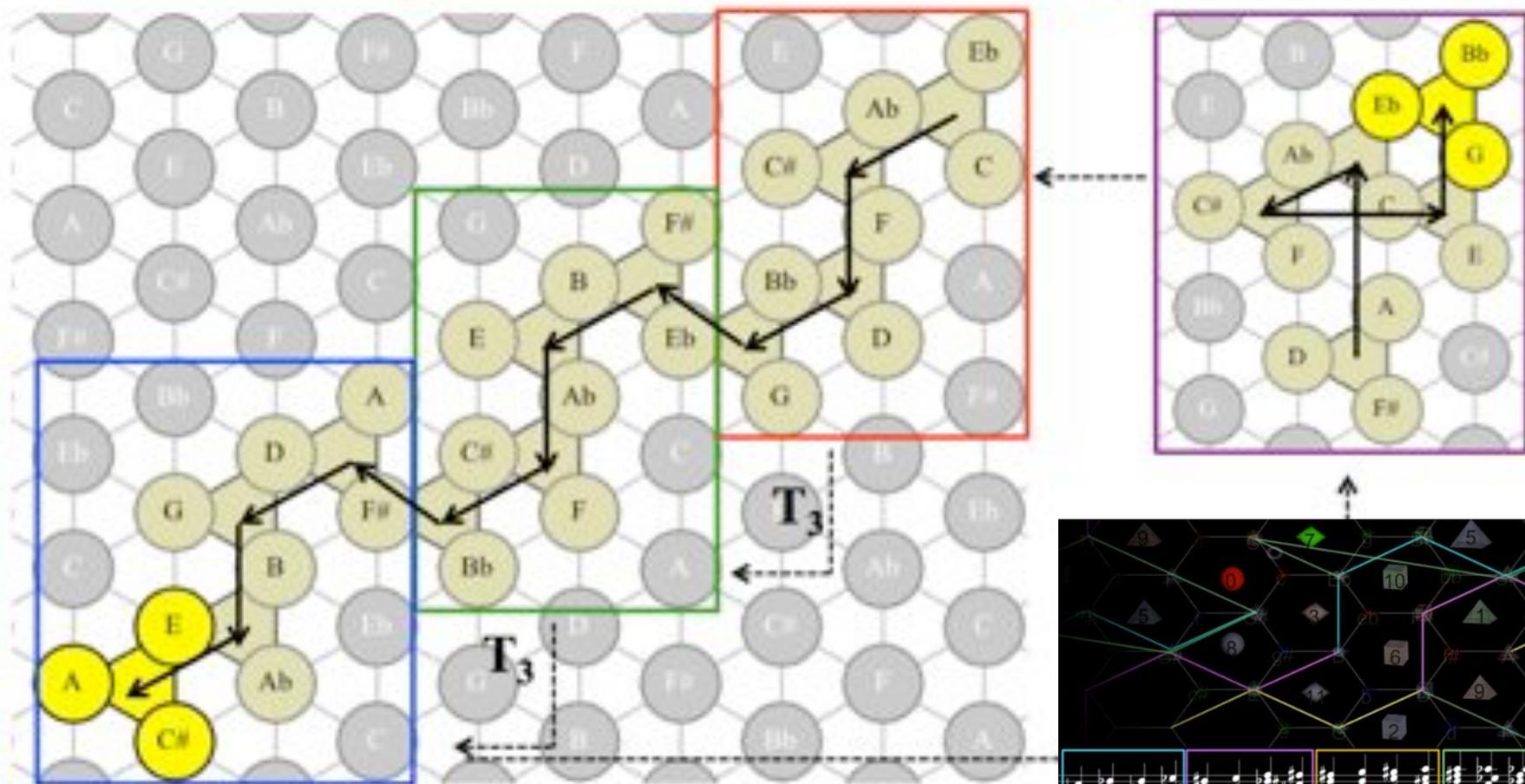
→ **Ré/La** → **Sol** → **Mi<sup>7</sup>** → **La<sup>7</sup>**

→ **Ré** → **Lab<sup>7</sup>** → **Réb** → **Do<sup>7</sup>** → **Mib**



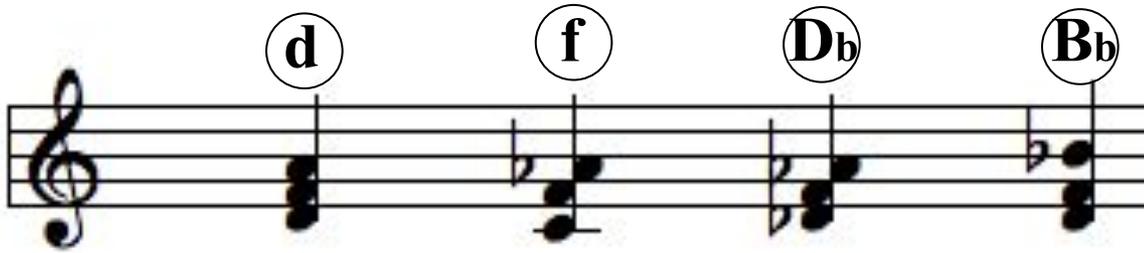
# Harmonies géométriques dans « Madeleine » (Paolo Conte)

La<sub>b</sub> Ré<sub>b</sub> Si<sub>b</sub> Mi<sub>b</sub> Si Mi Ré<sub>b</sub> Fa<sub>#</sub> Ré Sol Mi La Ré La<sub>b</sub> Ré<sub>b</sub> Do Mi<sub>b</sub>

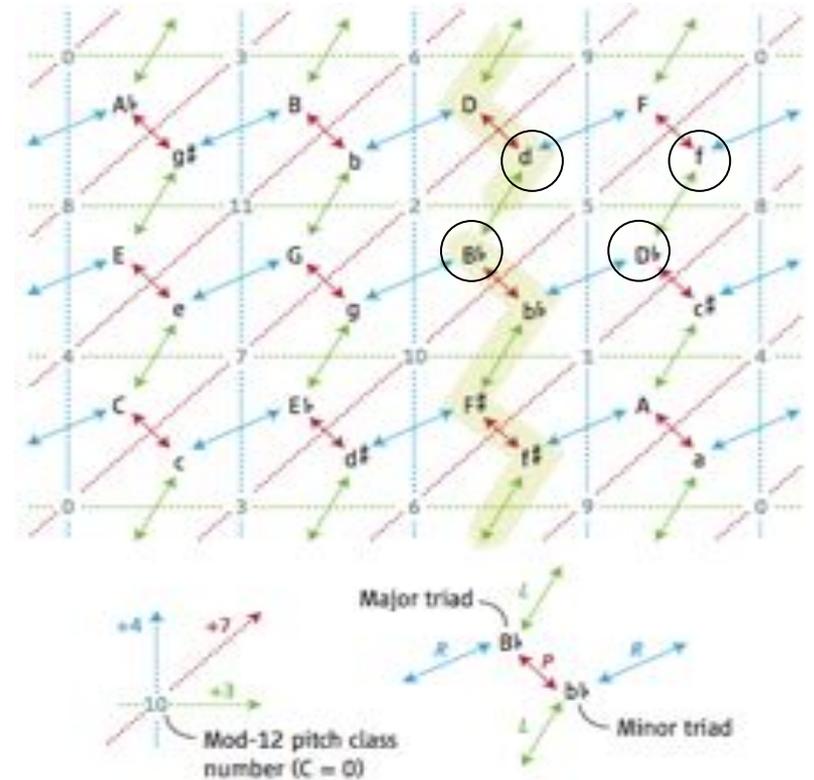
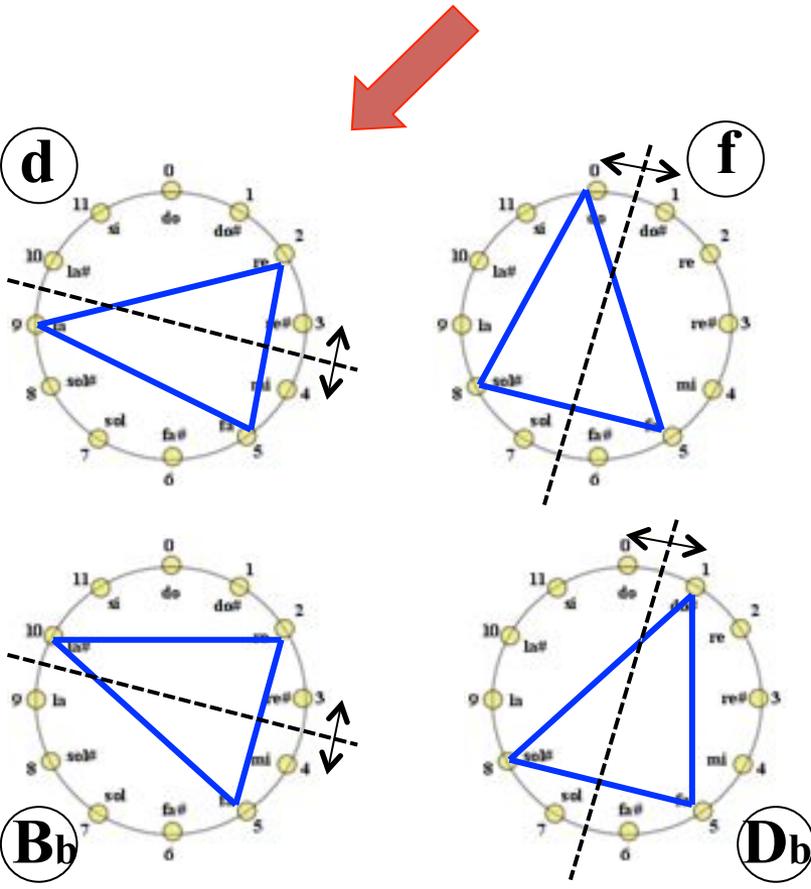


# Symétries spatiales dans la musique pop

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



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

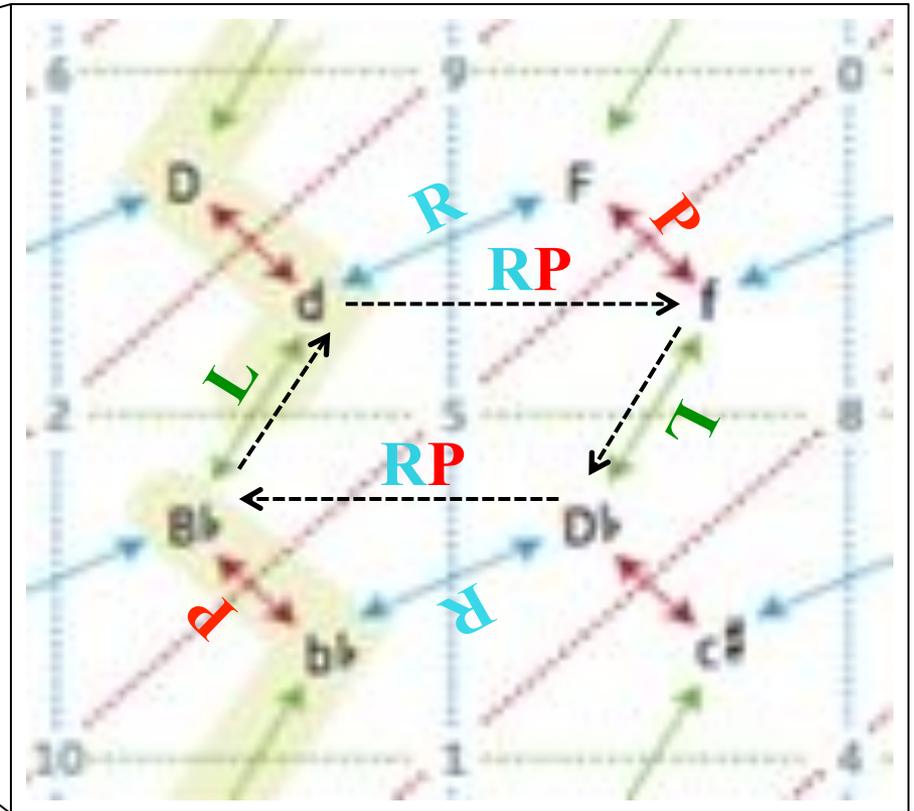
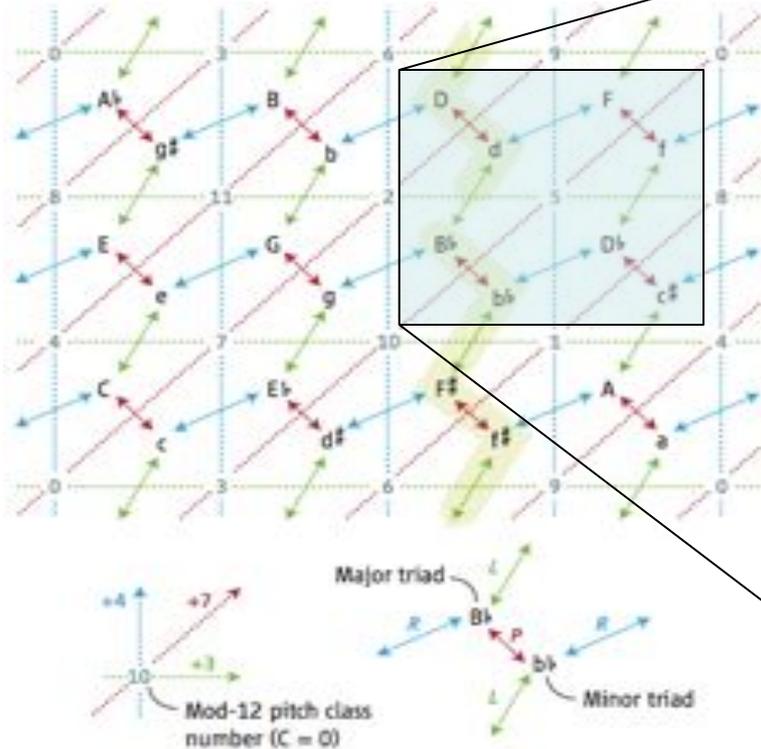


# Le parcours harmonique et ses raccourcis...

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

*Shake the disease* - 1985  
(Depeche Mode)

Séquence: **RPLRPL**



# Progressions harmoniques et symétries chez Zappa

Synthesizer

Chord progressions shown in the notation:

- Row 1: G+, A+, F+, A-, Ab+, G+, D+, F#-, F+, E+
- Row 2: B+, D#-, D+, C#+, Ab+, C-, B+, B#+, E+, B+, F#-, C#+, F#+, A+, E+, E-

Figured bass notation below the notes: 5/3, 6/4, 5/3, 5/3, 6/4, 5/3

Dynamic markings: *Fine*, *D.C. al Fine*

Guy Capuzzo, Neo-Riemannian Theory and the Analysis of Pop-Rock Music, *MTS*, 26/2, 2004, 177-200

Four Neo-Riemannian diagrams illustrating chord relationships:

- Red box:** Shows a progression from G+ to A+ to F+ to A- to Ab+ to G+.
- Green box:** Shows a progression from D+ to F#- to F+ to E+ to B+ to F#- to C#+ to F#+ to A+ to E+ to E-.
- Blue box:** Shows a progression from B+ to D#- to D+ to C#+ to Ab+ to C- to B+ to B#+.
- Purple box:** Shows a progression from E+ to B+ to F#- to C#+ to F#+ to A+ to E+ to E-.

Three curved arrows labeled  $T_{-3}$  indicate tritone transpositions between the diagrams.

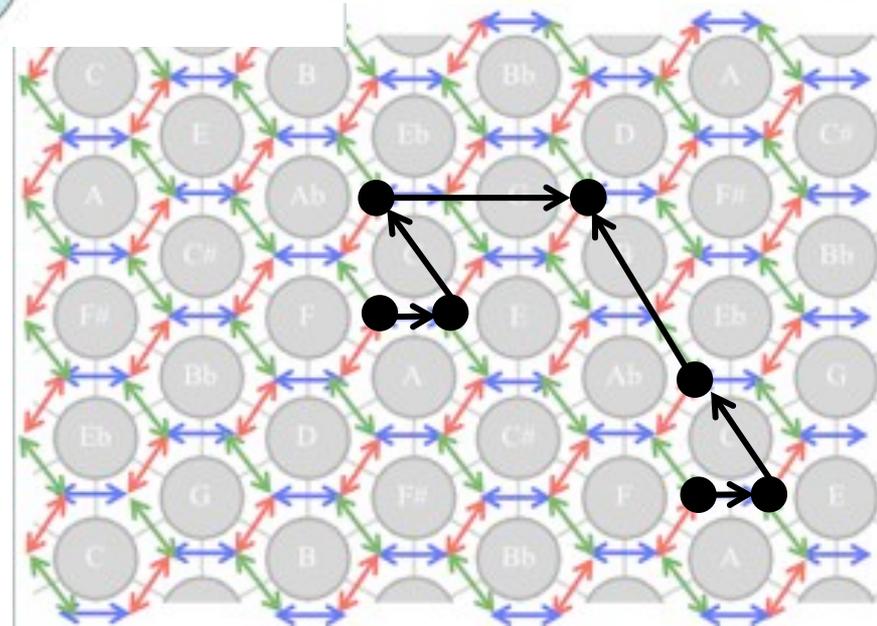
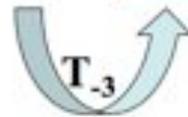
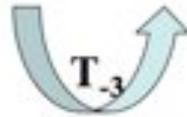
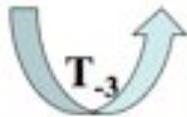
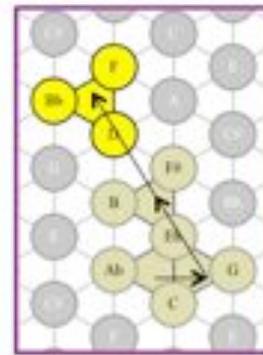
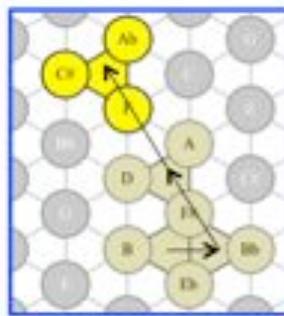
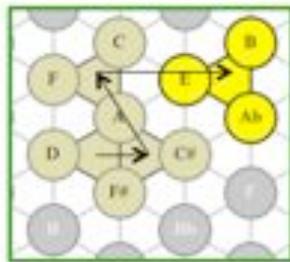
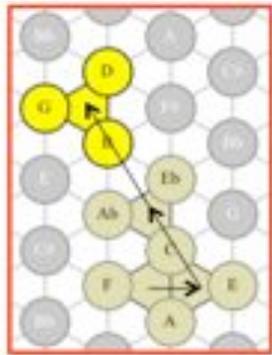
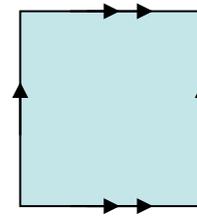
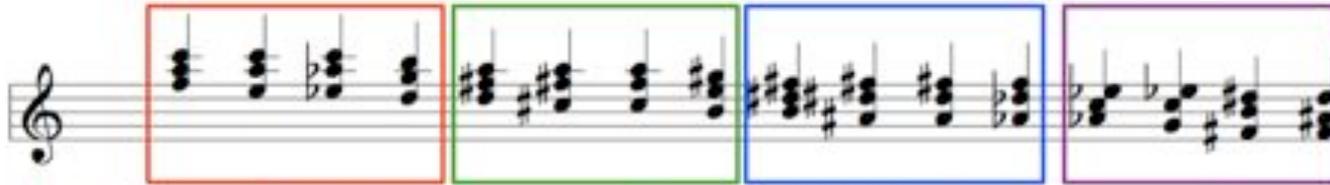


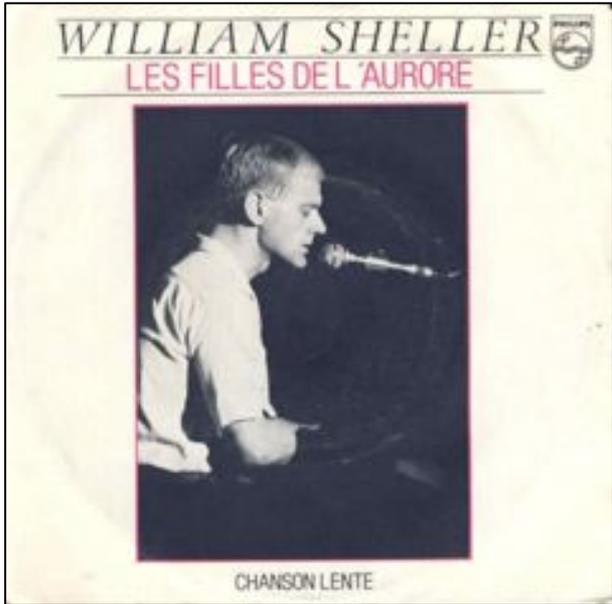
« Easy Meat » - 1981 (F. Zappa)  
min. 1'44" - 2'39"



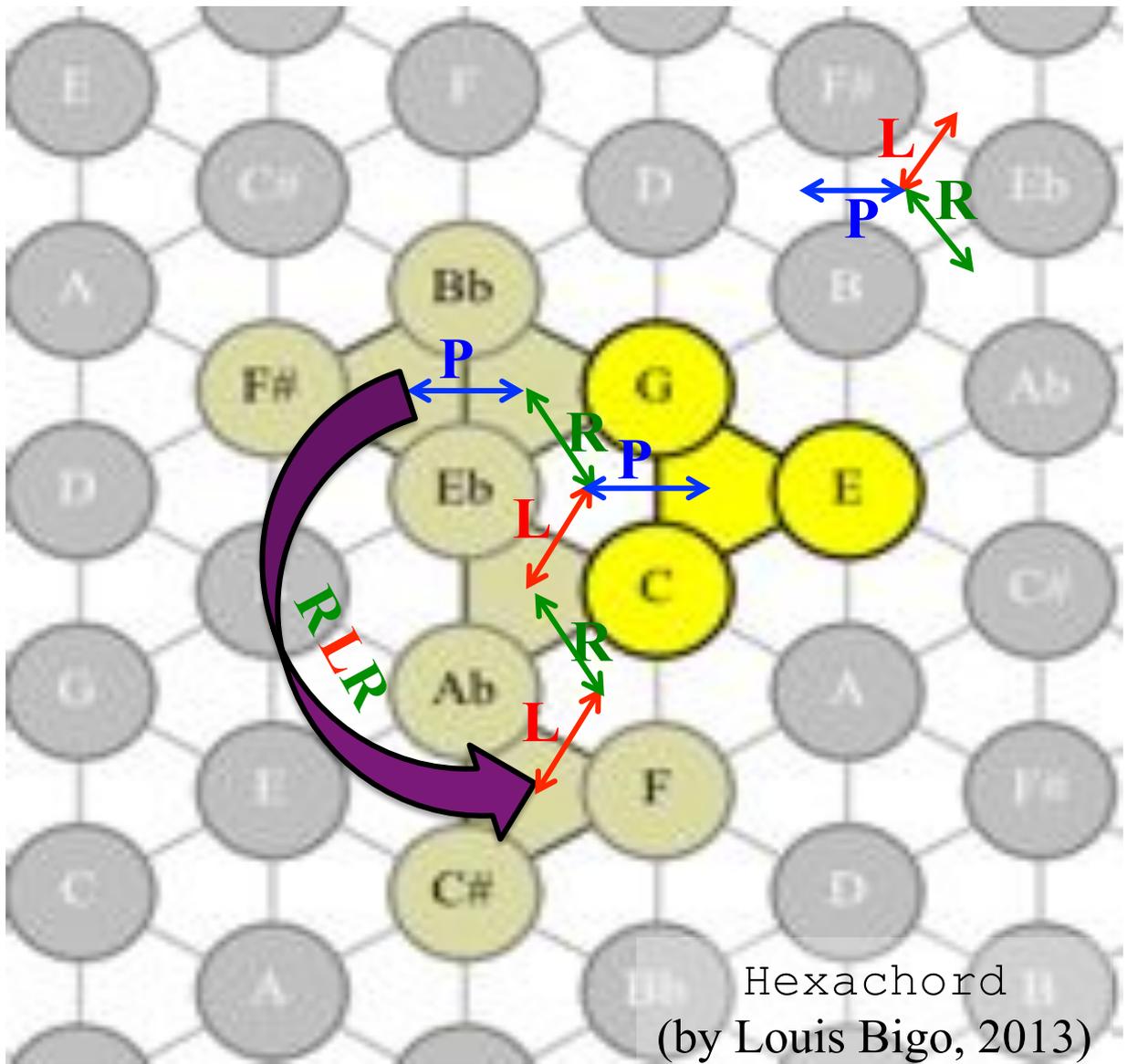
# La trajectoire spatiale comme signature

Fa la<sub>m</sub> La<sub>n</sub> Sol Ré fa<sub>#m</sub> Fa Mi Si la<sub>#m</sub> Ré Ré<sub>b</sub> La<sub>b</sub> do<sub>m</sub> Si Si<sub>b</sub>





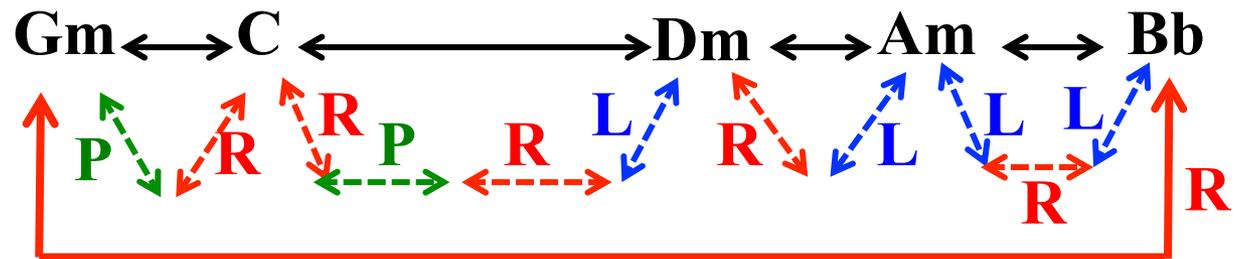
min. 0'33''





# LØVE

Julien Doré



## MON APACHE

(Arman Malika)

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

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

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

Ô mon inouï amazone  
tu nous quittes  
et l'été se fait automne  
black light, white beat

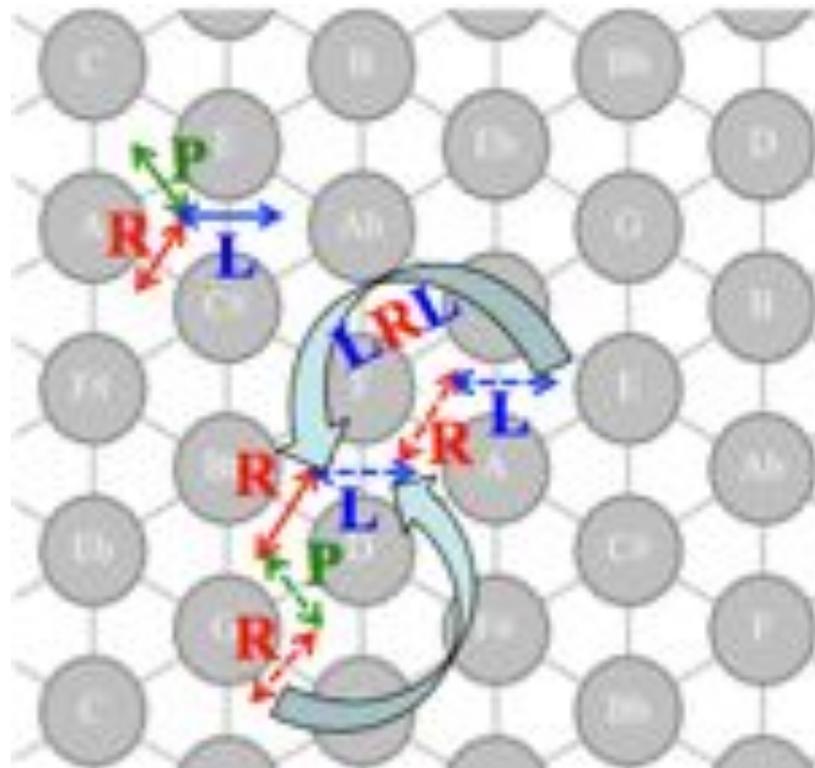
Une flèche en plein cœur  
un ciel à la dérive  
et je meurs  
de nous survivre

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

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





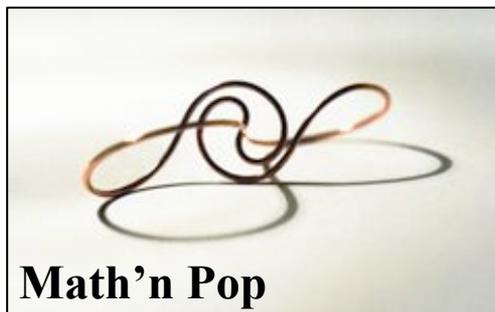
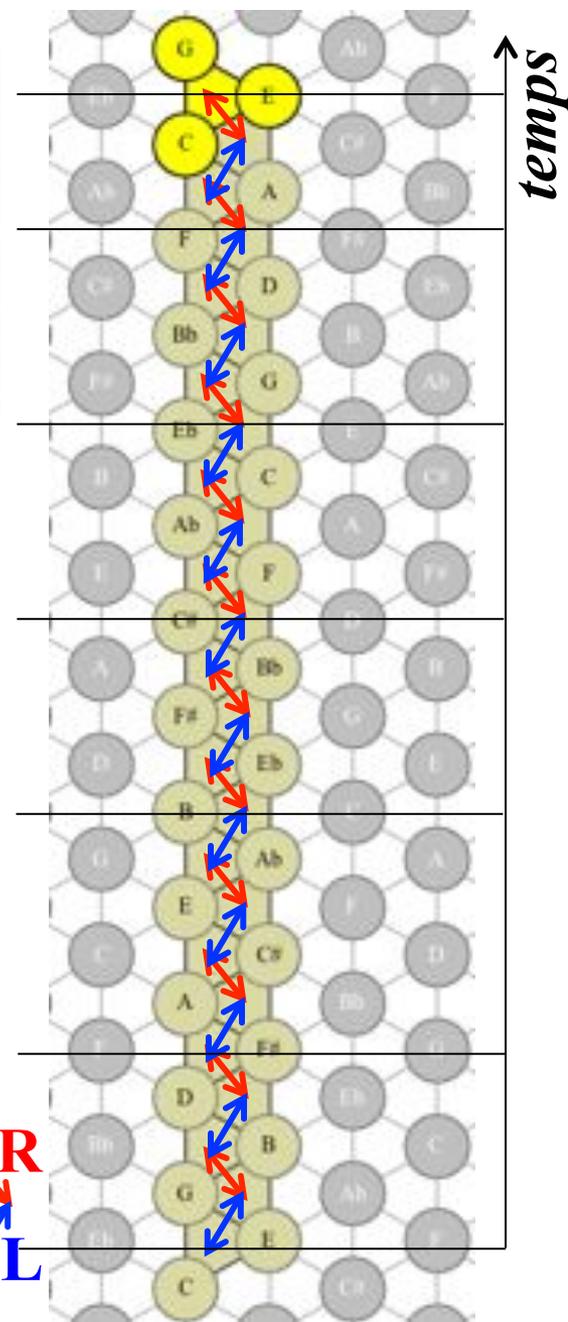




# Le blé en herbe

(Pola/Moreno/Dieu)

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



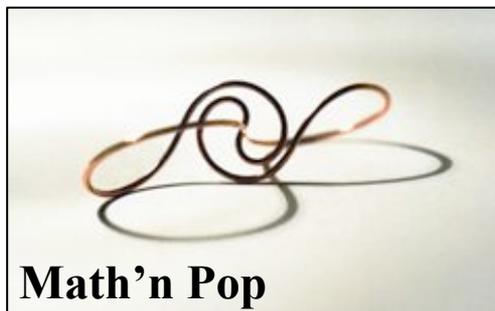
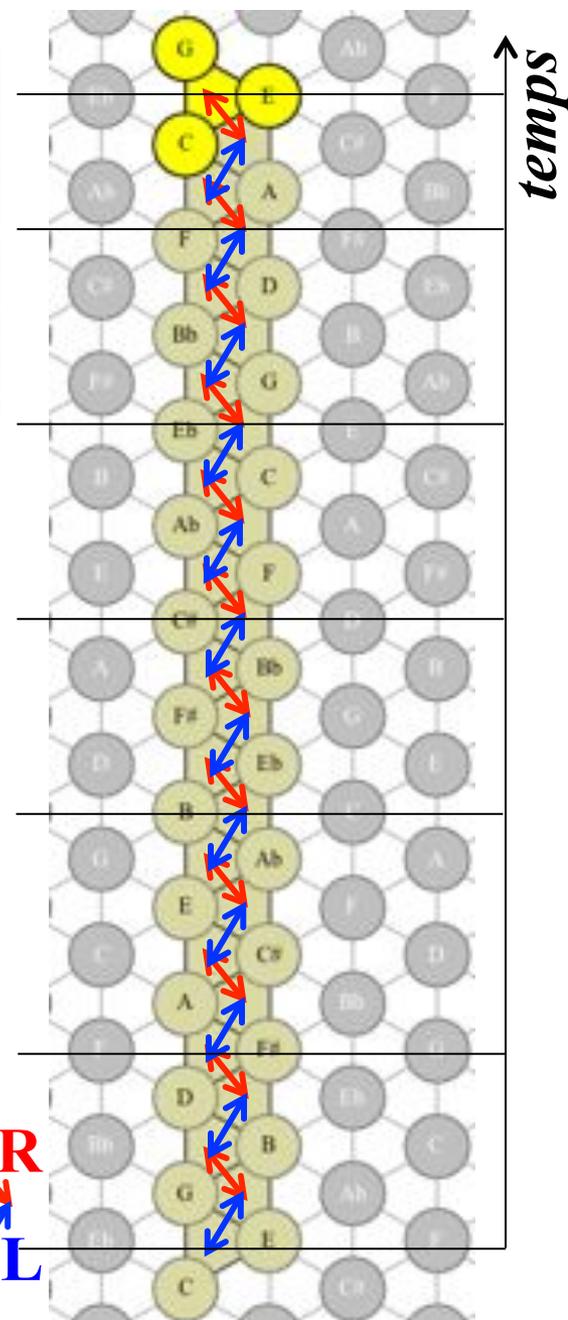
**Math'n Pop**



# Le blé en herbe

(Pola/Moreno/Dieu)

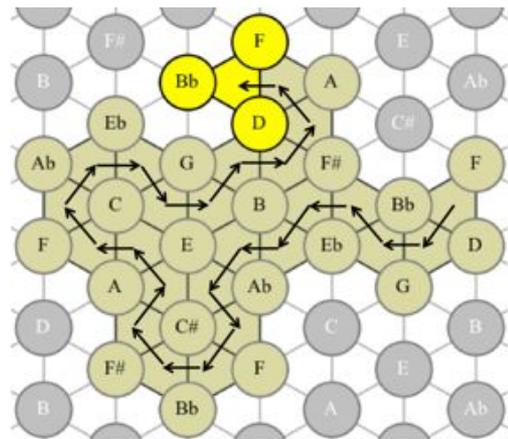
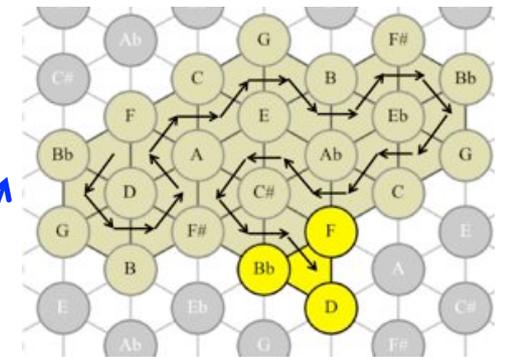
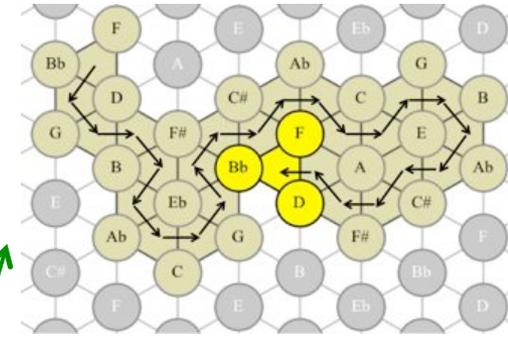
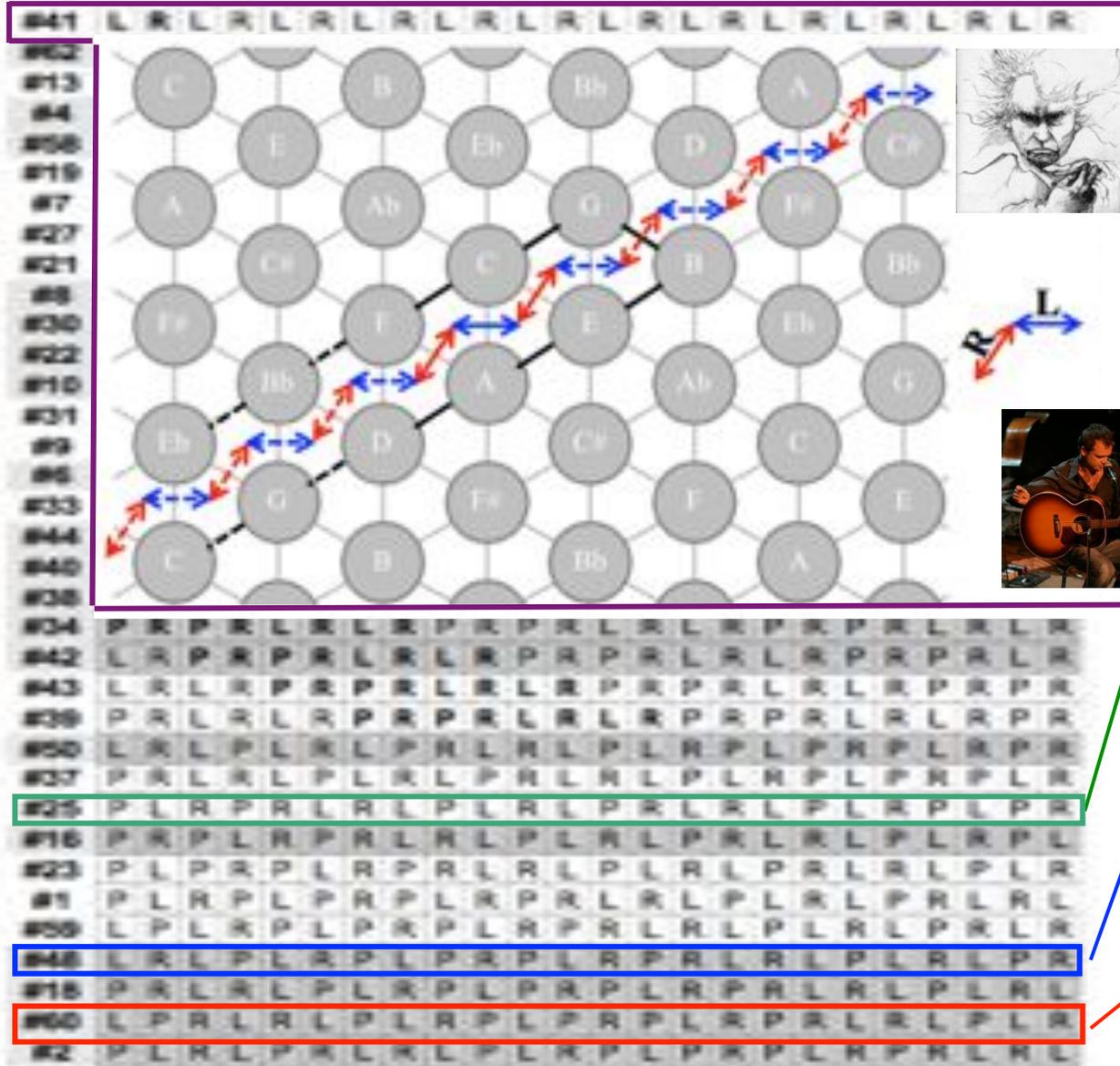
Plonger comme un enfant, cheveux au vent	Croiser matin dans l'herbe folle
Sous l'océan du blé en herbe	Deux tourterelles qui s'envolent
Marée d'épis couleur d'amande	Suivre les jeux des hirondelles
Qui tendent à caresser le ciel	Sur le paysage éternel
	Nager comme un enfant, cheveux au vent
Algues tendres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



→ **Le Blé en Herbe**



# Cycles hamiltoniens sans périodicité interne



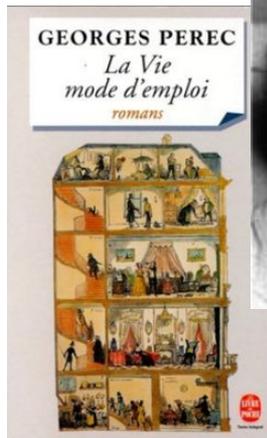




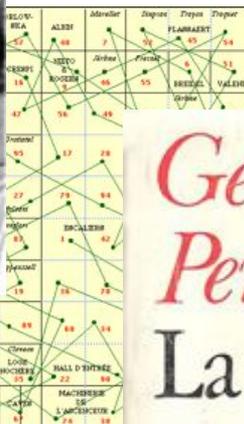
# Les contraintes dans l'art : l'OuLiPo (Ouvroir de Littérature Potentielle)



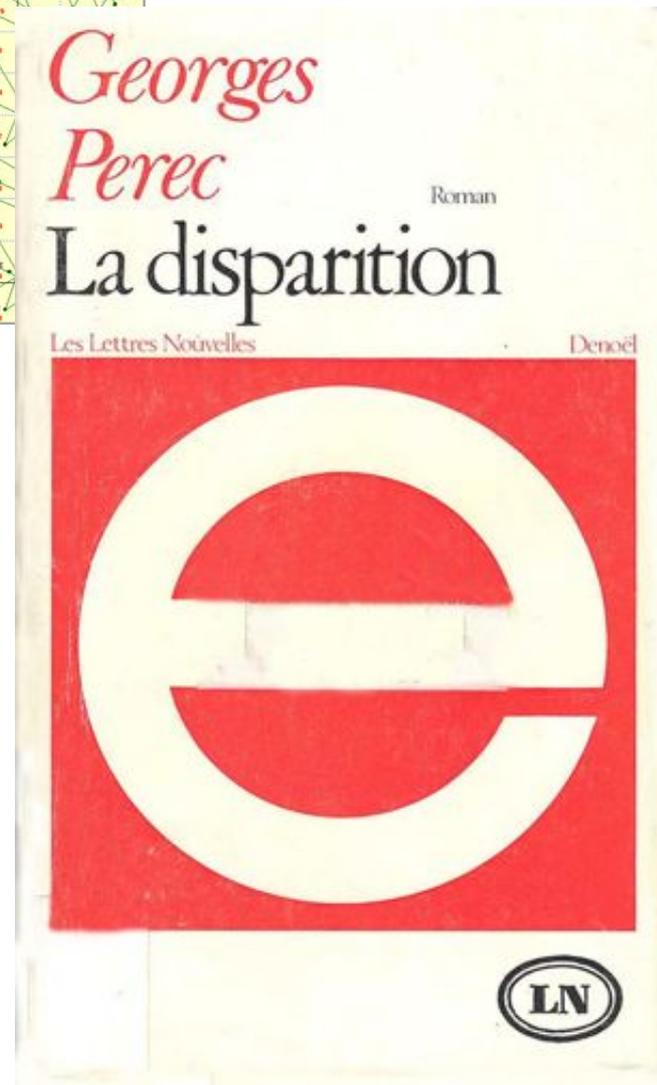
*Cent mille milliards de poèmes, 1961*



**Georges Perec**



*La vie mode d'emploi,*



**Raymond Queneau**



**Italo Calvino**

*Le Château des destins croisés, 1969*

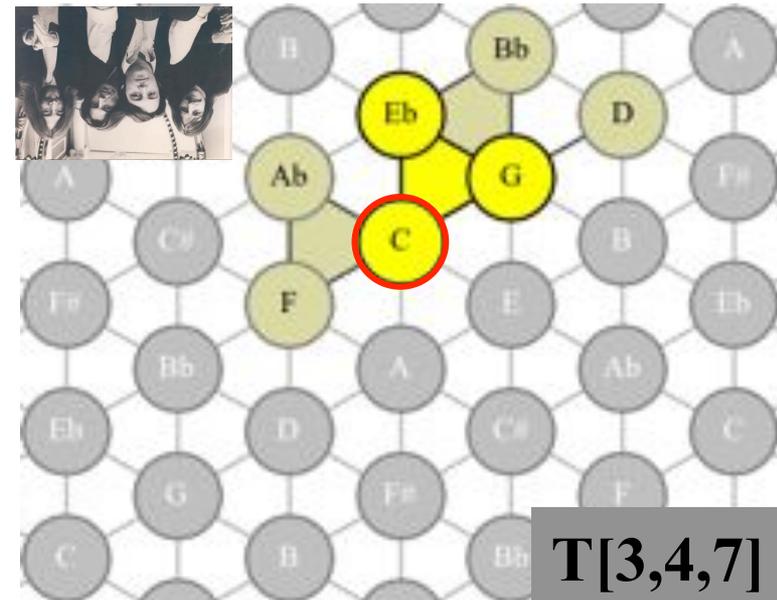
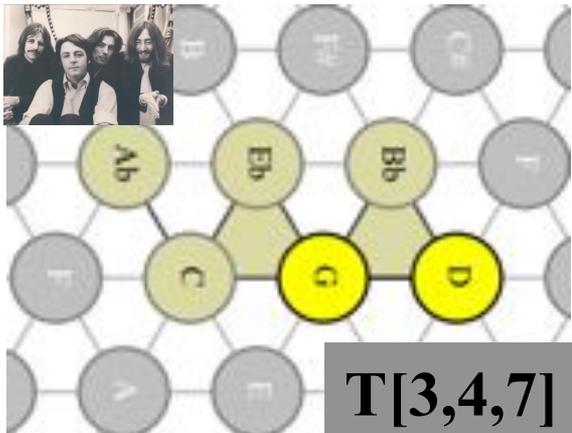
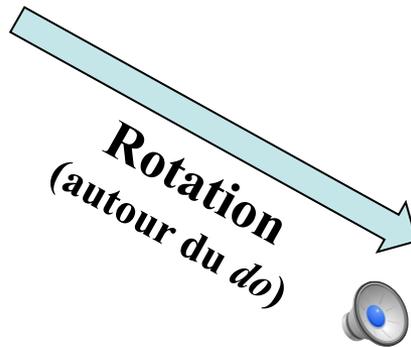
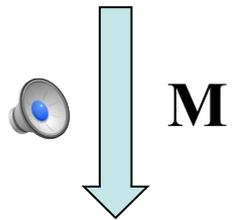
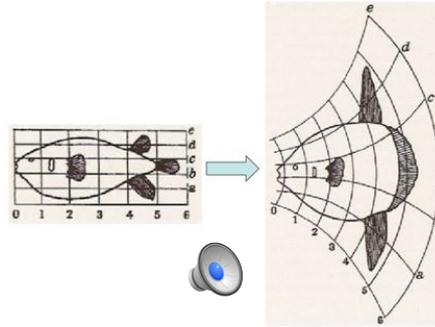
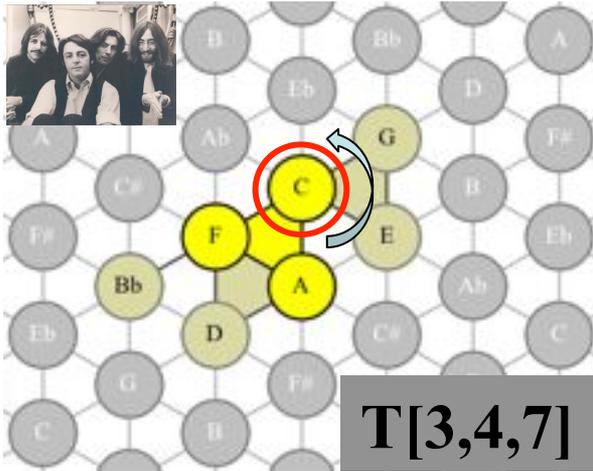
# Hexachord et la classification stylistique : DEMO

The screenshot displays a software interface for hexachord analysis, divided into several panels:

- 3D Model:** A 3D visualization of a hexachord complex, showing a green and blue polyhedron.
- Chromatic Scale:** A grid of circles representing the chromatic scale, with a path of yellow circles highlighting a specific hexachord.
- Graph of Complexes:** A graph showing the relationships between different hexachord complexes, with one complex highlighted in yellow.
- Bar Chart:** A bar chart titled "2-compactness" showing the compactness of various complexes. The y-axis is labeled "2-compactness" and the x-axis lists complexes from K(1,1,0) to K(4,4,4). A red bar for K(3,4,5) is significantly higher than the others.
- Control Panels:** Panels for "Tempo" (with a slider and Play/Stop buttons), "Chromatic complexes" (set to K(2,3,7)), "Heptatonic complexes" (set to CM), "Vertical compactness" (set to 2-compactness), and "Path Transformation" (Origin and Destination complexes set to K(3,4,5)).
- Complexity Chart:** A chart titled "2-compactness : bwv0281" showing the complexity of the piece over time, with a legend for various complexes.

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

# Transformations stylistiques sur les Beatles



F	—	C	—	G	—	D
A	—	E	—	H	—	F <sub>s</sub>
C <sub>s</sub>	—	G <sub>s</sub>	—	D <sub>s</sub>	—	B.

**MERCI DE VOTRE ATTENTION**

