"Concerférences": addressing different publics for mathemusical popularization

October 27, 2017

Abstract: Our discipline often suffers from ignorance or worse, misknowledge. A good way to get the message through about the importance of the relationship between maths and music is to put on a "concerférence", a French term coined to designate anything between a talk cum music and a concert cum fairly detailed scientific explanations. This format of exposition is quite versatile, and the content can be adapted to a wide range of publics. The present paper mainly relates a choice of such experiences in order to exemplify which selected topics can be fruitfully exposed to whom, with an eye on helping would-be "concerférencers" (or mathemusic speakers in general) in developing their own endeavors. The topics of Hamiltonian cycles in the *Tonnetz* and rhythmic tilings are presented in some detail.

Introduction

This chapter addresses the specific question of popularization. It is a very important dimension, because 'Maths and Music', as an autonomous discipline, is mostly unknown by the general public. This is a little paradoxical, since most people will readily issue blunt statements such as 'Ah yes, music is a part of maths' or 'You need to be a mathematician to understand music theory', usually meaning that it is useful for a musician to know how to count (to 12). I used to answer such remarks curtly with 'shoemakers count to higher numbers', but there are more constructive alleys which we must explore in order to attain general and academic recognition.

In recent years, there have been a number of occurrences of *"concerférences"* by mathemusical researchers, myself among and sometimes along with others. Obviously this is a successful concept, rapidly developing.[1] Nobody could place the time of its invention, since its definition may be a matter of degree of mixing theoretical exposition with musical or artistic performance, but I may perhaps claim coining the name a few years back.

Quite a few artists like to put in a few words of explanation alongside with their performance: I remember for instance the pianist Miguel Angel Estrela telling about the influence of Habanera on Tango before following up Ravel's *Habanera* with his transcription of Piazzolla's *Grand Tango*. On the other hand, I also heard pianists 'explaining' that Debussy's *L'Isle Joyeuse* is constructed on the whole-tone scale (?!), and such debatable half-truths

[1] See for instance Andreatta's page `http://repmus.ircam.fr/moreno/music`.

were certainly instrumental in provoking me (and other mathemusical actors) to provide sounder and more comprehensive arguments.
The interest of this specific form of talk is multifold:

- The alternance of music and theory enhances the perception of both, in the tradition of the 'good cop/bad cop' routine: theory enables a better appreciation and understanding of the music played, whereas the musical interludes alleviate the suffering otherwise inflicted by requiring intellectual efforts.
- The allure of an artistic show –the 'concert' part– is enticing enough for audiences who would not necessarily be interested in a dry, purely mathematical talk.
- This is true of course for non-specialized audiences, but also for specific ones, like corporate meetings (researchers, teachers, etc...), which could be less receptive to traditional conferences (even if the subject is actually the same).

This kind of manifestation, with its versatility and adaptability, is one of the best ways (though not the only one) to address general misconceptions and ignorance about our discipline: on the one hand, the general public often believes in a profound unity of maths and music but on wrong or shaky grounds (like 'music = numbers') while on the other, qualified scientists often dismiss the field as kindergarten mathematics mostly focused on rational approximations of $\log_2(3/2)$ and addition modulo 12. A multimedia show including video, graphics and of course music (recorded or performed), enables to hammer in the usefulness of group theory, categories, topology, graphs, polynomials, and so on, at an appropriate level. The only price to pay for such gratifying endeavors is the usual one in popularization, where one has to sacrifice a little of the rigor and exhaustiveness of a true scientific conference for the sake of understandability and the pleasure of the audience.

1 Concerférences for the general public

1.1 Choice of topics

In this section I will not just mention 'concerférences' for the most general public but also for *specific though non-specialized audiences*, like school/college/university and those cultural associations that sometimes ask for an unfamiliar event concerning music and maths. The common denominator would be the absence of any prior bystander knowledge pertaining to the matter. It could be objected that interested spectators –interested sometimes to the point of buying a ticket for the conference– would be informed or at least cultivated. In my experience it can be quite the reverse: secondary school students may be more knowledgeable than educated grown-ups, who will have learned more but forgotten aplenty, but the former can be relied upon for some half-baked but still fresh notions. For instance, with 14-year-olds I draw on the notion of identical vectors between different couples of points to help understand the notion of interval mod 12 on the Kremer circle; pointing out 'strange parallelograms' (the *Pink Panther* theme is a favorite) is appealing to them, because it comes as a welcome change and a relief from the usual definition drilled into them at school, see Figure 1.
This example shows that modular arithmetic can be a topic of choice for such publics, though it is not usually taught before pre-graduate (maths) level. However, with enough pictures and audio illustrations, the notion of pitch-class goes down quite well. Two of my favorite routines for demonstrating modulo octave equivalence are:

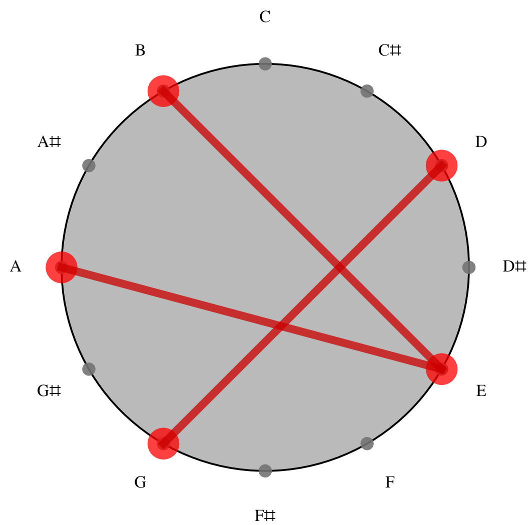

Figure 1: Some parallel fifths in the circle model

- A Shepard-Risset never-ending scale, played while a Penrose stair (or Escher fountain) is shown, and
- asking the audience to sing some popular song ('Brother John' or 'Black Sheep'), showing by example how voices spontaneously settle an octave apart.

French poetry-minded audiences (like the aforementioned cultural associations) can also enjoy searching for the author of the following revealing verse:

> "La treizième revient, c'est encor la première;"[2]

More generally, it is usually a good idea to establish unexpected connections –a romantic poet with modular algebra, Beethoven with graph theory as we will develop below– as it strikes the public's attention, mobilizes their personal knowledge as something that can help them tread unfamiliar ground, and establishes synaptic connections, which is the acknowledged way for memorizing new notions.

As usual in the case of specialists addressing laymen, it is a mandatory effort to remain modest in scope, and not to provide too technical or too detailed information: most of the 'obvious' stuff that researchers gloss over –say, set-theoretic notions like intersection or complementation, but also elementary musical notions like names of notes, keys, scales, triads...– is new and even difficult for the audience. For instance, addition mod 12 is fine (adding up pitch-classes and intervals), multiplication is not (M5-M7 operations).[3]
I remember only of one occasion when we dared to venture a bit further with non-professionals, who were especially enthusiastic about browsing new knowledge: Pierre de Fermat's birthday is celebrated every year in the family manor in Beaumont de Lomagne (South-West of France) by a *Fête des Mathématiques*[4], and in October 2014 we gave there a fairly thorough

[2] "The thirteenth comes back, and is still the first": Gérard de Nerval, *Chimères*. Googleable questions like this should not be overused however, lest smartphones captivate the attention of the audience instead of the speaker.

[3] It can be tried in high school however, because sentences like "$5\times5 = 7\times7 = 1$" jolt the young audience's attention, since it is close to their quotidian drilling but refreshingly different and even delightfuly shocking.

[4] `https://www.fermat-science.com/agenda-manifestations/`

'concerférence'.[5] Topics were: modular arithmetic in the cyclic model of pitch-classes and pc-sets, the *Tonnetz* with its cycles, among which Hamiltonian cycles with recent compositional applications in pop music (see below), geometrical musical spaces, Möbius strip in Bach's *Musical Offering*, rhythmical mosaic canons (tilings of periodic rhythms), Tom Johnson's square perfect tilings and their connections with Galois theory (with a wink at number theory aficionados in Fermat's own house!), maximally even sets (in scales and rhythms), ending with S. Reich's *Clapping Music* –a non-mosaic rhythmic canon with incrementation– performed by the audience. Quite a lot on their plate! Admittedly there may have been quite a few maths teachers or at least amateurs, and the younger part of the audience included many especially gifted pupils, so perhaps this should not count as a general-public occasion.

However, some notions that seem reserved for specialists can sometimes be adequate for general-public *concerférences*, if they lend themselves to nice, illustrative, graphical representations (even though the underlying mathematics is actually quite complicated). Most *geometrical musical spaces* are suitable, even orbifolds [11] (the Möbius strip of dyads is a nice one because part of the audience has some previous knowledge of the strip) or Baroin's 4D-Model [5]; but my favorite one is the *Tonnetz* (or its dual), cf. Figure 2.

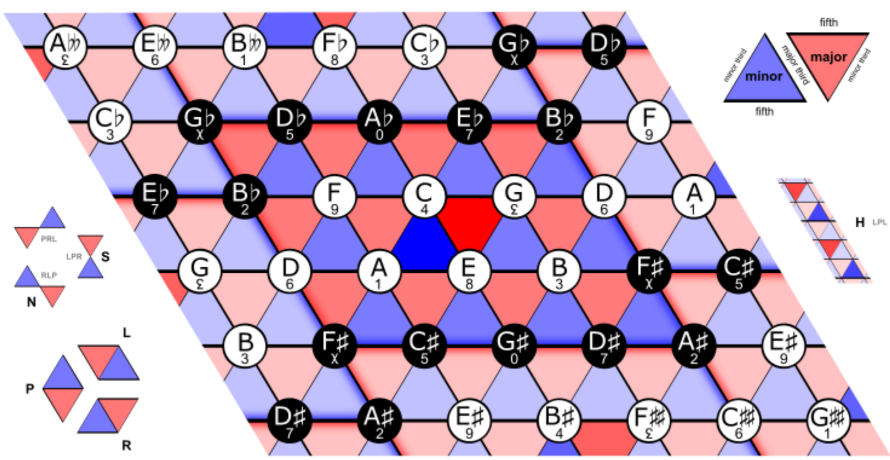

Figure 2: The *Tonnetz* (Wiki picture)

Its topological structure is quite easy to grab when the audience follows a sequence of chords/notes going through one side and turning up on the opposite one, and there is a wealth of interesting videos using this model. A fantastic pedagogical tool is Louis Bigo's software HexaChord,[6] which enables to follow chord progressions in real time as we can see in Figure 3.

1.2 The epic saga of Hamiltonian cycles on the *Tonnetz*

This makes a great story for any concerférencer, which spans almost three centuries[7]:

[5] With Moreno Andreatta and Gilles Baroin.

[6] Available at `http://www.lacl.fr/~lbigo/hexachord`.

[7] The adventure goes on, with current research on the graph of seventh chords recently studied in [6]. It is known to be Hamiltonian, but the exhaustive search for cycles stumbles on exponential complexity.

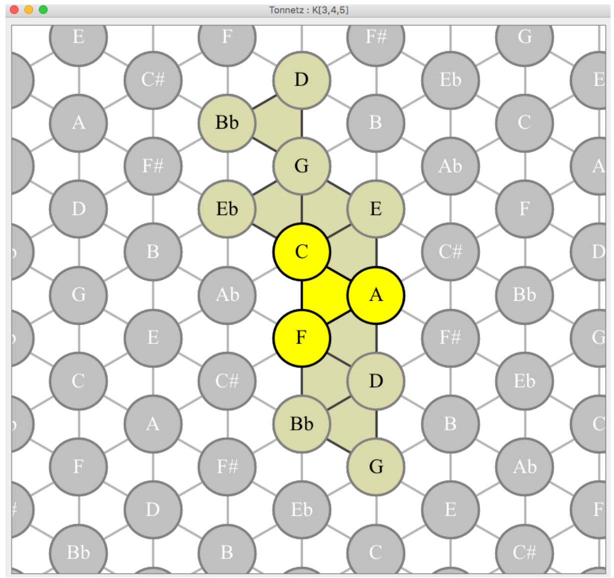

Figure 3: Cycling triads in the *Tonnetz* with HexaChord

Leonhard Euler invents the *Tonnetz* (and graph theory!) in his *Tentamen* in 1739, as seen in Figure 2. The edges of the graph are the consonant pure intervals of fifth and thirds, as per Euler's own theory of consonance based on simple rational ratios between sound frequencies. The *dual* graph is made of the centers of the triangles, connected to their neighbors. These triangles are major or minor triads, and moving to one neighbor triads involves changing one note only, a 'parsimonious' operation with maximal simplicity. These operations are the fundamental bricks of Öttingen's and Riemann's renewed theory of *Tonnetz* (1856): R (Relative) exchanges, say, C major and A minor (moving only the G to A); P (Parallel) exchanges C minor and C major and L (Leittonwächsel) downs the C major tonic, changing the chord to E minor –or the reverse. This grammar of transformations is taught nowadays as a powerful (and fashionable) tool for analysis of tonal music, much simpler than traditional and often ambiguous labelings of degrees in local tonalities.

But much had been done with P, L and R even before they were even named. For instance, Beethoven wrote a suggestive sequence of triads in the third movement of his Ninth Symphony (1824). The middle section of this cycle is shown in Figure 4; the operations are LRLRLR.... This was recognized as a cyclic sequence of parsimonious operations much later, by R. Cohn in 1996 who defined general P-cycles between pc-sets [7].

But Beethoven's cycle has one additional and remarkable quality: it passes through each of the 24 triads once and exactly once.[8] Such a cycle in a graph, crossing each vertex exactly once, is a Hamiltonian cycle; the notion emerged around 1856 – simultaneously with the resurgence of the *Tonnetz*.

However, it took again a century and a half for researchers to come to grips with the obvious question: what are the other possible Hamiltonian cycles in the *Tonnetz* of triads? It is certainly possible to find some solutions by hand, but an exhaustive search requires some raw computer power, since finding Hamiltonian cycles is now known to be an NP-complete problem. This was tackled and solved in 2009, by Albini and Antonioni [1] who found

[8] Actually Beethoven went from C major to A major only, leaving out the 6 last triads what would have completed the cycle. But carrying on would have been straightforward.

Figure 4: Cycling triads in Beethoven's Ninth Symphony

the 252 solutions. I was thrilled when I first encountered this result, which had just then become accessible with a personal computer (I checked on mine and it took a couple of hours at the time). The ultimate development of this exemplary sequence of mathemusical analysis was of course to use the new cycles for original compositions. In *concerférences*, we sometimes use G. Albini's seminal variant[9] of Bach's first cello Suite, *Corale #4* which shows beautifully the parsimonious character of chord transitions. However, when I am privileged to share the stage with Gilles Baroin and Moreno Andreatta, the latter plays and sings live one of his own 'Hamiltonian songs' while the former projects his stunning graphics renderings in diverse geometrical models, for instance *Aprile* [4] on a moving poem by Gabriele d'Annunzio. The three Hamiltonian cycle of triads used in *Aprile* appears in Figure 5.

Not anecdotically, journeying in the *Tonnetz* (or similar spaces) widens the musical repertoire to pop/rock music, which is mandatory both for general and youthful audiences. Other examples illustrated similarly in the *Tonnetz* (or alternative spaces) include Paolo Conte or Frank Zappa and can be visited at `http://www.mathemusic4d.net/`.

More generally, besides appropriate choices of topics, there are ways to ensure the audience's continued attention and satisfaction.

1.3 Meeting and involving the audience

1.3.1 Simple acts

If one wants to involve the audience, the most natural way to do so must be to have them sing, since anybody can do it (or believes so). I already mentioned how this can help grasp the notion of octave equivalence, for example. Also –barring special environments– one cannot expect to find many songs or tunes known to a whole audience, because of cultural and generational differences. The point is that clapping hands is the cheapest and most

[9] Cf. `https://youtu.be/rXR64vFcf-Q`

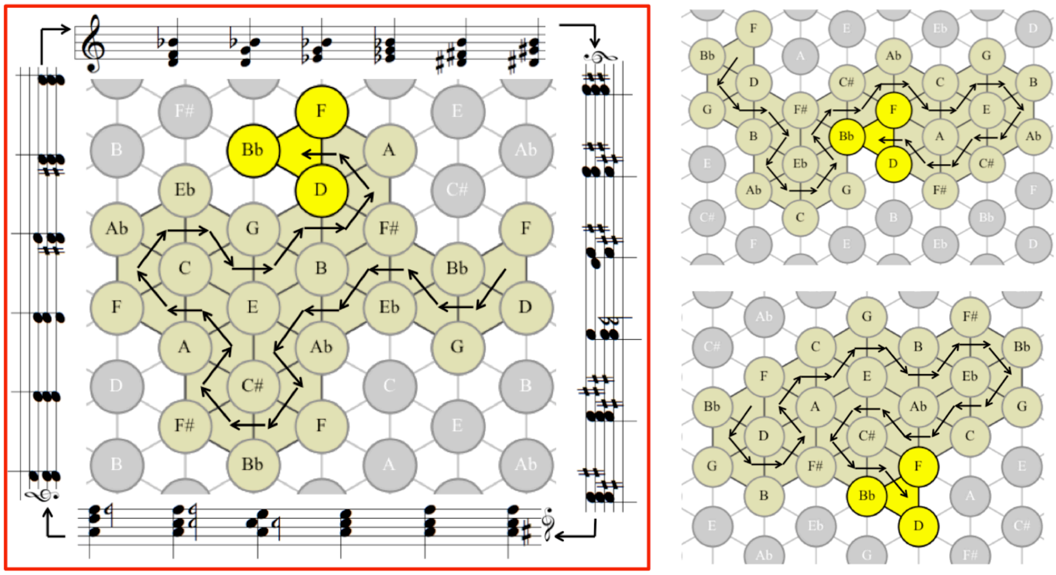

Figure 5: Hamiltonian cycles in the *Tonnetz* (*Aprile*, d'Annunzio/Andreatta)

readily available musical instrument, and that the capacity for playing regular rhythmic cells is fairly well shared among the human genus.

Invoking yet another muse, Terpsichore, may not cross the mind of many Mathematical Music theory experts, but dancing is a very evocative and powerful expression of music, notably but not exclusively because of its rhythmic component. In *La Chapelle Gély* in Montpellier I had an unexpected *impromptu* experience: I was learnedly explaining why the *tresillo* rhythm 10010010, i.e. , was a maximally even division of 8, showing its two different steps and generator, when M. Andreatta sat at the piano and attacked Piazzolla's *Libertango*; feet itching, I had no option but to invite a member of the audience to dance it, for what was generally considered as the best moment of the *concerférence*.[10]

In the same (long) *concerférence*, we had enough time to introduce the notion of rhythmic canons and tilings. This is a lovely topic for involving the public yet another way: most human beings can clap their hands to a beat, and indeed we were surprised at how well the audience managed Steve Reich's *Clapping Music*. I would nonetheless recommend simpler motives, like the one in Figure 6.

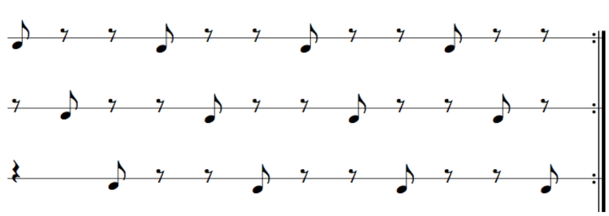

Figure 6: A simple rhythmic canon

More difficult but with less voices is the classic motif 0136 modulo 8, i.e. `1101001`:

[10] `https://www.youtube.com/watch?v=eUe1Ddkv2M4&t=1108s`

Figure 7: A more challenging rhythmic canon

1.3.2 Getting involved with rhythmic canons

Still more difficult is the general theory of rhythmic canons, cf. [3]. However, this is a very nice topic for concerférences since the basic principle can be experimented and felt from experience by the members of the audience: a rhythmic canon is made of different voices playing the same rhythm but with different onsets. Variants include modifying the motif not only by changing the onset, but also inverting it in time [no pitch inversion since pitch is ignored here] or playing it at different tempi (augmentation). A *tiling rhythmic canon* has exactly one, and only one, note for each beat. Producing tiling rhythmic canons is a real challenge: as of today there is no general rule for deciding whether a given rhythm can generated a canon (be it by translation, with retrogradation, or augmentation). For instance, motif 1001101 looks very similar to 1101001 just above, but it cannot tile by translation (try it); however, it tiles with its retrograde, as shown in Figure 8.

Figure 8: The habanera motif does not tile by translation but does by retrogradation

Partial results are known: for instance, any three-note rhythm does tile with retrogradation, but one has better start with the form of the motif which is balanced on the right as can be seen on Figure 9, with a more abstract/pictural presentation where the motives appear on each line.

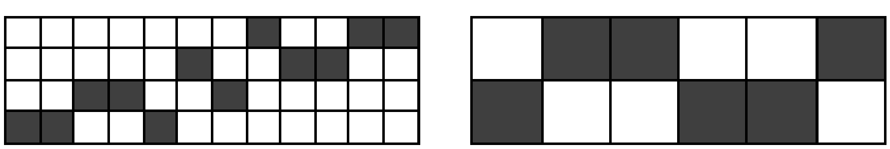

Figure 9: Tiling with 11001 and 10011

Similarly, motif 11011 cannot tile either by translation or retrogradation (irrelevant here since the motif is symmetric), because there is no way to fill the small hole in it without overlapping; but it can tile with augmentations. The smallest solutions appear on Figure 10 (I used them in a choral composition).

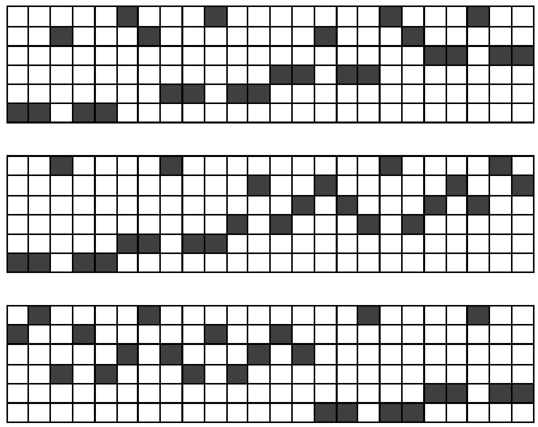

Figure 10: Tiling with augmentations of 11011

At times, I play *Noli me Tanguero*, a tango of mine whose rhythmic structure stems from retrogradation tilings of the motif 100100101, cf. Figure 11.

Figure 11: A six voice tiling by retrogradation

I used to mention Vuza canons a lot – tiling rhythmic canons by translation which are not concatenations of smaller canons – but nowadays I prefer to discuss simpler problems. For instance, composer Tom Johnson tried to tile with augmentations of the simplest three-notes motif 111, i.e. 10101, 1001001 and so on. He was puzzled to discover that one has to use all of ratios 3, 6 and 9, as happens in lines 1, 4 and 5 in Figure 12, or none of them. Why cannot one use, say, the 3-augmented motif 1001001 without the two other ones?
This is easily solved if each voice is interpreted as a polynomial: for instance, 111 is $1+x+x^2$ and 0010101 is $x^2+x^4+x^6$; the different voices in Figure 12 are $1+x^9+x^{18}, x^5+x^{12}+x^{19}, x^8+x^{14}+x^{20}$ and so on, adding up to

$$1+x+x^2+\cdots+x^{19}+x^{20}=\frac{x^{21}-1}{x-1}$$

In general, one has to combine several voices with ratio k and offset m and associated polynomial $x^m(1+x^k+x^{2k})$. Setting $x=j=e^{2i\pi/3}$ will make this polynomial vanish whenever k is *not* a multiple of 3. So does their sum which is $\frac{x^{3n}-1}{x-1}$ if n is the number of voices. This means that voices where the ratio *is* a multiple of 3 must have their polynomials cancel out for $x=j$. Since their values are $3j^m$, one must have three (or 6, or 9) of

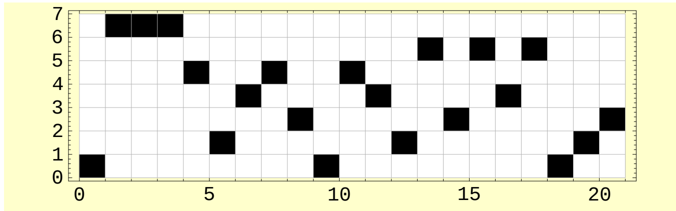

Figure 12: Tiling with $3k$-augmentations of 111

them, with appropriate values for the offsets m. This is a nice illustration of the power of polynomials and roots of unity.

Another of Johnson's problem about tilings by augmentation was solved with polynomials: why do tilings by augmentations of 11001 (with *binary* ratios: 2,4,8…) all have a number of notes which is a multiple of 15? The smallest such tiling is shown on Figure 13.

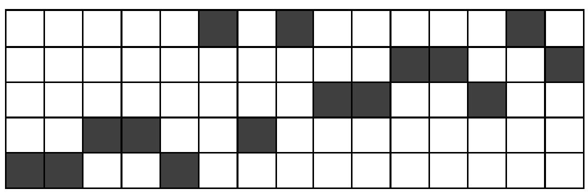

Figure 13: A tiling with 5 binary augmentations of 11001

However, this problem involves surprisingly advanced algebraic tools –Galois groups on finite fields, see [3]–, as the value 15 finally happens to be the number of invertible elements of $\mathbb{GF}_{16}$, which is the decomposition field of polynomial $1 + x + x^4$ in $\mathbb{GF}_2[x]$! This is perhaps best left for audiences with strong mathematical capabilities –I use it to convince these specific audiences that mathemusical research involves quite serious maths.

1.3.3 Further involvement

As mentioned above, in some cases a *concerférence* can be given at the invitation of some institution (high school, private association, university). In this case, there are interesting possibilities of interaction, before or after the talk. Besides the obvious dimension of communication (advertisement, articulation with previous events harbored by the institution, discussion of specific needs or interests), there may be some follow-up of the *concerférence* in classes: for instance, if the concepts of musical inversions and retrogradations have been shown, students can be enticed to try them on their own musical compositions, for instance with synthesizers online like `http://www.audiosauna.com/studio/`. A former student of mine, G. Baixas, did precisely that for 12 year olds: they had to create a melody and apply the transformations. In the process, most of them will have grasped (hopefully for the rest of their lives) that the composition of two planar axial symmetries is a central symmetry, cf. Figure 14.
This can easily lead to the installation of maths and music workshops, taken over by inspired local teachers, with the kind of curricula that are developed in other parts of this book.

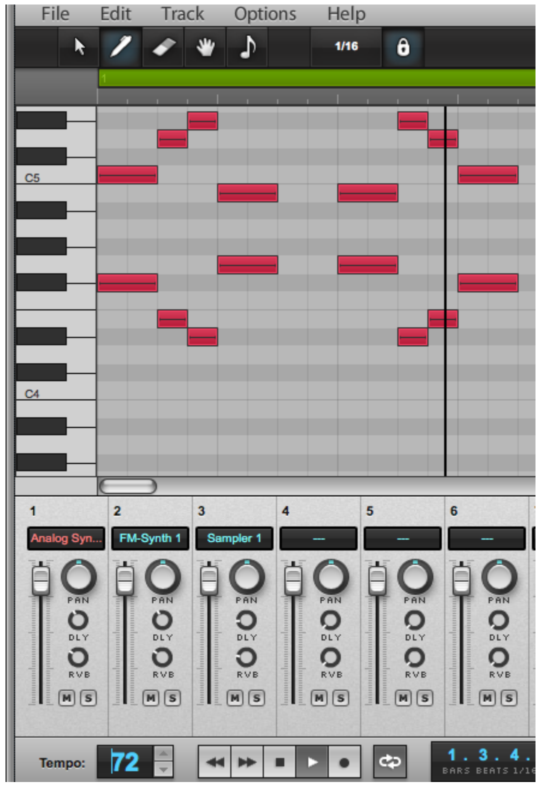

Figure 14: Composing symmetries with Audiosauna

2 Concerférences for specialists

Owing to the double heading of the discipline, the mathemusictalker can meet specialists in either music or sciences (not necessarily/only mathematicians). This can change the deal substantially.

For instance, again with Andreatta and Baroin we held a Bach evening, in November 2014 at *La Chapelle Gély* in Montpellier.[11] Most of the public was knowledgeable about some basic musical notions (who was J.S. Bach, what is a fugue, symmetries in counterpoint, even some ideas about tunings). In this case, the talker's job was to provide better, unambiguous definitions of the required operations. For instance, it was instructive to show the audience why the 5th and 6th canons of the *Goldberg Variations* cannot properly be named *'Canon alla Quarta'* (resp. *'alla Quinta'*) since they are canons by inversion and not simple transposition –hence there is no well defined, fixed interval, between a motif and its transformed version, as can be seen in Figure 15. In the same vein, graphical renderings (simplified sonograms) of the 30 variations showed at a glance the kind of symmetries used by the composer, whereas Jos Leys' famous video animation of the *Canon cancrizans* in *The musical Offering*[12] exemplified a global symmetry curving the whole musical space into a Möbius strip, which was duly realized live, both in glueing a printed score (with a twist) in front of the audience, and playing the canon with two instrumentists (one pushing the other off the piano stool at the end of the loop).

With the help of IRCAM, I organized in Paris in May 2012 a seminar for professors in

[11] http://images.math.cnrs.fr/+Bach-entre-nombre-et-geometrie+.html.

[12] https://www.youtube.com/watch?v=xUHQ2ybTejU

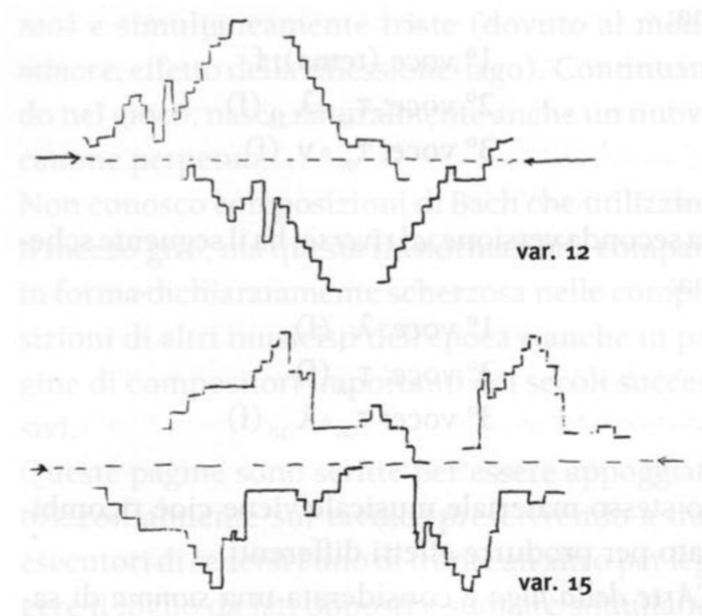

Figure 15: Canons by inversion in *Goldberg Variations*

the 'Classes Préparatoires' system (wherein I work) which seemed to fulfill a need.[13] Besides, this homogeneous category of teachers was given the incentive to push their students towards projects in maths and music which they might not have considered before the talk made them aware of the interest of such topics. Indeed, I have received a significant number of requests from their students for their 'TIPE' or *Travaux d'Initiative Personnelle Encadrés*, which are research projects for CPGE students with a tremendous importance in their evaluations. One such student even went through TIPE and a master thesis all the way to a Ph.D.[14] on the topic of rhythmic canons modulo p, a notion that I had invented in 2005. Other topics at TIPE level included: rhythmic canons (several times), spectral analysis for identification of bird's songs, variation of spectrum of a clarinet sound according to pitch, comparison of frets on a guitar with equal 12-TeT and its influence on production of harmonic notes, autosimilar melodies, maximally even sets, defining metrics on chord (or melody) spaces taking into account intervallic content, perception of 'pure' (sinusoidal) sound, Markovian analysis and synthesis of chord progressions in a *Tonnetz*, Polya enumeration in combinatorics of rhythms…
The scientific competence of such an audience[15] enables the speakers to indulge in discussing cutting-edge research in some depth. However, extra care has to be taken in explaining the musical fundamentals (pitch-classes, parameters/time spaces etc…) and providing simple, even basic, musical illustrations. It is easy, seeing their quickness in grasping subtle concepts, to forget that such publics can be extremely naïve on comparatively trivial musical questions, like octave identification, the distribution of white and black keys on a keyboard, the existence of microtonal systems, etc.…

[13] `http://repmus.ircam.fr/mamux/saisons/saison10-2010-2011/stage-math-musique`.
Though not properly a *concerférence*, I mention it in this chapter because there was a fair amount of musical content, like the Hamiltonian songs mentioned above.

[14] See [8].

[15] CPGE professors teach students around pre-graduate level, but typically hold a Ph.D. themselves, in Maths, Physics, Chemistry or Computer Science.

On the other hand, every so often scientists have some good amateur knowledge of music, or better. In the latter case, the mathemusictalker has to make his audience aware that music as a science has developed far, far beyond the old chestnuts of Pythagorean tuning and division of the octave, and involves much more modern tools than logarithms and diophantine approximation. It usually comes as a considerable surprise for such sophisticated audiences to discover that we use group theory, category theory, differential calculus, advanced algebra (like Galois theory on finite or continuous fields) and so on.
Whereas it is better to select a simple topic and gravitate around it when addressing non-specialists, it may be a good idea to take advantage of a knowledgeable audience in order to cover more *extensive* ground. In the present case, the four conferences (respectively by M. Andreatta, C. Agon, G. Assayag and myself) were about:

- A panorama of the discipline, with musical interpretations of mathematical problems (such as tilings) [9].
- The diversity of appropriate curricula in *Mathemusic* as exemplified by the ATIAM master formation in IRCAM.[16]
- Top notch computer and AI interaction with musicians and improvisers, with the OMax software [10].
- The extremely wide field of application of Discrete Fourier Transform in Music Theory (actually too wide by now to be presented here, see [2]).

One can go for even more technical presentations in the case of specialists associations, like professional mathematicians or math teachers. We encountered both with M. Andreatta and G. Baroin, respectively in Firenze[17] and Laon.[18]
In both occurrences we developed a presentation of sophisticated musical spaces –generalized *Tonnetze*– from a triple angle:

- Musical creation, through execution of pop songs composed by Andreatta using Hamiltonian cycles on the standard *Tonnetz* (cf. above Section 1.1).
- Graphical renderings, video animations in diverse geometrical projections of the *Tonnetz*, allowing to follow the moves around the 24 triads.
- At some point, a rather thorough theoretical explanation of the definition of the graphs and musical spaces involved, including the other *Tonnetze*.

The last point is the gratifying difference between a general popularization talk/show and one before an enlightened audience, that enables to provide sense and comprehensive meaning to an elsewise mainly decorative illustration of concepts: providing actual precise, scientific definitions in terms intelligible to the audience, and mathematical results stated in unambiguous terms more akin to a scientific paper presentation. However, such contexts are a luxury for a mathemusictalker.

[16] http://www.atiam.ircam.fr/fr/

[17] 18 April 2016, Conferenza-concerto "Matematica e musica" for *Festa della Mathematica*: http://roma.institutfrancais-italia.com/fr/node/7492.

[18] Journées APMEP, "Les mathématiques, quelle histoire ?", http://www.jnlaon2015.fr/programme/programme.php?item=10

Conclusion

It is an onerous task to break the ice between specialists of Maths and Music and the general public, but also an urgent one. The know-how of popularization events is immediately transposable to encounters with more knowledgeable publics, like maths or music or science teachers, that need to be reached too. Though scientists generally have no quarrel with a determinedly mathematical approach to musical questions, the reverse applies to some publics less familiar with 'the unreasonable efficiency of mathematics' who harbor a more romantic approach to the ineffability of music (which is a polite way of forbidding rational discourse on the topic), a point of vue unfortunately still well shared by many composers, analysts and practitioners –late French composer André Riotte once told me how much he was stung by Olivier Messiaen's violent reaction when he told him that limited transposition modes are readily obtained as orbits of a group action. My usual answer to the teleological argument that Music, being the breath of Gods, is best left respectfully unstained by maths, is: "the better you know the person you love, the better you love him/her", a fairly convincing metaphor if the public's reactions to it are anything to judge by.

It is our duty to go meet these people and help them correct these misinterpretations. The 'concerférences' described *supra* are a privileged means to this end, and one that I hope will develop and bloom in coming years. I have tried to help in this direction with the present contribution.

However, it may well be that newer ways of reaching large publics, like blogging and YouTubing, will prove best. Already these are more efficient in reaching younger publics who would not dream of getting away from their computer screen and walk all the way to a conference hall; already, some stunning scientific videos and blogs are seen by millions[19] and (even considering the high percentage of people it is wasted on) dispatch knowledge to many more than could ever be reached by traditional channels of information. So probably when we engineer concerférences, we should at least record them and upload the videos, thus stepping in the future in quiet assertion of the worth of our centuries-old discipline.

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