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# The art of asking (the right) musical questions to mathematicians: Tom Johnson's contribution to the MaMuX seminar

Moreno Andreatta

*CNRS-IRMA-CREAA, University of Strasbourg, Strasbourg, France*

*Équipe Représentations Musicales,  
IRCAM-STMS, Paris, France*

This article focuses on the role that Tom Johnson played as a composer posing all kinds of questions to mathematicians during the fifteen seasons of the MaMuX (Mathematics/Music and relations with other disciplines) seminar. This monthly seminar, that took place at IRCAM in Paris from 2001 to 2016, provided a very creative environment for the composer who was able to discover and explore new theoretical ideas that he successively (and successfully) applied in his compositions. At the same time, the theoretical questions the composer addressed to mathematicians had an important impact on mathematics and music research and enabled the “mathemusical” community to progress in many theoretical fields such as tiling problems, Block Designs, self-similarity, homometry, and juggling.

**Keywords:** Tom Johnson; MaMuX seminar; tiling; block designs; self-similarity; homometry; juggling

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## 1. Introduction

Can a composer truly play a role in the inner development of mathematics? The history of mathematics and music shows that many music theorists, musicologists and composers developed tools and ideas that deeply influenced the way in which music was approached from a scientific perspective. Sometimes, music theorists even succeeded in playing a role in the development of mathematics itself by paving the way to new ideas and constructions. Well-known examples are the invention of combinatorics by Marin Mersenne (1636) and graph theory by Leonhard Euler (1774). The problem of counting the number of possible melodies with a given number of notes (with and without repetitions) enabled Marin Mersenne to develop a panoply of tools giving rise to the new field of combinatorics and this largely before the systematization of the domain by Jacques Bernoulli in his work *Ars Conjectandi* (1713). In a similar way, it was a musical construction – the “Speculum Musicum” – that inspired Leonhard Euler in his investigations around the Königsberg problem, which eventually led to the developments of the new tools of graph theory.

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From an epistemological point of view, music theory seems to be much closer to mathematics than composition, but there are also cases of composers having developed a compositional system that is intrinsically based on some mathematical constructions that sometimes were unknown to the mathematical community of that time. One may naturally think of Johann Sebastian Bach's construction of canons and fugues, whose structural properties are naturally linked to the use of symmetries. As Iannis Xenakis suggests in his remarkable "Table of correspondences" between the development of music and mathematics (Xenakis 1971), the compositional process based on canons, especially in Bach's repertoire, is based on the composer's unwittingly manipulation of the Klein group of four elements. Moreover, for some enigmatic canonical compositions, such as the crab canon in two voices of the *Musical Offering*, Bach unconsciously invents (or discovers)<sup>1</sup> a mathematical structure that mathematicians would not formalize until one century later.

Twelve-tone music also offers many examples of compositional strategies that can be taken as a starting point for mathematical inquiries. One may think of the use of all-interval series by composers such as Alban Berg (in his *Lyrische Suite*), Luigi Nono (*Il canto sospeso*) or Elliott Carter (in his piano piece *Night Fantasies*), and the effort made by mathematicians, computer scientists and computational musicologists to provide the complete list of all-interval series and classify them. Twelve-tone music, in particular within the American set-theoretical tradition, offers a panoply of examples of constructions that can be taken as a starting point for a mathematical investigation. A well-known example is Milton Babbitt's Hexachord Theorem which has given rise to a large mathematical production.<sup>2</sup> But the most fascinating example of a compositional process which really contributed to make progress on the solution of difficult and still open mathematical conjectures is the construction of tiling canons and, especially, Vuza canons (Andreatta 2016). These are remarkable structures that enabled mathematicians to better understand the link between tiling problems and homometric structures and make significant progress towards the solution of the Spectral Conjecture in dimension 1 (Amiot 2009).

In the case of Tom Johnson, the compositional act is clearly guided by mathematical principles in a rigorous algorithmic approach. As we suggested in a detailed study devoted to algorithmic music (Andreatta 2013), the use of the computer is not a necessary condition for algorithmic composition. The algorithmic character of a musical process comes from the strict application of a system of rules that the composer decides to employ in order to produce results that will be either used without modification or applied to music composition after adding other rules or algorithmic processes. Composers such as Iannis Xenakis, on the contrary, always stressed the necessity of changing the final results if the algorithmic process does not provide the right answers. Despite some major differences, there are nevertheless some interesting common points in the ways in which Iannis Xenakis and Tom Johnson explore mathematically-based compositional strategies. The most striking common point between the two approaches is considering a piece of music as a solution of a given mathematical problem. Although Iannis Xenakis had surely a much stronger mathematical background than Tom Johnson, who is more self-taught, in both cases the composers felt the necessity of establishing a fruitful dialogue with professional mathematicians in order to grasp better the different mathematical tools they could use to realize their compositional ideas. In the case of Iannis Xenakis, the seminars – organized by Marc Barbut at CAMS (Centre d'analyse et de mathématique sociales) in Paris at the beginning of the

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<sup>1</sup> The duality between invention and discovery in mathematics is an intriguing philosophical problem that has interesting consequences in music. Tom Johnson's algorithmic compositions are philosophically much closer to the idea that mathematical objects are discovered rather than invented (Johnson 2001). One of the composer's main assumptions is that music "reveals" the structural properties of a mathematical object almost without human intervention. This is of course far from being the case, since the same mathematical object can give rise to a panoply of musical realisations, depending on the compositional application which remains a "creative" act.

<sup>2</sup> See Andreatta, Guichaoua, and Juillet (2024) for a review of the existing literature including some recent generalizations in the case of metric spaces with probabilistic measures.

1960s – offered to the composer the possibility of acquiring the skills in combinatorics and algebra that were fundamental in the development of what he called “symbolic music.” This category is introduced in opposition to that of “stochastic music,” making use of statistics and probability theory, tools that were much more familiar to him thanks to his former engineer studies in Greece at the National Technical University of Athens. It is also clear that his conversations and exchanges with Georges-Théodule Guibaud, another mathematician working at CAMS in that period, encouraged Xenakis to learn more about algebraic and sieve-theoretical formalisations of musical structures, which became essential in compositions such as *Akrata* (1964–65), *Nomos Alpha* (1966) and *Nomos Gamma* (1966–67).<sup>3</sup>

## 2. The MaMuX seminar: a catalyzer for the “mathemusical” community

One may argue that the MaMuX seminar at IRCAM played a similar role in the progressive assimilation of mathematical constructions that Tom Johnson successively introduced in his compositions. Analysing the way in which he participated in the different sessions of the MaMuX seminar is extremely inspiring since we are catapulted into the core of his creative process.

The MaMuX seminar ran monthly from November 2011 to May 2016. It sought to develop the relevance, both musical and mathematical, of the mathematics/music relationship through an exploration of possible links with other disciplines such as computer science, logic, philosophy, epistemology, linguistics, and cognitive sciences. The themes covered in the seminar included (among others): the formalization and representation of musical structures; mathematical and computer methods in musical theory, analysis and composition; set theory and transformational, diatonic and neo-Riemannian theories; mosaics and tilings; logic and computability in theoretical computer science, cognitive sciences and theories of perception; and the philosophy and semiotics of mathematics and music.<sup>4</sup>

The idea of creating a permanent monthly seminar at IRCAM on mathematics and music emerged after the very positive experience of the Diderot Mathematical Forum, a milestone event organized under the auspices of the European Mathematical Society. The Fourth edition of this international event was dedicated to “Mathematics and Music” and took place simultaneously in Lisbon, Paris and Vienna, on December 3–4, 1999.<sup>5</sup> As a first consequence of the Diderot Forum, a monthly seminar was created, entitled *mamuphi* (mathematics, music and philosophy) which is still active nowadays.<sup>6</sup> Several sessions of the *mamuphi* seminar were organized in collaboration with the MaMuX seminar, in particular the “Écoles mathématiques pour musiciens et autres non-mathématiciens” held by Yves André (2006–2009) and by Pierre Cartier (2009–2011) as well as the cycle devoted to Andrée Ehresmann’s “Memory Evolutive Systems” (2011–2012).

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<sup>3</sup> Besada (2025) offers a very interesting contribution to the quest of Iannis Xenakis’ algebraic sources with respect to his formalization activity in music theory and composition.

<sup>4</sup> The seminar was initially organized by Carlos Agon and Moreno Andreatta (2001–2011) and successively by Jean Bresson and John Mandereau (2011–2012), Jean Bresson (2012–2013), Hélianthe Caure (2013–2015), Grégoire Genuys and Jean-Louis Giavitto (2016). The 15 seasons are enumerated in the Online Supplement together with the complete list of participants.

<sup>5</sup> A volume published by Springer contains most of the papers presented in this conference. See Assayag, Feichtinger, and Rodrigues (2002).

<sup>6</sup> See the webpage of the seminar for more information about the past and future sessions of this monthly seminar (<http://www.entretmps.asso.fr/>).

### 3. Tom Johnson: an American composer at MaMuX

Within the fifteen years of the MaMuX seminar, Tom Johnson took actively part in 11 sessions, whose topics coincided with the music-theoretical interests the composer had at some point and the compositional projects that were initiated after the exchanges and the discussions during the seminar. One can see the evolution of ideas in Tom Johnson's compositions by following the talks he gave at the MaMuX seminar.

#### 3.1. *Tiling the (musical) line*

The first and probably most important topic that the composer discovered and systematically explored during many sessions of the MaMuX seminar was the tiling process in music. Several working sessions of the seminar were devoted to this topic and the first one (9 February 2002) contains many talks that were directly inspired by the questions Tom Johnson informally addressed to mathematicians during the months that preceded this session of the seminar. The paper by the mathematician Andranik Tangian, entitled "Enumeration of Rhythmic Canons and Fugues with Several Rhythmic Patterns (A Solution to Johnson's Problem)," clearly shows the influence of the composer's questioning on the mathematical research. This is also the first session in which Tom Johnson introduced his point of view on tiling canons in music in a paper entitled "Tiling the line in theory and in practice" (Johnson 2002). Less than one year later, the first compositions based on rhythmic tiling processes were presented by Tom Johnson in a session of the MaMuX seminar entitled "Deterministic and aleatoric tools in music analysis and composition" (25 January 2003). The composer's talk was entitled "Some observations about the theory of linear tilings. Around *Tilework* (14 pieces for 14 instruments)" (Johnson 2003).

Tom Johnson was interested in a particular type of tiling of the line process in which a tile is not only translated, as in usual rhythmic canons, but also deformed through augmentations, recalling compositional techniques used in counterpoint theory. In the case of the rhythmic tilings studied by Tom Johnson, the augmentation process has the property that the multiplicative factors of a given tile are all different.<sup>7</sup> These rhythmic tilings were called "perfect" and the investigation on the mathematical properties of these musical structures began in the third season of the MaMuX seminar. The mathematical and musical aspects of perfect rhythmic tilings were presented by the composer in a talk entitled "Perfect Rhythmic Tilings" (24 January 2004). The following year, one of the first session of the fourth season of the MaMuX seminar was dedicated to the topic of diagrams, mosaics and tilings in music. Tom Johnson gave a talk entitled "Musical Questions for Mathematicians" (Johnson 2004). The text is introduced by a note that explains his philosophy with respect to the MaMuX seminar:

As a composer working with mathematical structures and deterministic sequences, I often confront questions I am not qualified to answer. At such times mathematician colleagues such as Jean-Paul Allouche or Franck Jedrzejewski or Emmanuel Amiot or Jon Wild are often able to give me answers, and sometimes this information enables me to compose a type of music that has never been heard before. Recently, working on a series of "rational harmonies," I find that my progress is frequently blocked by mathematical barriers. Rather than bothering particular colleagues with my rather long list of rather thorny questions, it seems preferable to present them in a general way, so that mathematicians may work on whatever questions seem most interesting to them. Sometimes the answers they find may be useful in contexts far larger than some particular Tom Johnson's composition (Johnson 2004).

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<sup>7</sup> Thomas Noll had the idea of relaxing these constraints and exploring tiling rhythmic canons in which the several voices can have the same multiplicative factor. This led to the family of "Augmented Tiling Canons" that were implemented in *OpenMusic* and integrated in the *MathTools* environment. See [Andreatta et al. \(2006\)](#).

### 3.2. *Self-similarity and self-replicating loops*

Although tiling problems remained a source of inspiration for his musical activity, Tom Johnson decided to also explore different mathematical aspects related to combinatorics in music composition including a topic that he investigated largely in his first theoretical book entitled *Self-Similar Melodies* (Johnson 1996). The concept of self-similarity in music has benefited from the work of professional mathematicians who contributed to the formalization of new mathematical properties that were not taken into account in Tom Johnson's original research. The first session of the sixth season of the MaMuX seminar (14 October 2006) was centered on the topic of self-similarity in mathematics and in music. This session gave to the composer the possibility of discussing his way to apply self-similar processes in composition in a talk entitled "Self-Similar Structures in my Music: an Inventory" (Johnson 2006). In the same session, Emmanuel Amiot presented his new mathematical results on self-similarity applied to music by describing the algebraic set-up of Tom Johnson's original idea in a talk entitled "Self-Replicating Loops: the theory." The contribution of Emmanuel Amiot to the present issue clearly shows that this topic is far from being closed.<sup>8</sup>

### 3.3. *Exploring the combinatorial universe of block designs*

The next mathematical topic that Tom Johnson became interested in was the theory of Block Designs. As before, the MaMuX Seminar became the privileged place to share thoughts about this theory already applied to composition in 2003 with the piece *Kirkman's Ladies*. The session on 6 February 2009 of the seminar was entirely devoted to Block Designs in music analysis and composition. Tom Johnson gave a talk entitled "Composing with Block Designs" and the percussionist Adam Weisman took part in the session by illustrating some pieces making use of this combinatorial theory. Since *Kirkman's Ladies* (2003), Tom Johnson wrote several pieces with combinatorial Block Designs. In his presentation, the composer discussed in particular the system (11, 4, 6), used to compose *55 Chords*, an organ piece, but he also presented other compositions such as *Block Design for Piano*, *Septet*, *Twelve*, and the *Vermont Rhythms*, which were recently premiered in Cambridge by the Dutch ensemble Klang. The mathematical aspects of Block Designs were largely investigated by Franck Jedrzejewski who also gave a talk in the same session, entitled "Groups and  $t$ -designs." Groups not only play an important role in the formalization of the combinatorial properties of Block Designs but they are also the key for creating and visualizing existing designs. As shown by Reinhard Laue in his talk entitled "Creating and Visualizing Designs by Groups," many prominent examples of Block Designs have interesting properties that can be captured, in an elegant way, by symmetry groups. The program DISCRETA, developed at the University of Bayreuth by Laue's team, enabled mathematicians to construct  $t$ -designs with prescribed symmetries that can possibly also be represented as patterns on a graph. Tom Johnson's interest for the theory of Block Designs was associated with the discovery of two additional combinatorial concepts that the composer decided to investigate with the help of several mathematicians: the theory of juggling and the theory of homometry.

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<sup>8</sup> Following an original intuition by Emmanuel Amiot, self-similar melodies (or "self-replicating loops") can also be used to construct particular tilings. As in the case of "Augmented Tiling Canons," this model has been implemented and integrated in *OpenMusic* visual programming language and offers new perspectives for computer-aided composition. See Amiot, Agon, and Andreatta (2007).

### 3.4. *Juggling and homometry: two new fields to be investigated*

The Spring 2011 session of the MaMuX seminar (1 April 2011) allowed the composer to propose a little journey through some of his compositions based on Steiner systems, which are special cases of Block Designs where the elements of a given set are distributed in a collection of subsets of a given cardinality such that every pair of elements is present only once. This session also permitted a more detailed analysis of the different ways in which a given combinatorial structure is applied to a particular composition. This point was raised by composer Gilbert Delor in his talk on the different ways Tom Johnson used the Block Design  $(12, 4, 3)$  in his piano piece *Twelve* (2008): the exploration of the combinatorial properties of the Block Design, the use of underlying graphs, the construction of scales, the relation between rhythmic uniformity and harmonic complexity, the duality between order and chaos and, finally, the presence of a number of symmetries or regularities which are difficult to appreciate in the listening process. The new content of Tom Johnson's talk – entitled “Combinatorial Designs in my music / First essays of application of mathematical theory of juggling to music” (Johnson 2011) – concerns his discovery of the mathematical theory of juggling and its possible applications to music. Surprisingly, the theory of juggling was deeply connected with tilings, as the composer showed with the piece *Dropping Balls* for a solo juggler (Luke Wilson) and the piece *Three Notes for Three Jugglers* written for Sean Gandini and his ensemble.

As the composer said, “from a mathematical point of view the two constructions are very similar, but the way of applying them to music remains very different” (Johnson 2011). Some months later, a special session of the MaMuX seminar was organized at the Centre Pompidou entirely devoted to juggling theory applied to music composition. In the session of 6 January 2012, Tom Johnson together with the mathematician Franck Jedrzejewski and the jugglers Luke Wilson and Jonathan Lardillier gave a talk entitled “Transforming mathematics into music, music into juggling and juggling into writing process.” The talk was accompanied by the projection on a screen of the performance of the piece *Three Notes for Three Jugglers*, premiered by Gandini Juggling at the Festival of Steim few months earlier and the performance of Tom Johnson's piece *Dropping Balls* by the juggler Luke Wilson. In addition and in parallel to juggling, Tom Johnson explored a new “mathemusal” domain: homometry. This topic was discovered thanks to the sessions of the MaMuX seminar that were organized in collaboration with Franck Jedrzejewski and Emmanuel Amiot, who became interested in the mathematical formalization of this concept whose roots can be traced back to crystallography. Research on homometric structures in music became in that period an extremely rich field, with several academic dissertations and articles devoted to the theoretical and computational properties of homometry as applied to music analysis and composition. See Mandereau et al. (2011a) and Mandereau et al. (2011b) for a first comprehensive study on the mathematical aspects of homometric structures as musical distributions.

Homometric structures in music were commonly used, although with a different terminology, in American set-theoretical tradition and there are many examples of composers (Anton Webern, Milton Babbitt, George Perle, Elliot Carter) making use of  $Z$ -related pitch-collections, i.e. chords sharing the same interval content. Tom Johnson's piece *Intervals* (2013) for flexible instrumentation is probably the first composition that exhaustively uses homometric harmonies (and more precisely the collection of 48 all-interval tetrachords arranged for two monodic instruments) throughout the piece.

## 4. The MaMuX seminar as an experimental platform for two comprehensive books

As we have seen, the number of mathematical constructions that Tom Johnson explored and applied in music composition during the first decade of the MaMuX seminar is impressive. It

goes from the different ways to tile the line with transformations of a rhythmic pattern to the mathematics of juggling, passing through the combinatorial theory of Block Designs, permutation groups, the study of Hamiltonian cycles on some graphs and the theory of homometry. All of these theoretical constructions and musical applications were summarised in a book that the composer wrote in collaboration with Franck Jedrzejewski, entitled *Looking at Numbers* (Johnson and Jedrzejewski 2014). A special session of the MaMuX seminar was devoted to this book and took place on 22 March 2013. As stressed by the authors in their text of presentation of the seminar session, the publication of *Looking at Numbers* provides the opportunity for the authors to describe the state of art of these new “mathemusal” objects and to pave the way to future research. There is clearly one central aspect in Tom Johnson’s research which is the “visual” dimension that is well expressed by the title of the book. As pointed out by the composer Gilbert Delor in his talk entitled “Le visuel dans l’œuvre de Tom Johnson,” the visual dimension was always present in Tom Johnson’s work, from the 1973 *Imaginary Music* drawings to the piano 4-hand work *Symmetries* (1980–1989) that was initially conceived in a graphical form. In fact, as Tom Johnson and Franck Jedrzejewski affirm in the “Instructions for the Reader” section of the book, the initial aim was to collect the drawings made by the composer between 2008 and 2012 “as he attempted to map out his mathematical music” but the project became something different and was finally co-authored with Franck Jedrzejewski “after some 10 years of mutual experiences through MaMuX, the mathematics and music seminars held almost every month at IRCAM” (Johnson and Jedrzejewski 2014).

Two years later, on 6 March 2015, a special session of the MaMuX seminar was organized around Tom Johnson’s new book entitled *Other Harmony. Beyond tonal and atonal* (Johnson 2014). The short note that accompanied Tom Johnson’s presentation at the seminar clearly shows the aim of this new book:

Hundreds of harmony books have been devoted to tonality, and many have dealt with atonality, which has usually meant serialism, but this book considers all of the Other Harmony that has dominated musical practice for at least 50 years. After considering theories of Forte, Euler, Hauer, Slominsky, Obouhow, Schillinger, and Messiaen, the book considers some of my own harmonic practices having to do with heights, sums modulo  $n$ , homometric pairs and combinatorial designs. I will do my best to summarize the important points in all this, playing some musical examples, and to talking about some of the questions I still have.

As Franck Jedrzejewski suggests in his talk that followed Tom Johnson’s presentation, entitled “From Total Harmony to Combinatorial Harmony,” the real question underlying this new book is the definition of a new category of harmony that is based on the combinatorial character of the pitch and rhythm spaces. This goes with what Tom Johnson stresses in the short presentation of the volume (Johnson 2014) that one finds in the cover:

I think we finally need a new harmony book that goes beyond tonal and atonal and considers all the Other Harmony that has dominated and continues to dominate music.

The duality tonal versus atonal has somehow polarized the debate of the contemporary music community since the second half of the twentieth century and the list of music-theorists and composers included in the book (Leonhard Euler, Josef Matthias Hauer, Nicolas Slominsky, Nicolas Obouhow, Joseph Schillinger and Olivier Messiaen) clearly suggests that a third way is possible which goes in fact beyond tonality and atonality. Tom Johnson might also have included in this list the Romanian composer Anatol Vieru who also proposed an alternative to the tonality/atonality duality (Vieru 1985). This approach was systematically explored and formalized through an algebraic perspective by Dan Tudor Vuza (Cazaban et al. 2006), a mathematician who had a deep influence on Tom Johnson’s tiling-based compositions.

Clearly, the label of “minimalist composer” often applied to Tom Johnson’s compositional practice is very reductive, as Emmanuel Amiot pointed out in his final talk of the same MaMuX session focusing on the composer’s desire for exhaustiveness. A new musical expression is in fact possible via an exhaustive exploration of the combinatorial properties of a musical system.

After briefly discussing the tonality/atonality dichotomy, the book displays the alternative orientations in music composition (or what the composer defines as “other”). Once again, the composer acknowledges the influence that the sessions of the MaMuX seminar had in all these “other” music-theoretical orientations which “will all be pretty familiar to the mathematicians and music theorists who attended the monthly music and mathematics MaMuX seminars at IRCAM in Paris between 2001 and 2010.”<sup>9</sup>

The reader will therefore discover (or re-discover) how the composer dealt with very ubiquitous notions such as equality and completeness (p. 109–118), heights and sums (p. 121–131) as well as more intuitive music-theoretical concepts such as chord progressions (p. 135–142) and adjacent intervals (p. 145–152) and, last but not least, some mathematical concepts driven by MaMuX such as sum modulo  $n$  (p. 155–168), all-interval tetrachords and other homometries (p. 171–187), block designs (p. 191–207) and parallel classes (p. 211–222). The book ends with a chapter entitled *Almost Not* which expresses the composer’s perspective on the new musical expression which is made possible through all of these combinatorial properties of a musical system. This perspective was developed in his very last presentation at the MaMuX seminar within a special session entitled “From mathematics to a new expression.”<sup>10</sup>

## 5. From mathematics to a new (musical) expression

What is the heritage of Tom Johnson in contemporary music? Is there a kind of “Johnson’s school” to which composers all around the world might belong? The way in which mathematical concepts and structures have been applied to music by the composer is surely very singular and its radical character does not seem to be easily adapted to other composers’ approaches. Nevertheless, as Tom Johnson suggested several times during the MaMuX seminar, the existence of a kind of legacy clearly appeared in a session of the seminar entitled “Music and mathematics as seen by composers.” The session took place on 14 January 2011 and was introduced by the composer himself who stressed the fact that the panoply of mathematical models applied to music composition is in fact a new way of exploring algorithmic composition that can be investigated by other composers. This suggestion surely applies to the five young composers who took part in the session: Samuel Vriezen, Brian Parks, Christopher Adler, Michael Winter, and Steve Gisby.

This MaMuX session was organized as part of a very intense week that celebrated Tom Johnson’s theoretical and compositional achievements as well as his influence on several young composers, in particular those who took part in the seminar. On 15 January 2011, a concert was organized at the American Church in Paris, including mathematical music such as *Activated Progressions* by Brian Parks, *Eleven Sequences* by Christopher Adler, *Six-Note Melody* (1987) by Tom Johnson and *Sort I* by Michael Winter. The following day, a second long concert took place at the *Instants Chavirés* in Montreuil, in collaboration with *La Muse en circuit* of Alfortville. The program of the concert included a new work for piano four hands by Steve Gisby, *Fourths and Fifths* by Samuel Vriezen, *Infinite Melodies* by Tom Johnson, *Mississippi Hot Dog* by Brian Parks and *A Meditation for Solo Piano* by Michael Winter. And finally, Monday 17 January, several events were hosted at the *Maison Européenne des Sciences de l’Homme et de la Société* in collaboration with the Centre d’Étude des Arts Contemporains (University of Lille 3) and the Muzzix collective of the Conservatoire of Lille, including a lecture and discussion with the mathematician Jean-Paul Delahaye and the composer Tom Johnson as well as the performance

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<sup>9</sup> See the introduction to the volume, p. vi.

<sup>10</sup> The entire session has been recorded and the video of Tom Johnson’s talk is available on IRCAM channel: <https://medias.ircam.fr/fr/x908e84>

of several pieces based on mathematics (by Tom Johnson, Christopher Adler, Steve Gisby, Brian Parks, Samuel Vriezen, and Michael Winter).<sup>11</sup>

Tom Johnson's last talk at the MaMuX Seminar took place on 11 December 2015 and was entitled "Mathematics in my music." In this talk the composer showed once more how different mathematical constructions became musical compositions. Three pieces are analyzed in details: *Kirkman's Ladies* (2005), a composition for flexible instrumentation displaying the Block Design (15, 3, 1); *Vermont Rhythms* (2008) for 2 saxophones, trombone, guitar, piano and percussion, based on the Block Design (11, 6, 1); and *Slight Variations*, a work in progress for piano based on a couple of homometric hexachords that was published the following year. As Tom Johnson pointed out:

I'm a MaMuX participant from the very beginning, which is 2001. This seminar has been very important for me because I have met several mathematicians [...] and the exchanges have stimulated my music a lot. I'm not mathematician myself but I have learned a lot of mathematics, especially combinatorics.

These words that Tom Johnson chose to accompany his last talk at the MaMuX seminar perfectly summarise the creative dynamics that took place in the fifteen years of exchanges and collaborations between the composer and his mathematical colleagues.

## Acknowledgments

On the behalf of all the organizers of the MaMuX seminar, I wish to warmly thank all the participants of the monthly seminar for their contribution as well as IRCAM and CNRS for regularly supporting the fifteen seasons of this milestone event that played a major role in the constitution of an international 'mathemusical' community. I'm grateful to Emmanuel Amiot for his invitation to contribute to this Special Issue that constitutes a celebration of Tom Johnson's inspirational ideas in the field of relations between music and mathematics. Many thanks to the referees for their useful comments and suggestions. Special thanks to Darrell Conklin and Emmanuel Amiot for their additional suggestions and their careful reading of the manuscript.

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<sup>11</sup> Video available at: <https://webtv.univ-lille.fr/video/4068/musique-et-mathematiques-conference>.

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**Online Supplement to**  
**“The art of asking (the right) musical questions to mathematicians:**  
**Tom Johnson’s contribution to the MaMuX seminar”**

Moreno Andreatta<sup>a,b</sup>

<sup>a</sup>*CNRS-IRMA-CREAA, University of Strasbourg, France;*

<sup>b</sup>*Équipe Représentations Musicales, IRCAM-STMS, Paris, France*

The MaMuX seminar ran monthly from November 2011 to May 2016. The seminar was initially organised by Carlos Agon and Moreno Andreatta (2001-2011) and successively by Jean Bresson and John Mandereau (2011-2012), Jean Bresson (2012-2013), Hélianthe Caure (2013-2015), Grégoire Genuys and Jean-Louis Giavitto (2016).

The 15 seasons are enumerated here below and are accompanied with the complete list of topics and participants. For a detailed description of each session with links to available material (powerpoint presentation, articles, videos, . . .) the reader can refer to the main webpage: <http://repmus.ircam.fr/mamux/saisons/home>.

**Keywords:** Tom Johnson; MaMuX seminar; Tiling; Block Designs; Self-Similarity; Homometry; Juggling

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*2012 Computing Classification Scheme:* mathematics of computing

- *First Season (2001-2002)*

**17 November 2001:** Introduction to the Mathematical Theory of Music. With the participation of Guerino Mazzola and Moreno Andreatta.

**15 December 2001:** Theory of local and global concepts in music. First part: ‘objective’ theory. With the participation of Guerino Mazzola.

**19 January 2002:** Theory of local and global concepts in music. Second part: ‘functorial’ theory’. With the participation of Guerino Mazzola.

**9 February 2002:** Mosaics and tilings in music. With the participation of Harald Friperinger, Emmanuel Amiot, Andranik S. Tangian, Tom Johnson, and Georges Bloch.

**16 March 2002:** American Set Theory and theories of diatonicism. With the participation of Luigi Verdi, Franck Jedrzejewski, Guerino Mazzola, and Moreno Andreatta.

**23 March 2002:** Mathematical tools in music. With the participation of Pierre Lusson, Fabien Lévy, Stephan Schaub, Olivier Lartillot, and Benoît Meudic.

**13 April 2002:** On Tone Systems. With the participation of Yves Hellegouarch, Thomas Noll, and Guerino Mazzola.

**27 April 2002:** A Study Day devoted to Iannis Xenakis. With the participation of André Baltensperger, Agostino Di Scipio, Mikhail Malt, Gérard Assayag, Stéphane Schaub, Moreno Andreatta, Makis Solomos, and Benoît Gibson.

- 18 May 2002:** Mathematical structures in performance and improvisation. With the participation of Guerino Mazzola and with a concert by Patrizio Mazzola and Guerino Mazzola.
- *Second Season (2002-2003)*
    - 9 November 2002:** Algebraic-semiotic aspects in music and musicology. With the participation of Thomas Noll, Marta Grabocz, Mathilde Vallespir, Guerino Mazzola, and Costin Cazaban.
    - 14 December 2002:** Musical formalisations and representations – Between Set Theory, Diatonic Theories and Neo-Riemannian approaches. With the participation of Nicolas Meeùs, Jean-Marc Chouvel, Jean-Pierre Cholleton, Gérard Assayag, Franck Jedrzejewski, Moreno Andreatta, Thomas Noll, and Xavier Hascher.
    - 25 January 2003:** Deterministic and aleatoric tools in music analysis and composition I. With the participation of Emmanuel Amiot, Tom Johnson, Andranik Tangian, Franck Jedrzejewski, and Paulo C. Chagas.
    - 15 February 2003:** A Study Day on Milton Babbitt and combinatorics in music. With the participation of Célestin Deliège, François Nicolas, Alain Louvier, André Riotte, and Alain Bancquart.
    - 7-8 March 2003:** Cognitive sciences, mathematics and music perception. With the participation of Guerino Mazzola, Edward Gollin, Thomas Noll, Anja Fleischer, Stephen McAdams, Jean Petitot, PerAage Brandt, and Michael Leyton. Pre-session on computer-aided music analysis, with the participation of Thomas Noll, Anja Fleischer, Olivier Lartillot, Geoffroy Peeters, Vittorio Cafagna, and Domenico Vicinanza.
    - 12 April 2003:** Deterministic and aleatoric tools in music analysis and composition II. With the participation of Mikhail Malt, Stefan Göller, Gérard Milmeister, Benoît Meudic, Guerino Mazzola, Stefan Müller, and Chantal Buteau.
    - 10 May 2003:** Music informatics. With the participation of Philippe Codognet, Yann Orlarey, Marco Stroppa, Karim Haddad, Mikhail Malt, and Guerino Mazzola.
  - *Third season (2003-2004)*
    - 8 November 2003:** Micro-tonality and modal systematics. With the participation of Didier Aschour, Alain Bancquart, Franck Jedrzejewski, Amine Beyhom, Carlos Agon, and Moreno Andreatta.
    - 13 December 2003:** Formalisation and representation of musical structures. With the participation of John Rahn, Oren Kolman, Guerino Mazzola, Moreno Andreatta, Jon Wild, Dave Meredith, and Olivier Lartillot.
    - 24 January 2004:** Tilings and combinatorial problems in music theory and composition. With the participation of Emmanuel Amiot, Franck Jedrzejewski, Georges Bloch, and Tom Johnson.
    - 20 March 2004:** Group theory, category theory and topos theory in music and in arts – Theoretical aspects and philosophical perspectives. With the participation of Guerino Mazzola, Franck Jedrzejewski, Thomas Noll, Frédéric Patras, Peer Bundgaard, Charles Alunni, Moreno Andreatta, and Peter Johnstone.
    - 21-22 May 2004:** Computational tools in music analysis, logics and transformational theories. With the participation of Stephan Schaub, Elaine Chew, Chantal Buteau, Olivier Lartillot, Benoît Meudic, Petri Toiviainen, Thomas Noll, David Clampitt, and Vittorio Cafagna.

- *Fourth Season (2004-2005)*
  - 20 November 2004:** Diagrams, mosaics and tilings in music. With the participation of Franck Jedrzejewski and Tom Johnson.
  - 18 December 2004:** Algebraic structures and symmetries in music. With the participation of Thomas Noll, Andrei Rodin, and Franck Jedrzejewski.
  - 12 February 2005:** A Study Day on transformational and neo-riemannian theories (organised in collaboration with the Centre de Recherche Langages Musicaux of the University of Paris IV, Sorbonne). With the participation of Stephan Schaub, Moreno Andreatta, Thomas Noll, Franck Jedrzejewski, Richard Hermann, Nicolas Meeùs, Philippe Cathé, Xavier Hascher, and Jean-Marc Chauvel.
  - 13 March 2005:** Logic and calculability in computer science. With the participation of Gilles Dowek, François Pachet, Daniel Schell, Charlotte Truchet, Frank Valencia, Camilo Rueda, Elaine Chew, and Alexandre François.
  - 17 April 2005:** Around the notion of complexity in mathematics, computer science, and music. With the participation of Fabien Lévy, Hugues Dufourt, Jean-Paul Allouche, Andranik Tangian, and Nicolas Darbon.
  - 19 June 2005:** On rhythmic tiling canons and musical mosaics. Theory and implementation. With the participation of Emmanuel Amiot, Moreno Andreatta, and Carlos Agon.
- *Fifth season (2005-2006)*
  - 15 October 2005:** Around transformational logics in music: from Lewin/Klumpenhouwer to topos-theoretical logics of diagrams. With the participation of Moreno Andreatta, Xavier Hascher, and Guerino Mazzola.
  - 12 November 2005:** A meeting with Jean-Yves Girard.
  - 14 January 2006:** Philosophy of music / philosophy of mathematics. With the participation of Carmine Emanuele Cella and Albino Lanciani.
  - 25 February 2006:** Around temporal logics in music and computer science. With the participation Gérard Ligozat, Camilo Rueda, and Antoine Allombert.
  - 11 March 2006:** Knot theory and braids in mathematics and music. With the participation of Patrick Dehornoy, Franck Jedrzejewski, and Thomas Noll.
  - 29 April 2006:** Homage to André Riotte and Marcel Mesnage. With the participation of André Riotte, Marcel Mesnage, Jean-Michel Bardez, Alain Poirier, Nicolas Meeùs, Xavier Hascher, Claudy Malherbe, François Nicolas, Gérard Assayag, Stéphan Schaub, Moreno Andreatta, and Jean-Claude Thevenon. Piano recital by Thérèse Malengreau.
  - 20 Mai 2006:** Analytic philosophy and music theory. With the participation of Stéphan Schaub, Emmanuel Amiot, and Guerino Mazzola.
- *Sixth Season (2006-2007)*
  - 14 October 2006:** Self-similarity in mathematics and in music. With the participation of Tom Johnson, Emmanuel Amiot, and Guerino Mazzola.
  - 18 November 2006:** Logics in mathematics and computer. With the participation of Pascal Boldini.
  - 9 December 2006:** Mathematical School for musicians and other non-mathematicians by Yves André. A first perspective on operator algebras (von Neumann algebras).
  - 27 January 2007:** Mathematics/Music/Physics. With the participation of Patrice Bailhache, Franck Jedrzejewski, and Xavier Hautbois.

- 10 February 2007:** Music informatics. With the participation of Jean-François Perrot and Jean Bresson.
- 24 March 2007:** Mathematical School for musicians and other non-mathematicians by Yves André. On Grothendieck's topology.
- 12 May 2007:** Mathematical School for musicians and other non-mathematicians by Yves André. Galoisian ideas (ambiguity theory).
- *Seventh Season (2007-2008)*

**6 October 2007:** Mathematics/Music and computer-aided composition. With the participation of Arturo Fuentes and Guilherme Carvalho.

**1 December 2007:** Mathematical School for musicians and other non-mathematicians by Yves André. Linear representations and harmonic analysis.

**15 December 2007:** Compositional and philosophical stakes of mathematical theory of categories. With the participation of Guerino Mazzola and Ralf Krömer.

**11-12 January 2008:** Mathematics/Music and Cognition. A special session organised within the Symposium "Around Fred Ler Dahl and Ray Jackendoff's *Generative Theory of Tonal Music*". With the participation of Nicolas Meeùs, Costas Tsougras, Ray Jackendoff, Fred Ler Dahl, Carol L. Krumhansl, Irène Deliège, Michael J. Bruderer, Thomas Noll, Rob Seward, Emiliós Cambouropoulos, Geraint A. Wiggins, Marcus Pearce, and Daniel Mullensiefen.

**2 February 2008:** Tiling rhythmic canons and Fuglede Spectral Conjecture. With the participation of Carlos Agon, Moreno Andreatta, Emmanuel Amiot, Edouard Gilbert, Franck Jedrzejewski, and Mihalis Kolountzakis.

**15 March 2008:** Mathematical School for musicians and other non-mathematicians by Yves André. Singularities.

**5-6 April 2008:** International Workshop of Computational Music Analysis. A session organised by Chantal Buteau and Christina Anagnostopoulou. With the participation of Fernando Gualda, Olivier Lartillot, Darrell Conklin, Philippe Cathé, Yun Kang Ahn, Atte Tenkanen, Christina Anagnostopoulou, and Chantal Buteau.

**25 April 2008:** Mathematics/Music and Cognition – Diatonic theories. With the participation of Moreno Andreatta, Eytan Agmon, Emmanuel Amiot, Thomas Noll, Julien Junod, and Pierre Audétat.

**17 May 2008** (at the École normale supérieure): Mathematical School for musicians and other non-mathematicians by Yves André. Duality (and dualities).
  - *Eight Season (2008-2009)*

**7 November 2008:** Around complexity in the arts. With the participation of John Casti, Jean-Pierre Boon, Athanase Papadopoulos, and Geoffroy Drouin.

**5 December 2008:** Concurrent processes in music informatics. A session organised in collaboration with the LIX of the Ecole Polytechnique. With the participation of Camilo Rueda, Frank Valencia, Carlos Olarte, Mauricio Toro, and Arshia Cont.

**17 January 2009:** Mathematics and Cognition. With the participation of Andrée C. Ehresmann and Jean-Paul Vanbremeersch. A common session with the *mamuphi* (mathematics, music and philosophy) seminar.

**23 January 2009:** Music and Cognition. Around the contributions of John Sloboda. A special session co-organised with Irène Deliège and under the auspices of the ESCOM (European Society for the Cognitive Sciences of Music). With the participation

of Jane Ginsborg, Daniel Müllensiefen, Geraint A. Wiggins, Mario Baroni, Rossana Dalmonte, Roberto Caterina, Michel Imberty, Nicholas Cook, Barbara Tillmann, Emmanuel Bigand, Adam Ockelford, Richard Parncutt, and John Sloboda.

**6 February 2009:** Combinatorial Block Designs. With the participation of Reinhard Laue, Franck Jedrzejewski, and Tom Johnson.

**6 March 2009:** Mathematics/music and semiotics – The temporal semiotic units. A session organised in collaboration with the MIM Laboratory of Marseille. With the participation of Marcel Formosa, Philippe Bootz, Xavier Hautbois, and Jean-Paul Allouche.

**3 April 2009:** Mathematics/Music and Cognition. Discrete Fourier Transform and music perception. With the participation of Emmanuel Amiot, Julien Junod, Isabelle Viaud-Delmon, and Carlos Agon.

**9 May 2009:** Geometry of Interaction and music. With the participation of Yves Lafont, Thierry Paul, Carmine Emanuele Cella, and François Nicolas.

- *Ninth Season (2009-2010)*

**10 October 2009:** Information geometry and music. With the participation of Arnaud Dessein, Hichem Snoussi, Frédéric Barbaresco, and Arshia Cont.

**13 November 2009:** Around the geometrisation of logic and music informatics. With the participation of Olivier Michel, Antoine Spicher, and Jean-Louis Gavitto.

**4 December 2009:** Functorial approaches in music informatics. With the participation of Gérard Milmeister, Florian Thalman, Guerino Mazzola, and Thomas Noll.

**15 December 2009:** Mathematical School for musicians and other non-mathematicians by Pierre Cartier. How to translate at best the ideas of symmetry.

**15 January 2010:** Knot theory and music. With the participation of Franck Jedrzejewski, Leone Slavich, and Timothy Porter.

**12 March 2010:** Representations for computer science. Graphs and S-languages. With the participation of Yannis Manoussakis, Fivos Maniatakos, Gilles Baroin, Sylviane R. Schwer, and Antoine Allombert.

**13 March 2010:** Mathematical School for musicians and other non-mathematicians by Pierre Cartier. Around probabilities.

**9 April 2010:** Chu spaces and music. With the participation of Vaughan Pratt, Paul-André Melliès, and Timothy Porter.

**4 May 2010:** Special session on word theory and music. With the participation of Thomas Noll, David Clampitt, Norman Carey, and Jean-Paul Allouche.

**14 May 2010:** Algorithmic music. With the participation of Gerhard Nierhaus, Michael Koenig, and Markus Noisternig.

**15 May 2010:** Mathematical School for musicians and other non-mathematicians by Pierre Cartier. Conceptual changes of probability theory in the 20th century.

- *Tenth Season (2010-2011)*

**8 October 2010:** Formal models of counterpoint. With the participation of Julien Junod, Karim Haddad, and Moreno Andreatta.

**10 December 2010:** Generalised Interval Systems and Homometry Theory. With the participation of Daniele Ghisi, John Mandereau, and Guillaume Lachaussée.

- 11 December 2010:** Mathematical School for musicians and other non-mathematicians by Pierre Cartier. Conceptual changes of probability theory in the 20th century: after 1950 (first part).
- 14 January 2011:** Music and Mathematics as seen by composers. Tom Johnson with five young composers: Christopher Adler, Steve Gisby, Brian Parks, Samuel Vriezen, and Michael Winter.
- 4 February 2011:** Mathesis and subjectivity (around musical logic). With the participation of Hugues Dufourt.
- 5 February 2011:** Mathematical School for musicians and other non-mathematicians by Pierre Cartier. Conceptual changes of probability theory in the 20th century: after 1950 (second part).
- 11 March 2011:** Homage to Marcel Mesnage. Computational musicology and algorithmic composition. A special session organised in collaboration with the SFAM (French Society of Music Analysis). With the participation of André Riotte, Thérèse Malengreau, Bruno Bossis, Luigi Verdi, Jean-Michel Bardez, Claudy Malherbe. Performance by Marc Dumazert and Philippe Pennanguer.
- 1 April 2011:** Combinatorial tools in composition – Block Designs, juggling and homometry. With the participation of Tom Johnson, Gilbert Delor, and Franck Jedrzejewski.
- 30 April 2011:** Mathematical School for musicians and other non-mathematicians by Pierre Cartier (with the participation of Annick Lesne). A duo on entropy.
- 19 May 2011:** Special session organised in collaboration with the UPS (Union des Professeurs de classes préparatoires Scientifiques). With the participation of Moreno Andreatta, Carlos Agon, Gérard Assayag, and Emmanuel Amiot.
- 20 Mai 2011:** Graphs, trees and automata in music informatics. With the participation of Gérard Assayag, David Aubert, Alessandra Carbone, Cyril Gavaille, Thierry Lecroq, Arnaud Lefebvre, Benjamin Lévy, Fivos Maniatakos, and Pierre Roy. Concert on computer-aided improvisation with OMax.
- *Eleventh Season (2011-2012)*

**7 October 2011:** Memory Evolutive Systems (1) – Modelling of hierarchy and emergence. With the participation of Ron Cottam and Andrée Ehresmann.

**4 November 2011:** Constraints programming in music. A special session organised around the release of the book *Constraint Programming in Music* (Charlotte Truchet & Gérard Assayag, eds). With the participation of Gérard Assayag, Mika Kuuskankare, Serge Lemouton, Camilo Rueda, and Sascha Van Cauwelaert.

**2 December 2011:** Memory Evolutive Systems (2) – Self-organisation and learning. With the participation of Andrée Ehresmann.

**6 January 2012:** Juggling theory and musical application. With the participation of Tom Johnson, Franck Jedrzejewski, Luke Wilson, Jonathan Lardillier, Jean-Christophe Novelli, and Florent Hivert.

**3 February 2012:** Synchronous languages. A session organised in collaboration with the Parkas team of the Ecole Normale Supérieure in Paris. With the participation of Louis Mandel, Yann Orlarey, Marc Pouzet, Karim Barkati, and José Echeveste.

**9 March 2012:** Memory Evolutive Systems (3) – Modelling of cognition and organisation of physical measures. With the participation of Andrée Ehresmann, François Viallefond, and John Mandereau.

**30 March 2012:** Trees and hierarchical structures in music informatics. A session organised in collaboration with INRIA. With the participation of David Rizo, David Janin, and Florent Jacquemard.

**4 May 2012:** Models of harmonic structures. With the participation of Gilles Baroin, Stéphane de Gérando, Louis Bigo, François Durand, and Hugues Seress.

- *Twelfth Season (2012-2013)*

**12 October 2012:** Mathematical and computational models of creativity. With the participation of Moreno Andreatta, Andrée Ehresmann, René Guitart, Guerino Mazzola, and Andranik Tangian.

**9 November 2012:** Around rhythm. A special session organised in collaboration with the working group on rhythm at IRCAM (coordinated by Karim Haddad and Mikha'il Malt). With the participation of Pascal Michon and Emmanuel Amiot.

**7 December 2012:** Computational tools for music analysis. With the participation of Béatrice Fuchs, Mathieu Giraud, Charles de Paiva Santana, and Jean Bresson.

**11 January 2013:** Fractals – Theories and musical applications. With the participation of Alain Le Méhauté, Nicolas Darbon, Franck Jedrzejewski, and José Luis Besada.

**1 February 2013:** Representations of audio signals. Perspectives for music performance and manipulation. A session organised in collaboration with Josselin Minier and Jean-Marc Chouvel. With the participation of Pierre Couprie and Alain Bonardi.

**22 March 2013:** The aesthetics of numbers. Combinatorial models, groups and graphs. A special session organised around the book *Looking at Numbers* by Tom Johnson and Franck Jedrzejewski, with the participation of Gilbert Delor.

**5 April 2013:** Mathematics and spatial representation. With the participation of Laurent Najman, Gérard Ligozat, Anton Freund, and Moreno Andreatta.

**6 May 2013:** PCLIB, a Pure Data Library for pitch-class analysis and composition. With the participation of Oscar Pablo Di Liscia.

**24 May 2013:** Operation research and combinatorial optimisation. With the participation of Christoph Dürr, Philippe Esling, Daniel Schell, and Ola Rinta-Koski.

- *Thirteenth Season (2013-2014)*

**13 September 2013:** A Special Session hosted by the mathematical department of Perpignan. With the participation of Carlos Agon, Emmanuel Amiot, Moreno Andreatta, Gilles Baroin, Hélianthe Caure, and Philippe Esling.

**4 October 2013:** Music analysis, models and cognition. With the participation of Jônatas Manzolli, Charles de Paiva, Alexandre Popoff, and Shihab Shamma.

**8 November 2013:** DiVino – On some links between music and oenology. With the participation of Christophe Lavelle, René Wyttenbach, and Nicolas Vérin.

**6 December 2013:** Time, rhythm and arithmetic. With the participation of Philippe Riot, Alain Le Méhauté, Jean-Louis Giavitto, and Karim Haddad.

**27 January 2014:** Musical notation. A session organised by the working group on new spaces of music notation of the AFIM (French Association of Music Informatics). With the participation of Pavlos Antoniadis, Julia Blondeau, Bruno Bossis, Mike Solomon, and Marco Stroppa.

**28 January 2014:** The contribution of music to maps and vice-versa. A special session organised at the University of Avignon within the *CartoMuse* project.

**14 March 2014:** Mathematical and computational models in ethnomusicology. With the participation of Aude Julien da Cruz Lima, Marc Chemillier, and Frédéric Voisin.

**18 April 2014:** Sonic scenes. With the participation of Olivier Warusfel, Grégoire Lafay, and Vincent Mignerot.

**9 May 2014:** Perception of time. With the participation of John Wearden, Mark Gotham, and Virginie Van Wassenhove.

- *Fourteenth Season (2014-2015)*

**26-27 of September 2014:** Special session on tiling problems in mathematics, computer science and music (hosted by the LIRMM in Montpellier). With the participation of Mihalis Kolountzakis, Guilhem Gamard, Emmanuel Amiot, Victor Poupet, Hélianthe Caure, Alexander Shen, Nicolas Saby, Hervé Lehning, and Moreno Andreatta.

**27 October 2014:** Physical modelling in composition. With the participation of Anders Vinjar.

**5 December 2014:** Mathematics and music from the Arabic tradition. With the participation of Ahmed Djebbar, François Nicolas, and Florence Baschet.

**23 January 2015:** Cartoons and music. With the participation of Zviane and Geoffroy Monde.

**6 February 2015:** Temperaments and visualisations. With the participation of Gilles Baroin, André Calvet, and Stéphane Marcand.

**6 March 2015:** Other Harmony. With the participation of Tom Johnson, Emmanuel Amiot, and Franck Jdrzejewski.

**3 April 2015:** Modern music, shapes and persistence. With the participation of Mattia Bergomi, Massimo Ferri, and Barbara Di Fabio.

- *Fifteenth Season (2015-2016)*

**20 November 2015:** Music, emotion and perception. With the participation of Hervé Platel, Pierre-Henri Vulliard, and Yohana Lévêque.

**11 December 2015:** From theoretical mathematics to a new expression. With the participation of Laurent Derobert, Carmine Emanuele Cella, and Tom Johnson.

**22 January 2016:** Special session on Xenakis. With the participation of Benny Sluchin, Sharon Kanach, Makis Solomos, Mikhail Malt, Moreno Andreatta, and Arturo Tamayo.

**12 February 2016:** Mathematical morphology and spatial representations. With the participation of Isabelle Bloch, Jamal Atif, Louis Bigo, and Renaud Chabrier.

**11 March 2016:** Tiling problems in music. With the participation of Hélianthe Caure, Pascal Terracol, and Pierre Audibert.

**20 May 2016:** Music and mathematics by Magic Malik. With the participation of Malik Mezzadri, Frédéric Faure, and Alexandre Ratchov.