1st of February 2008 // London, UK

SUSY (for three string instruments of similar register)

// by nikolaos-laonikos psimikakis-chalkokondylis

SuSy (for three string instruments of similar register)

SuSy is an abbreviation for SuperSymmetry, a concept in subatomic particle physics. Supersymmetry is a symmetry discovered by scientists in the 1970's, with which they can compare subatomic particles with very peculiar properties regarding their existence in space to other particles similar to them (but they wouldn't be able to be regarded as "similar" without this kind of symmetry – much like without rotational symmetry a vector on the vertical axis of a plane can't be compared to a vector of the same magnitude but on the horizontal axis of the plane).

While the concept of supersymmetry doesn't have anything to do with the rest of the piece, I chose to use it as a title for this piece simply because it is a word that links the concept of canon to the three irrational numbers I've used, as well as the instruments. A canon is above all a symmetric kind of composition, and this piece is symmetric in many ways. Also, the concept of symmetry has been explored in other ways other than the apparent ones (I.e. inversion, augmentation, diminution, retrograde etc), most importantly in the use of primes numbers to shape the piece, as prime numbers are numbers which are symmetric and asymmetric at the same time (as I show below). The letters of the three irrational numbers I chose to use, phi, e and pi, could refer to the subatomic particles of photon, electron and pion respectively, all of which are subject to the superstring theory (to which the concept of supersymmetry applies). Lastly, since supersymmetry is a concept in the string/superstring theories in physics, there is a kind of pun between the term "string" in the string/superstring theories and the term "string" in music (as in "string instrument").

Initially, I wanted to write a piece that makes use of the unique ability of the string instruments to sustain a sound seemingly indefinitely. Also, the ease with which string instruments do glissandi and can play quartertones, as well as the vast array of techniques that are performable on the strings, some of which have been used in the piece. However, when I first presented the idea to my teacher, he asked me "how about page turning?", and indeed, I hadn't thought about page-turning – and of course, page-turning would create a silence in the piece that I didn't want. In the beginning we tried to think of ways to have to pages turn automatically (either by another person or by having the score in digital form where the page would be turned with the push of a button with the feet etc), but then my teacher told me how he let the pages become part of one of his pieces, so I decided to do the same. I thus created a piece where pages are the building blocks, and page-turns are the "silences" in the piece. When the piece is performed live, the players must take the amount of time indicated to turn the page. This way, some imitation in page turning can be observed (for example, the first and last times the players turn pages, they turn their page in the order they started playing; or at the 7" page of the first instrument, before that the first instrument plays a short page-turn, then a short page, and then a longer page-turn, and then the last instrument performs the long page-turn almost together with the first instrument, and then performs a short page and then a short page-turn, which is in a way a kind of inverted imitation between those two instruments at that particular point, among others).

Thus, the piece consists of pages and page-turns. If in normally-notated music there is "counterpoint", then in this piece there is "counterpage", where a certain page is set against another page, and a page-turn is set against either a page or a page-turn (but I wouldn't call it "strict counterpage", since there were no rules in distributing the pages). Each page has a different length, and all the lengths

are prime numbers. I decided to use prime numbers as the durations of the pages (and page-turns) because primes are numbers which are in a way both symmetric and asymmetric. They are asymmetric numbers in that they can't be divided in two (like even numbers), but if you select the very middle number of the number (i.e. In 17, if you choose the number 9), there is a perfect symmetry around it, i.e. There is the same amount of numbers/objects to the left and right of that number in the real line [Fig.1]. Therefore, each page consists of a prime number of seconds, and the whole piece lasts for a prime number of seconds as well (231 seconds in total)

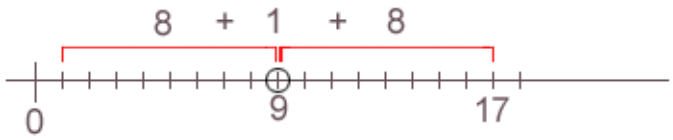


Figure 1: how a prime number is symmetrical around its middle number.

I also chose to use irrational numbers as the basis for the contour material on each instrument's pages. I used there particular kinds of numbers to shape the piece (in terms of form and material) because they related to each another, although it doesn't look like it: **primes** are numbers which can't be represented as the **multiple** of two integer numbers (other than themselves and 1). **Irrational numbers** are numbers which can't be represented as the **quotient** of two integer numbers.

The way I used irrational numbers (or, to be more precise, their first 12 decimal points – the number 12 here has nothing to do with the twelve chromatic notes in the tempered scale; it just happened that the 12th decimal point of all three irrational numbers I chose to use, phi, pi and e, is the number 9, so it seemed like all these numbers come to a full stop) creates a kind of functional canon. That is, I applied the same function on each of the 12 decimal points of the irrational numbers, and created a specific kind of contour for each of the instruments. These contours are very similar, but different too, since the irrational numbers are different, so this is a less direct canon [Figure 2].

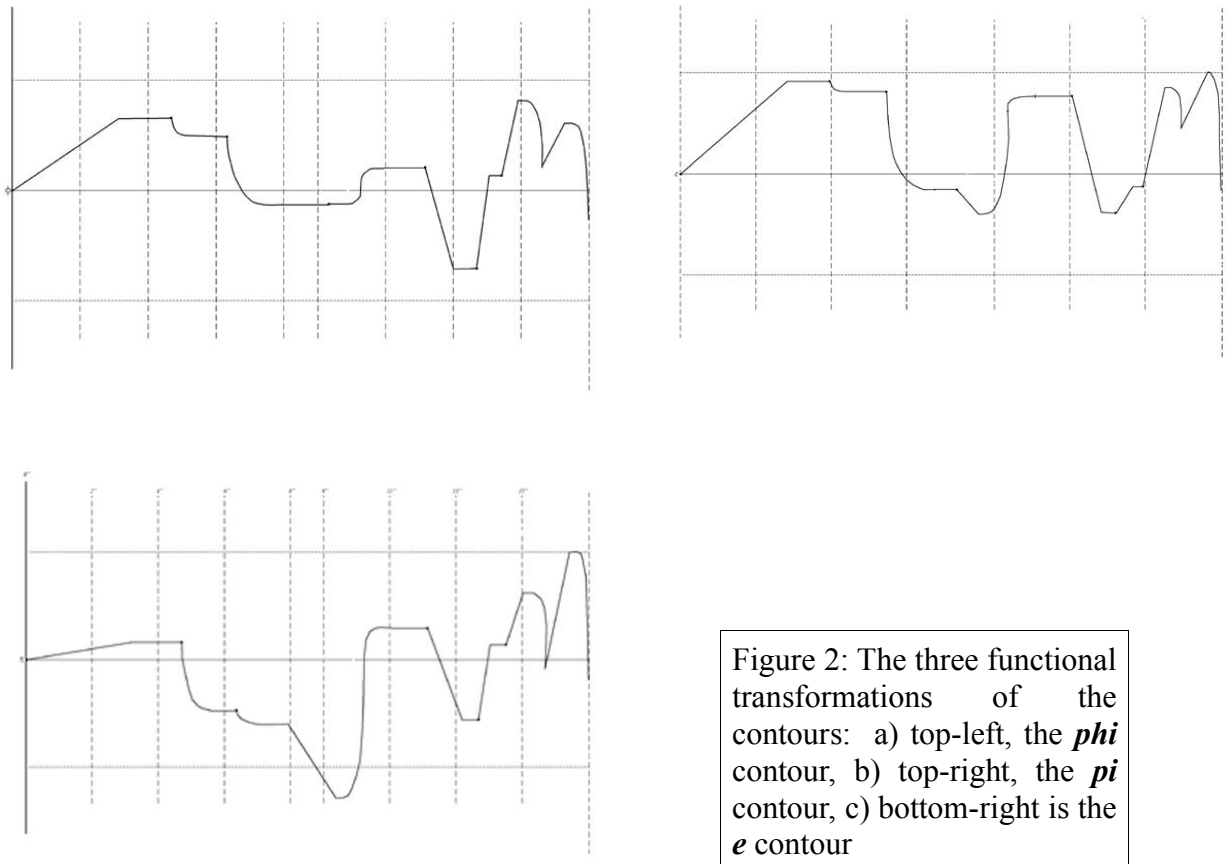
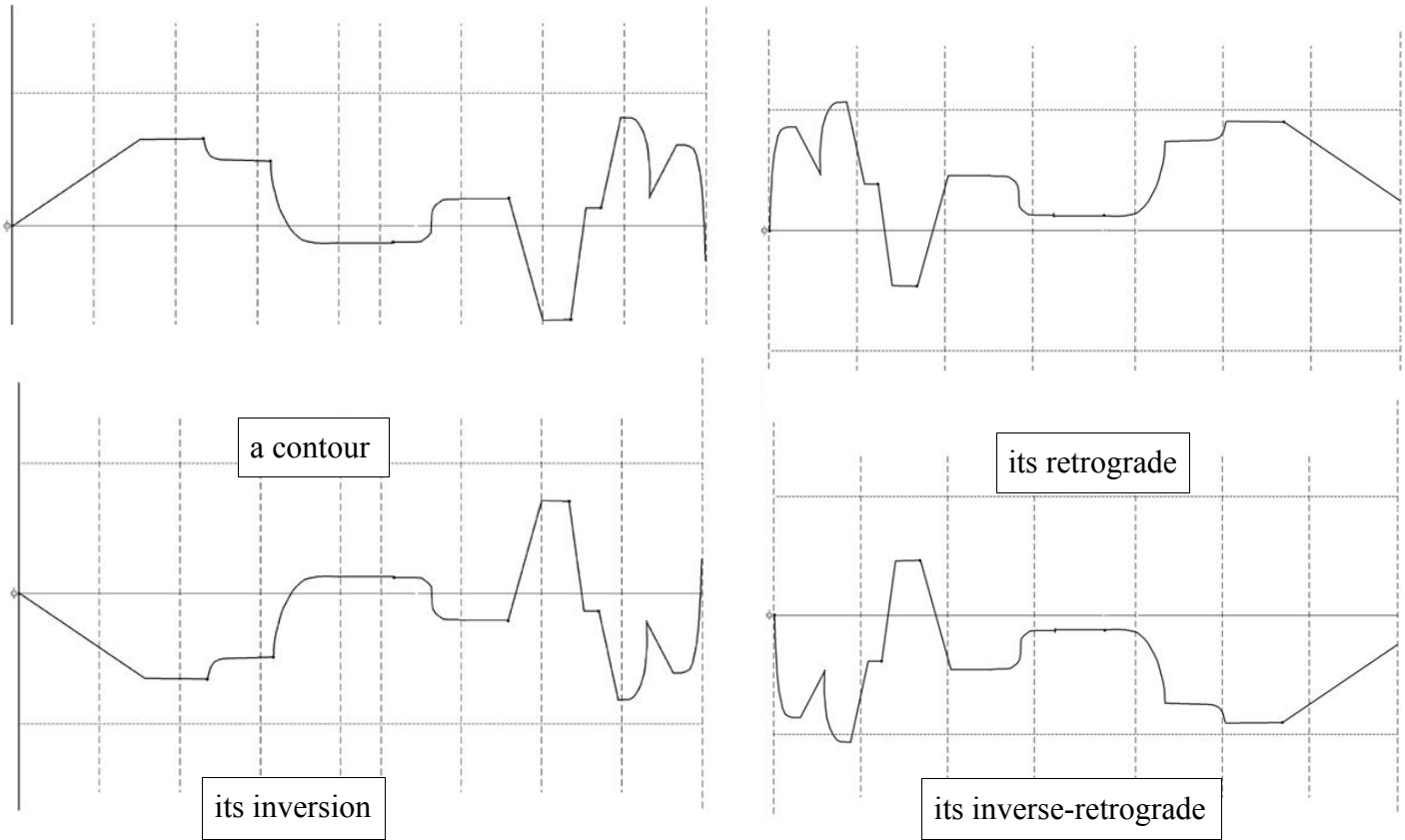


Figure 2: The three functional transformations of the contours: a) top-left, the ***phi*** contour, b) top-right, the ***pi*** contour, c) bottom-right is the ***e*** contour

As it was mentioned before, the piece is based on pages and page-turns. Each page contains a transformation of the contour that belongs to each instrument. The transformations include the inverse, retrograde and inverse-retrograde forms of the contours, as well as augmentation and diminution in terms of duration, and augmentation and diminution in terms of intervals.

Each page comes with a few indications on it, as it can be seen in the explanation page of the score. There is an indication on how long the page should last. This is what determines the temporal augmentation or diminution of the contour. However, unlike augmentation and diminution of, say, a motif in a canon by Bach, there is no “default” or “original” duration of the contour, according to which the rest are augmentations or diminutions of. Rather, they are all temporal transformations of the contour, as if taken from somewhere else and placed there. An analogy to the visual art would be the following: the way a Bach motif in a canon would be augmented or diminished is similar to taking a photograph of an object, and then shrinking or enlarging the printed photo to get various sizes of the object. What I did is similar to taking multiple photographs of that object, some of them really close, some of them from far away, and thus get my various sizes of the object in photographs. In the latter way, the detail in each photograph remains the same, while in Bach's process, there is less detail in the expansions and contractions of the initial photo. This can also be represented in the music, as in a Bach canon, the augmentation and diminution of a motif bears less importance than the motif itself, while in my piece all the contours are treated equally, with none of them having more importance than the others (in all three instruments).



Another indication is two dotted lines at equal distances from the solid central line in each page. The players have to decide an interval that these two lines indicate. For example, if a player says that the distance between the central line and each of the dotted lines is an octave, he has to play the contour as accurately as possible with respect to the octave. The players are free to choose a different interval for each page, or a single interval for all pages. A combination of both between instruments is encouraged, to create a more varied soundscape. Therefore, by indicating the contour but not the absolute pitches or absolute intervalic frame in which they should play the contour, the piece depends a lot on the choices of the performers, and will vary depending on the skill of the performers and their personal tastes.

Other indications include dynamics (which are notated in a traditional way under the contour), vertical lines to aid the performers synchronize themselves, the page-turn duration after that page (bottom-right corner), and an indication on how to play the particular page (the bottom-left boxes in each page – they indicate whether a page should be played normally, with tremolo, with a continuous pizzicato, with harmonics). The third box indicates "string movement", that is, the players may be instructed to play the contour a string below or above the string they are currently playing on, or play at the highest or lowest string, or even play two strings together. That change of strings is a literal one, I.e. the players must not continue playing at the same pitch they ended on but on another string, but rather physically move their hand onto the next string and continue from there.

In terms of organisation of the piece, I used the transformations of the contours in the following manner (each of the shapes taking one page, with a total of 6 pages per instrument):

ϕ: A – IR(A) - A - I(A) – R(A) - A
e: I(A) – R(A) - A – A – R(A) - I(A)
π: A – R(A) – I(A) – A – IR(A) - A

where **A** is the "original" shape (I have defined an "original" shape so that I can refer to its transformations – it doesn't contradict what I said above about no shapes having more importance than others), **I(A)** is the inverse (vertical flipped), **R(A)** is the retrograde (horizontally flipped) and **IR(A)** is the inverse-retrograde (both vertically and horizontally flipped).

It is obvious that the set up of the contour transformations for the middle instrument is symmetric horizontally (I.e. the last three pages are the first three pages in the reverse order), and also that the sequence of contour transformations on the third instrument is exactly the same as the one on the first instrument, but backwards. This was done so that the middle instrument provides a kind of symmetric centre (in terms of form) for the rest of the piece, while the other two instruments play around it a single pattern of contours, normally and reversed at the same time.

The durations that were used in the pages were 7", 11", 17", 29", 43" and 97", and the page-turn durations were 2", 2", 3", 5" and 7". They were distributed among the instruments and their pages as follows (with the page-turn durations in brackets and smaller font)

ϕ: 17" [2"] 29" [2"] 7" [5"] 97" [7"] 43" [3"] 11"

e: 17″ [2″] 97″ [7″] 43″ [5″] 29″ [3″] 7″ [2″] 11″
π: 17″ [2″] 29″ [5″] 11″ [3″] 43″ [7″] 97″ [2″] 7″

You can see that the durations form a canon in themselves, at points. For example, in the beginning they all play the page with the same duration, then the same rest, and then the last instrument continues to follow the first one up to the end of the 29″ page. Also, in the first two instruments, the 97″ page precedes the 43″ page, while in the last one it's the other way around. Also, all instruments end the piece with short page-turns and short pages. I tried to be more free when distributing the rest of the pages and page-turns to create more interesting textures. For example, I made sure that the two 5″ page-turns in the first and third instruments fall almost together (with a 1″ difference), so that at that point we only hear the middle instrument, and I also did the same with the two 7″ page-turns in the middle and last instruments (as can be seen in the overall score that is provided with the score of the piece).

In terms of dynamics, I used them more freely than other elements of the music, to create interesting textures and sounds (and I did the same with playing techniques as well). However, there is still a kind of "canon" as to how the dynamics are distributed among the pages. For example, in all 7″ pages, the instruments play, starting from ***sffz*** and ending on ***pp***, or in al 97″ pages, all the instruments perform a gradual crescendo from ***ppp*** to ***fff***, then back to ***ppp***.

It is, therefore, a very "fluid" canon, with many important elements of the piece (like the interval with respect to which the players must perform the contour, or the starting pitch) left up to the performers. It is very interesting how the less elements a system contains, the more symmetric it is. Therefore, canon can exist even without an absolute indication of intervals, pitches, durations, rests, and can be defined by contours, dynamics, general shapes, durations of shapes.

In general, there were many issues regarding the piece and its performance (which hasn't taken place yet, but I have spoken with each of the players and they have told me all the difficulties they've had with the piece). For example, in an earlier version of the piece I had defined very precisely that the dotted lines above and below the central line are octave indications (I.e. the interval between the two dotted lines was a two octaves), and I had indicated a small circle with a very precise interval (including microtones) in places in the contour where the players arrive at. However, the players told me that they found this extremely difficult to play, as they had to read a lot of information and perform with an accuracy that is very demanding, or almost impossible for the players. Thus, I decided to relieve the score by removing these two very demanding elements of the music, and stick to the most essential ones, that is the contour, the way they play each page, and the durations of the pages.