

A Physicist's view on Chopin's Études: Op.10 n.3, Op.25 n.1

Massimo Blasone
Dipartimento di Fisica, Università di Salerno

- Historical notes
- Some original ideas/fantasies

Motivations

- Obtain new viewpoint for interpretation;
- Many studies on mathematical structure of music, not really useful for musicians;
- Qualitative approach: using ideas from Physics to understand musical structures;
- Understanding where is beauty in Music...
- Enigmatic character of Chopin's music (Le Pianiste, 1833).

Chopin's Études

- Two books: 12 Études Op.10 – 1833 and 12 Études Op.25 – 1837;
- Long previous tradition of Études (Clementi, Czerny, Moscheles, etc..) as exercises to develop specific technical aspects;
- Summa of piano virtuosism, very large positions for the hand, new way of attacking the keyboard, etc..
- High artistic level: “perfect fusion of the athletic and aesthetic” (L.Kentner);
- Novel harmonic combinations, large harmonic progressions, instrumental figurations used as themes (cantabile character of figuration);
- Simple form: one or two thematic ideas, often in form of song ABA;
- The collection of 24 Preludes contains similar material.

Chopin's Études: from Paganini to Liszt



N. Paganini (1782-1840)



F. Chopin (1810 - 1849)



F. Liszt (1811 - 1886)

ÉTUDES

OPUS 10

Dédiées à son ami F. Liszt

Komponiert 1829-1832

Allegro ♩=176
legato

Opus 10 Nr. 1

1.

f

1 2 4

5 1 2 4 5

8

Leg.

*

- Études Op.10 dedicated to Franz Liszt.
- In 1829 Paganini gave a series of 10 concerts in Warsaw which deeply impressed the young Chopin. They met later in Paris in 1837, Paganini much appreciated Chopin's piano playing.
- Paganini's 24 *Capriccios* for the violin were a model for Chopin's Études. The other musical example (also for the Preludes) was the Well Tempered Clavier by J.S.Bach.

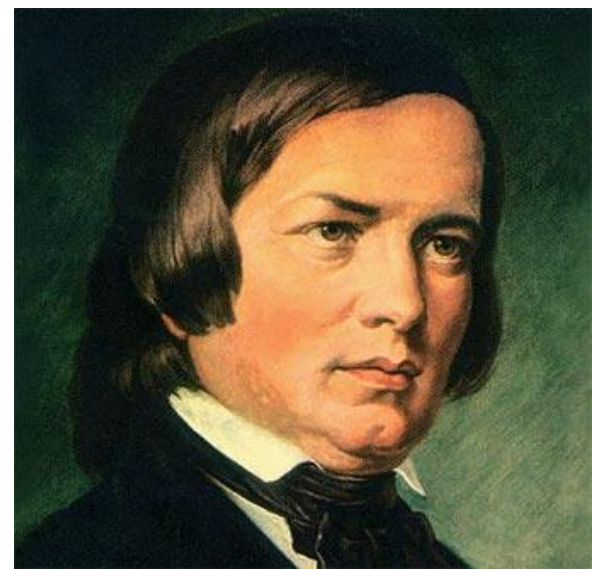
Criticism to Chopin's Études

- Berlin editor and composer Ludwig Rellstab wrote about the Op. 10 Études: *"Those who have crooked fingers, can treat them by means of these exercises. But those who suffer from no such ailment would do well to avoid them."*
- Franciszek Mirecki criticized the monotony of the themes in the Études, saying that *if notes would be colored, instead of black, these scores could be used as wallpaper...*

- As a music critic, Robert Schumann immediately recognized the value of Chopin:

”Hats off, gentlemen, a genius!”

is the famous incipit of Schumann’s review of Chopin’s Op.2 Variations on “Là ci darem la mano” by Mozart.



R. Schumann (1810-1856)

- He also included Chopin as one of the characters in his Carnival.
- Chopin’s Etudes op.10 were also very positively reviewed in the magazine *Le Pianiste*, just after their publication in 1833.

Titles

- Chopin always used only generic titles for his compositions (Etudes, Preludes, Nocturnes, Ballades, etc.) refusing any programmatic intent for his music.
- Nevertheless, many of his composition are very evocative of (subjective) images, and titles remained attached to some pieces in particular (Tristesse, Raindrop, etc).

(Arbitrary) names for Etudes and Preludes (by A.Cortot and H. von Bülow)

Étude Op. 10, No. 1 Waterfall
Étude Op. 10, No. 2 Chromatique
Étude Op. 10, No. 3 Tristesse
Étude Op. 10, No. 4 Torrent
Étude Op. 10, No. 5 Black Keys
Étude Op. 10, No. 6 Lament
Étude Op. 10, No. 7 Toccata
Étude Op. 10, No. 8 Sunshine
Étude Op. 10, No. 11 Arpeggio
Étude Op. 10, No. 12 Revolutionary

Étude Op. 25, No. 1 Aeolian Harp

Étude Op. 25, No. 2 The Bees
Étude Op. 25, No. 3 The Horseman
Étude Op. 25, No. 4 Paganini
Étude Op. 25, No. 5 Wrong Note
Étude Op. 25, No. 6 Thirds
Étude Op. 25, No. 7 Cello
Étude Op. 25, No. 8 Sixths
Étude Op. 25, No. 9 Butterfly
Étude Op. 25, No. 10 Octave
Étude Op. 25, No. 11 Winter Wind
Étude Op. 25, No. 12 Ocean

1.C major - Agitato (Reunion)
2.A minor - Lento (Presentiment of Death)
3.G major - Vivace (Thou Art So Like a Flower)
4.E minor - Largo (Suffocation)
5.D major - Molto allegro (Uncertainty)
6.B minor - Lento assai (Tolling Bells)
7.A major - Andantino (The Polish Dancer)
8.F-sharp minor - Molto agitato (Desperation)
9.E major - Largo (Vision)
10.C-sharp minor - Molto allegro (The Night Moth)
11.B major - Vivace (The Dragonfly)
12.G-sharp minor - Presto (The Duel)
13.F-sharp major - Lento (Loss)
14.E-flat minor - Allegro (Fear)
15.D-flat major - Sostenuto (Raindrop)
16.B-flat minor - Presto con fuoco (Hades)
17.A-flat major - Allegretto (A Scene on the Place do Notre-Dame de Paris)
18.F minor - Molto allegro (Suicide)
19.E-flat major - Vivace (Heartfelt Happiness)
20.C minor - Largo – C minor (Funeral March)
21.B-flat major - Cantabile (Sunday)
22.G minor - Molto agitato (Impatience)
23.F major - Moderato – F major (A Pleasure Boat)
24.D minor - Allegro appassionato (The Storm)

Etude op 10 n.3

Lento ma non troppo ♩=100 Opus 10 Nr. 3

legato

3.

p

- Chopin said about this etude that “In all my life I have never again been able to find such a beautiful melody.”
- “ The third one is among the most difficult ones. The melody is beautiful, but difficult to render. I recommend the chromatic scale in diminished sevenths which is new and of good taste; I cannot say the same for the following passage [the one marked *con bravura*] which has not a pleasing effect....”

Chaulieu, Le Pianiste 1833

43 *con forza* *con fuoco*

46 *f con bravura*

49 *cresc.* *stretto*

52 *legatissimo* *ritenuto e cresc.* *f* *p*

55 *sempre p* *dim.*

59 *smorzando poco rall.* *a tempo* *plagatissimo*

67 *poco cresc.* *cresc.* *stretto* *cresc.*

70 *f* *dim.* *pp*

74 *rallent.* *smorz.*

attaca il presto con fuoco

- The piece has the structure of a song : A-B-A' with a central section marked "*più mosso*" where some chromatic scales and a long passage in double-sixths appear, based on diminished seventh chords.
- Such chords are symmetric ones, each made of four notes. In our tonal (equal tempered) system, based on the division of the octave interval into twelve equally spaced intervals (half-tones), there are three such chords, exhausting the 12 notes:

C^{°7} E^{♭°7} F^{♯°7} A^{°7}
 D^{♭°7} E^{°7} G^{°7} B^{♭°7}
 D^{°7} F^{°7} A^{♭°7} B^{°7}

F[♯] G[♯] A[♯] B[♭] C[♯] D[♭] E[♭] G[♯] A[♯] B[♭]
 F G A B C D E F G B[♭] B C

Tonal phase transition

- With respect to the original symmetry among the twelve tones of the tempered system, the choice of a given tonality represents a breakdown of such symmetry, establishing a “reference frame” to which we refer when listening a piece.
- We can thus regard the first section as an ordered phase (crystal), in which the symmetry is broken by the affirmation of the tonal area of E major.
- The central section contains a progressive dissolution of the tonal structure, up to the symmetric, effectively atonal double sixths passage (where all 12 tones are present).
- The return to E+ (via the dominant B+) is obtained by breakdown of the tonal symmetry by insisted repetition of a minor sixth interval, by a C♯.
- It follows a section where the accumulated energy gets dissipated.

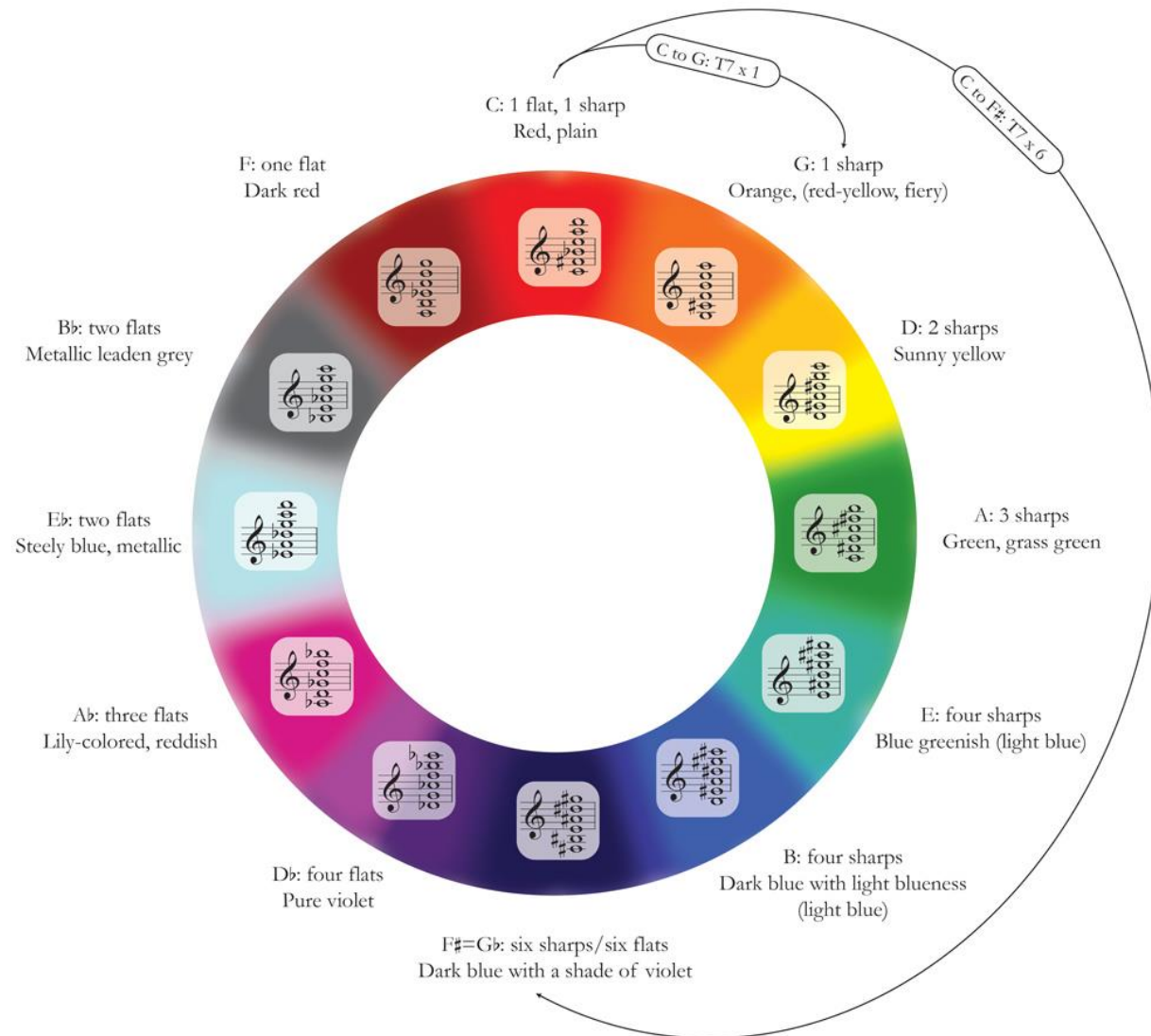
- It is very remarkable that such a C \sharp re-appears at the end of the piece, in the main theme, adding a nostalgic feeling to the melody.



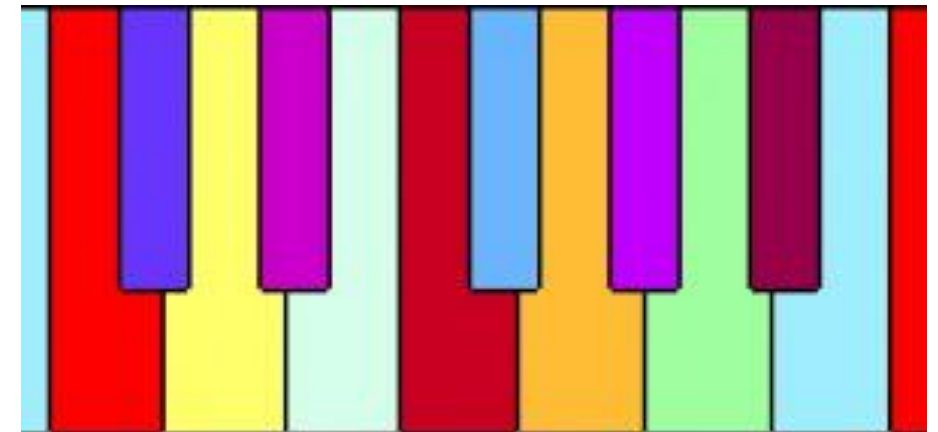
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- One can thus have the following vision freely inspired by the Kibble-Zurek mechanism of defect formation: the crystal goes into the fire where it melts, then it cristallizes but defects appear (C \sharp)
- Tonal phase transition (with defects)
- Note dynamical markings: ff, con fuoco, con bravura, f.

Scriabin: synesthesia



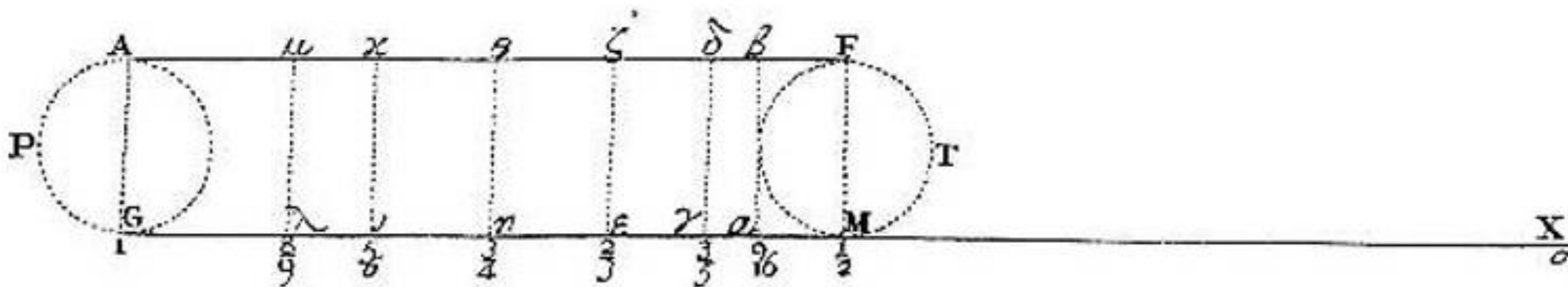
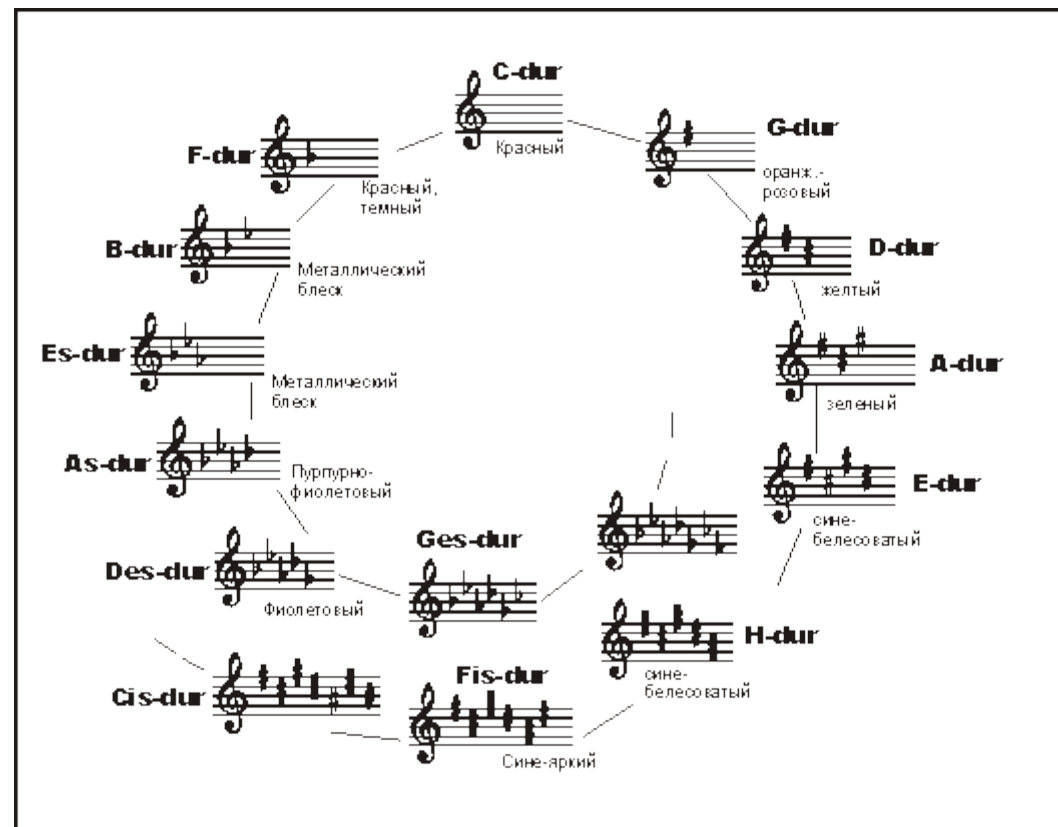
A. Scriabin (1872 - 1915)



Three Centuries of Color Scales

		C	C#	D	D#	E	F	F#	G	G#	A	A#	B
Isaac Newton	1704	Red		Orange		Yellow	Green		Blue		Purple		Pink
Louis Bertrand Castel	1734	Dark Blue	Teal	Green	Olive	Yellow	Orange	Red	Dark Red	Pink	Purple		
George Field	1816	Dark Blue		Purple		Red	Orange		Yellow		Olive		Green
D. D. Jameson	1844	Red	Orange	Yellow-Orange	Yellow	Green	Teal	Blue	Purple	Pink	Purple	Pink	Pink
Theodor Seemann	1881	Dark Red	Red	Orange	Yellow	Green	Teal	Blue	Purple	Pink	Dark Red	Black	
A. Wallace Rimington	1893	Red	Dark Red	Orange	Yellow	Olive	Green	Teal	Purple	Pink	Dark Blue	Pink	
Bainbridge Bishop	1893	Red	Dark Red	Orange	Yellow	Light Green	Green	Teal	Purple	Pink	Pink	Red	
H. von Helmholtz	1910	Yellow	Green	Teal	Blue	Purple	Pink	Red	Orange	Orange	Orange	Orange	Orange
Alexander Scriabin	1911	Red	Pink	Yellow	Blue	Blue	Dark Red	Blue	Orange	Purple	Green	Blue	Blue
Adrian Bernard Klein	1930	Red	Red	Orange	Orange	Yellow	Light Green	Green	Teal	Blue	Purple	Pink	Pink
August Aeppli	1940	Red		Orange		Yellow		Green	Teal		Blue	Purple	Purple
I. J. Belmont	1944	Red	Orange	Orange	Yellow	Yellow	Light Green	Green	Teal	Blue	Purple	Pink	Pink
Steve Zieversink	2004	Light Green	Green	Teal	Blue	Purple	Pink	Dark Red	Red	Orange	Yellow	Yellow	Yellow

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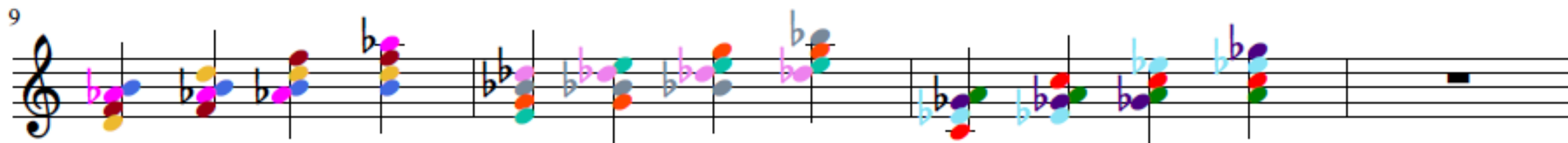


Drawing by I. Newton representing the correspondence between colors and sounds.

Symbolism in Scriabin

- C (Red) - Human will
- D (Yellow) - Happiness
- E (Light Blue/green) - Dream
- F (Dark Red) - Creativity
- A (Green) - Matter
- B (Dark Blue) - Contemplation

Scriabin's color code for musical notation (using MuseScore)



- Final image for the Etude op.10 n.3:

Blue crystal (Turquoise) with red spots.

- OK, but then yet another title !!
- Not just a title, rather an analogy with a *physical process*.
- Possible meaning: metaphor of an internal trip from an adolescent age of unlimited dreams, through some dramatic event, to a later stage in which same emotions/images are necessarily different.
- Perhaps physical processes describe well music because musical structures resonate with structures already present in our brain (aesthetic experience), which are previously created as image of natural phenomena.
- Music as a probe for brain dynamics.

- The blue crystal

21

a tempo
ten. *ten.* *ten.*

ff *sempre legato* *dim.* *rall.* *pp*

The image displays a musical score for a piece titled "The blue crystal". It consists of two staves: a treble clef staff on top and a bass clef staff on the bottom. The key signature is three sharps (F#, C#, G#). The score begins at measure 21. The treble staff features a series of chords and melodic lines, with notes highlighted in various colors (pink, blue, green, purple, cyan). Performance markings include "a tempo" at the start, followed by "ten." (tenuto) markings above three groups of notes. The dynamic marking "ff" (fortissimo) is placed below the first measure. The instruction "sempre legato" is written below the first two measures. "dim." (diminuendo) is placed below the fourth measure. "rall." (rallentando) is placed below the sixth measure, and "pp" (pianissimo) is placed below the seventh measure. The bass staff contains a simple accompaniment with notes highlighted in pink, blue, and cyan. A large slur covers the entire piece.

- The blue crystal with red spots (bars 104-105)

101

a tempo

f

dim.

This musical score shows two systems of piano music. The first system covers bars 101 and 102. The second system covers bars 103, 104, and 105. The music is in a key with three sharps (F#, C#, G#) and a 3/4 time signature. The first system starts with a treble clef and a bass clef. The treble clef has a melodic line with notes colored in pink, blue, and purple. The bass clef has a bass line with notes colored in pink, blue, and purple. The first system is marked *a tempo* and *f* (forte). The second system is marked *dim.* (diminuendo). The notes in the second system are colored in pink, blue, and purple.

103

pp

This musical score shows two systems of piano music. The first system covers bars 103 and 104. The second system covers bars 105 and 106. The music is in a key with three sharps (F#, C#, G#) and a 3/4 time signature. The first system starts with a treble clef and a bass clef. The treble clef has a melodic line with notes colored in pink, blue, and purple. The bass clef has a bass line with notes colored in pink, blue, and purple. The first system is marked *pp* (pianissimo). The second system is marked *pp* (pianissimo). The notes in the second system are colored in pink, blue, and purple.

Etude op 25 n.1

ÉTUDES

OPUS 25

Dédiées à Madame la Comtesse d'Agoult

Komponiert 1832-1836

Allegro sostenuto ♩ = 104

Opus 25 Nr. 1

1.

p

Ped.

3

* Ped.

* *

4 5

R.Schumann on Etude op 25 n.1:

"Imagine that an aeolian harp possessed all the musical scales, and that the hand of an artist were to cause them all to intermingle in all sorts of fantastic embellishments, yet in such a way as to leave everywhere audible a deep fundamental tone and a soft continuously-singing upper voice, and you will get the right idea of his playing.

But it would be an error to think that Chopin permitted every one of the small notes to be distinctly heard. It was rather an undulation of the A flat major chord, here and there thrown aloft anew by the pedal.

Throughout all the harmonies one always heard in great tones a wondrous melody, while once only, in the middle of the piece, besides that chief song, a tenor voice became prominent in the midst of chords. After the Etude a feeling came over one as of having seen in a dream a beatific picture which when half awake one would gladly recall."

- Small notes are just color, anticipation of Impressionism (Debussy);
- Phase-number uncertainty relation:

$$\Delta n \Delta \varphi \geq 1/2$$

The distinct perception of the internal structure (small notes) is not compatible with the perception of the whole.

- Coherent states, with free, unperturbed, dynamics in the first part of the pièce.
- Approaching the modulation to the distant A+ key, the dynamics becomes very strong due to gradients in the harmony (potential) and the coherent states deform (squeezing).
- At the end first decoherence and finally evaporation take place.

- Unperturbed dynamics

Piano

p

3

3

ped

ped

3

p

3

3

ped

ped

- “Potential well”: higher voice cannot reach F# until sufficient energy is provided (by gradients in the harmony)

26

p

Two staves of music, Treble and Bass clef. The key signature has three flats. The music is marked *p*. The notes are color-coded: red, orange, yellow, green, blue, purple, pink, and cyan. A large slur covers the entire passage. The bass line has a series of notes with a *ped* marking and asterisks below it.

28

ritenuto

Two staves of music, Treble and Bass clef. The key signature has three flats. The music is marked *ritenuto*. The notes are color-coded: green, blue, purple, pink, cyan, yellow, orange, and red. A large slur covers the entire passage. The bass line has a series of notes with a *ped* marking and asterisks below it.

- Perturbed dynamics (squeezing)

40

p *cresc.* *f*

Led *Led* *Led* *Led* *Led* *Led*

42

f *appassionata*

Led *Led* *Led* *Led*

- Decoherence

94 *leggierissimo* 8va

pp

Red

Detailed description: This block shows measures 94 and 95 of a musical score. The key signature has three flats (B-flat, E-flat, A-flat). The tempo marking is *leggierissimo*. The dynamic is *pp*. The notation is for a grand staff with a treble and bass clef. A large slur covers both staves. The right hand (treble clef) has a melodic line with notes colored red, cyan, and magenta. The left hand (bass clef) has a rhythmic accompaniment with notes colored red, cyan, and magenta. A 'Red' label is placed below the bass staff. The marking '8va' is at the top right.

96 (8va)

Detailed description: This block shows measures 96 and 97. The key signature remains three flats. The right hand (treble clef) has a melodic line with notes colored red, cyan, and magenta. The left hand (treble clef) has a rhythmic accompaniment with notes colored red, cyan, and magenta. A 'Red' label is placed below the bass staff. The marking '(8va)' is at the top left.

- Evaporation

98

ppp

Red

Detailed description: This block shows measures 98 and 99. The key signature remains three flats. The dynamic is *ppp*. The notation is for a grand staff with a treble and bass clef. The right hand (treble clef) has a few notes, including a red one. The left hand (bass clef) has a few notes, including a red one. A 'Red' label is placed below the bass staff. The marking 'Red' is at the bottom right.

Another example of coherent states: Prelude op.28 n.8

Molto agitato

8


5 2 4 3 2 1

3 2

P * P * P * P * P * P * P *

Similar structure to Etude op 25 n.1. Non-compact case.

Other ideas and perspectives

- Fractals, (harmonic) horizons, attractors, etc..
- Definition of a potential based on harmonic relations dynamics (forces); 
- Tempo as a function of dynamics;
- Pedagogical use of colors in musical notation.