Colour and Colorimetry
Multidisciplinary Contributions

Vol. X B

Edited by
Maurizio Rossi

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From Pythagoras to Kandinskij: colourful architecture

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The idea that there is a correspondence between music and colour is a very old one. In The Republic's Mith of Er, talking about the Celestial Spheres, Plato says[1]: *'The largest* [the circle of the fixed stars] *is spangled, and the seventh* [the sun] *is brightest; the eighth* [the moon] *coloured by the reflected light of the seventh; the second and fifth* [Saturn and Mercury] *are in colour like one another, and yellower than the preceding; the third* [Venus] *has the whitest light; the fourth* [Mars] *is reddish; the sixth* [Jupiter] *is in whiteness second.*[…] *on the upper surface of each circle is a siren, who goes round with them, hymning a single tone or note. The eight together form one harmony[…]'.* Er's tale is based upon the Pythagorean[2] concept of the Harmony of the Spheres by which the interval between the earth and the sphere of the fixed stars was considered to be a *diapason*, the most perfect harmonic interval. The allowing arrangement is most generally accepted for the musical intervals of the planets between the earth and the sphere of the fixed stars: from the sphere of the earth to the sphere of the moon; one tone; from the sphere of the moon to that of Mercury, one half-tone; from Mercury to Venus, one-half; from Venus to the sun, one and one-half tones; from the sun to Mars, one tone; from Mars to Jupiter, one-half tone; from Jupiter to Saturn, one-half tone; from Saturn to the fixed stars, one-half tone. The sum of these intervals equals the six whole tones of the octave.[3] Through Er's Mith, Plato extends Pythagora's concept, which saw the number as the universal principle that is reflected as light or sound, a qualitative living reality that had to be experienced, binding together planets, tones and colours.
The science of canonics, which was invented by the Pythagoreans, is metrical geometry applied in all of its essentials. According to its procedures, each musical pitch is represented by a length on the canon or rule, a length that is practically measurable. In *Menon*, Plato, speaking through Socrates, describes color as "an effluence of form, commensurate with sight, and sensible."[4] In *Theætetus* he discusses more at length on the subject thus trough Socrates: "Let us carry out the principle which has just been affirmed, that nothing is self-existent, and then we shall see that every color, white, black, and every other color, arises out of the eye meeting the appropriate motion, and that what we term the substance of each color is neither the active nor the passive element, but something which passes between them, and is peculiar to each percipient; are you certain that the several colors appear to every animal, say a dog, as they appear to you?"[5]
From XIVth and XVth centuries many scholars and architects such as Francesco di Giorgio Martini, Luca Pacioli, Leon Battista Alberti, Fabio Calvo, Giovanni Paolo

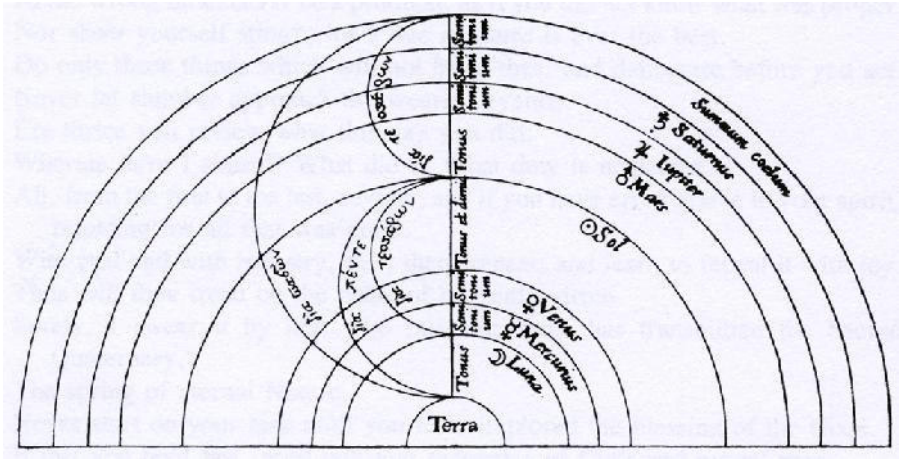

Fig. 1 – The intervals and Harmonies of the Spheres. From Stanley's *The History of Philosophy*.

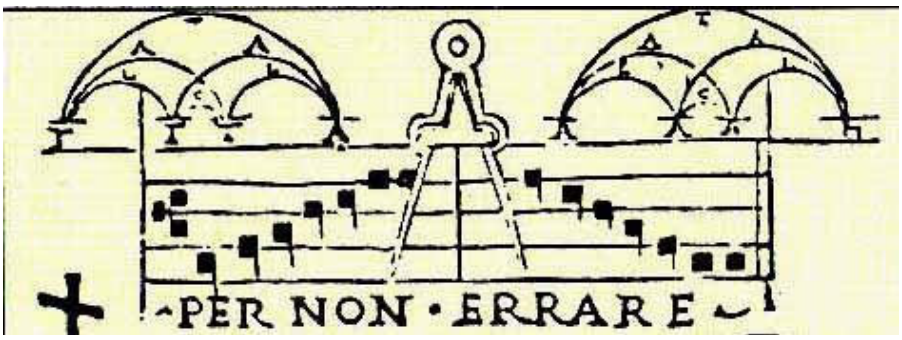

Fig. 2 – On this manuscript of the fifteenth century are symbolized the two main uses of harmonic proportions in music and architecture. The link between the two disciplines is emphasized by the ascending octave that culminates in a compass. On the very top of the image are shown the perfect musical intervals already theorized by Pythagoras: the octave, fifth and fourth, respectively, identified in fractions of 2/1, 3/2 and 4/3.

Lomazzo, Cesare Cesariano, Sebastiano Serlio, Raffaello, Paolo Giovio, fra Giocondo da Verona, Jacopo Barozzi da Vignola, Andrea Palladio and his student Vincenzo Scamozzi began a long series of studies, designs and treaties in which buildings were erected through the rule of musical proportions and such a method was referred as obvious and unavoidable for the construction of their work. In the XVIIth century, both Francoise Blondel and Bernardo Vittone stand out from their fellow scholars. The application of the musical theories became an important practice in architecture. Leon Battista Alberti wrote "I am every day more and more convinced of the truth of the Pythagorean saying, that Nature is sure to act consistently, and with a constant analogy in all her operations. From whence I conclude that numbers by means of which the agreement of sounds affects our ears

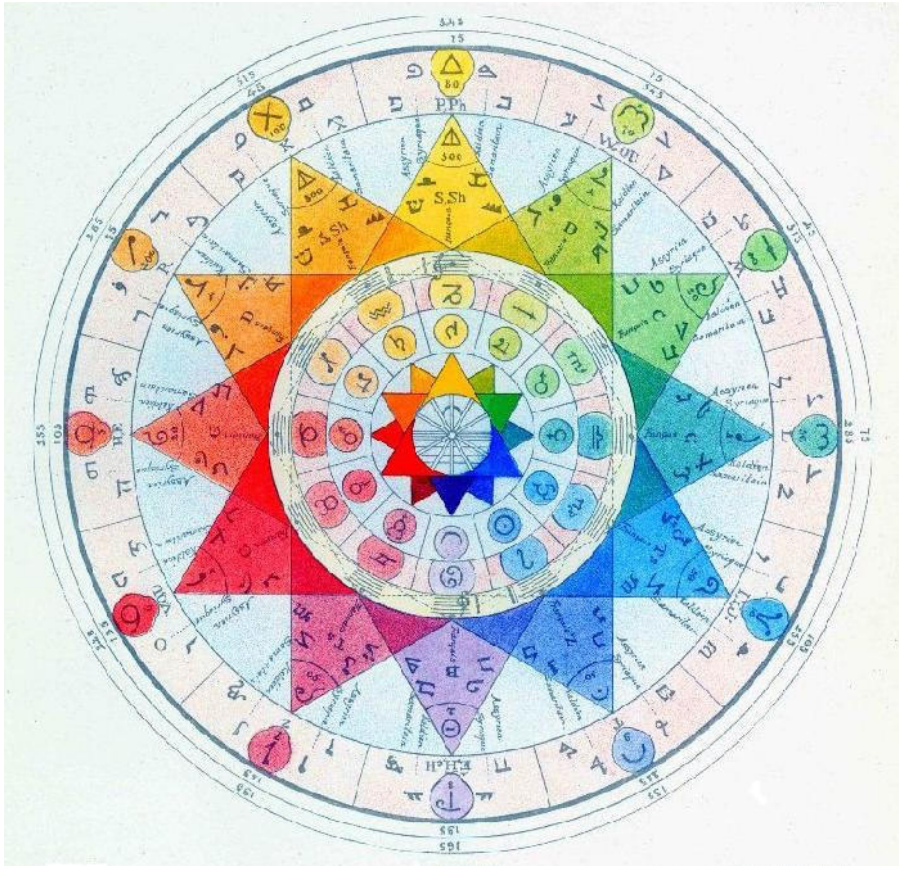

Fig. 3 – The system of *archéomètre* comprises different concentric zones of equivalents which each contain a respective messenger or medium of information: colours, planets, zodiacal signs, musical notes, letters and numbers. From Saint-Yves d'Alveydre's *Archéomètre*.

with delight, are the very same which please our eyes and mind. We shall therefore borrow all our rules for the finishing of our proportions from the musicians, who are the greatest masters of this sort of numbers, and from those things wherein nature shows herself most excellent and complete."[6] And again, the "musical numbers are these, one, two, three, four [...] All of these, taken in twos, are skillfully used by architects to plan markets, squares and open spaces in which they focus exclusively to two proportions, length and width: and they even use them, taken in threes, to plan sitting rooms, council's rooms etc. In these, they use the same measure for width and length, and they want that the height corresponds to a convenient proportion."[7] In 1683, François Blondel, architect and urban planner, published at the *Académie royale d'architecture* his teaching in the *Cours d'architecture, ou*

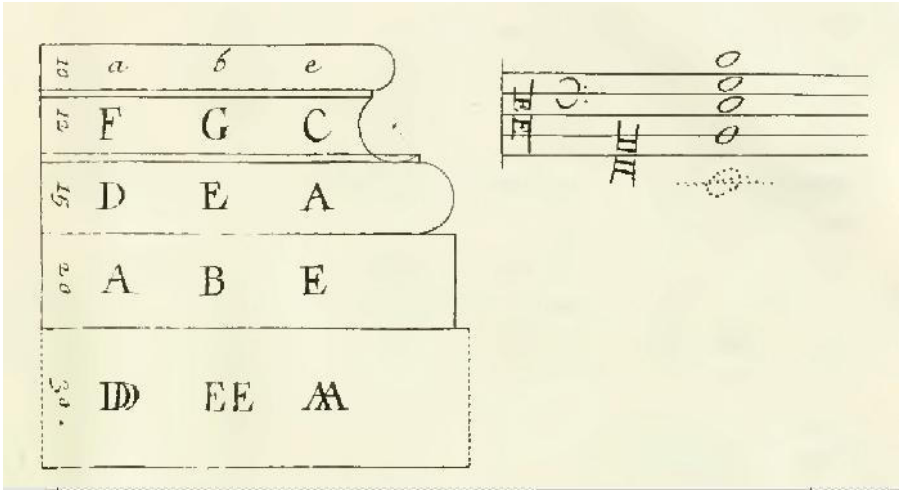

Fig. 4 – Musical proportions of the Actic Base. From Blondel, *Cours d'architecture.*

Traite de la decoration, distribution et construction des batiments where he drew the sum of his teaching, building the ultimate codification of the where he drew the sum of his teaching, building the ultimate codification of the architectural rules that from the Renaissance onwards had an universal value.[8] Blondel shows how to build an attic base; within each moulding he draws some letters of the alphabet and a series of five numbers, while at the side of it, he draws a pentagram. The letters written on the base of the column correspond to the same notes written on that portion of the pentagram on the right of the image. The first seven letters of the alphabet express the sequence of sounds: La (A), Si (B), Do (C), Re (D), Mi (E), Fa (F), Sol (G). The same notes are expressed in letters on the pentagram through the use of three of the seven 'ancient' keys of interpretation. On the pentagram, from top to bottom, we find the Bass, the Contralto and the Soprano key. Reading the notes, written according to the different codes expressed by their keys, we have the following sequence to be read vertically: ADFA on the left of he base, BEGB in the middle and EACE on the right. Reading horizontally, each portion of the column expresses a fifth ratio (3:2).

In 1760, Bernardo Vittone[9], referring to the work of Blondel who had regarded architecture to music, wanted to *"*…explain the relationship between the parts of this [Attic] Base with the tunes of a Perfect Musical Tone, for an easier understanding, I will explain it in terms of *Canto Fermo*. The main parts which make up this base are, between themselves, in the same proportions as the numbers 10, 12, 15, 20, of these, the first one, 10 is the height of the upper *torus* and matches, in the grave tone, *re* of *d la sol re*, the second number, 12 is the height of the *scotia* and matches *fa* of *f fa ut*, 15 is the height of the lower *torus* and matches *la* of *re d'a la mi re*, and 20 matches *la*, or *re* of *d la sol re*, so that placing those tunes, which

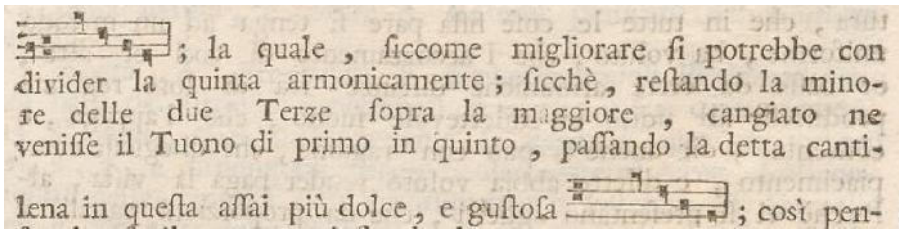
; la quale, ſiccome migliorare ſi potrebbe con divider la quinta armonicamente; ſicchè, reſtando la minore delle due Terze ſopra la maggiore, cangiato ne veniſſe il Tuono di primo in quinto, paſſando la detta cantilena in queſta aſſai più dolce, e guſtoſa ; così pen-

Fig. 5 – Vittone's *Canto Fermo* tunes: *re la fa re* using *Fefaut* key and *si fa re si* using *Cesolfaut* key. From Vittone, *Istruzioni Elementari*.

correspond to the parts of the base, on a scale of *Canto Fermo*, they will express this lullaby".[10]

Zodiac Sign	**Planet**	**Colour**	**Music Note**
Aries	Mars	Red/orange	FA mi#
Taurus	Venus night	Red	MI fa b
Gemini	Mercury night	Red/violet	re# mi b
Cancer	Moon	Violet	RE
Leo	Sun	Blue/violet	do# re b
Virgo	Mercury	Blue	DO si#
Libra	Venus	Blue/green	SI do b
Scorpio	Mars night	Green	la# si b
Sagittarius	Jupiter	Yellow/green	LA
Capricorn	Saturn night	Yellow	sol# la b
Aquarius	Saturn	Yellow/orange	SOL
Pisces	Jupiter night	Orange	fa# sol b

Tab. 1 – Colours, planets, zodiacal signs, musical notes. 'b' stands for bemolle while '#' stands for diesis. From Saint-Yves d'Alveydre's *Archéomètre*.

However, we must differentiate between the association of color-music that comes from the phenomenon of synesthesia[11], as in the case of Vasilij Kandinsky, and an universally applicable intellectual exercise. The famous painter used to associate colours to particular instrumental timbres, rather than particular harmonies.[12] In *Il linguaggio dei colori* from *Dello Spirituale nell'arte*, Kandinsky associated, in the low register, the colour green to the tone of the violin, in the high register and in the low register the colour blue respectively to the flute and to the organ and the contrabass, yellow to the trumpet, red to the brass instruments and in particular to the tuba (in some of its nuances, to the cello), orange to the viola or, in the contralto, violet to the english horn and to the bassoon. For Kandinsky, music wasn't inspired by a program, but rather reflected the inner experiences, which went far beyond the

'content' of the paintings, manifesting themself in a purely musical form.[13] During the same period, Alexander Nikolayevich Skrjabin, a Russian composer and pianist, empirically drew up a table of corresponding musical and chromatic tones. In his symphonic work *Prometheus*, Skrjabin applied his method in a very persuasive way so that DO corresponded to red, SOL to pink-orange, RE to yellow, LA to green, MI and SI to white-blue (blue moon), fa# to vivid blue, do# to purple, la b to purple violet, mi b and si b to steel grey, FA to brown-red.
After having discovered the dualities colour-music and music-architecture, it may be easy to convert architecture in colour. But to do this, we must proceed with caution. Now let's take, for example, Blondel's *Base attica* and Vittone's explanation on how it should 'sound'; the next step is to define what colour matches the melody we discovered. It may be possible to use Kandisky's or Skrjabin's matching charts but that would result in a very subjective result since it is extremely unlikely that any two synesthetes will report the same color. It is imperative to find a unique and universal chart, something that comes directly from the primeval tradition, always equal to itself, imperturbable and immovable regardless of time and space. In 1903, the Frenchman Alexandre Saint-Yves d'Alveydre (1842-1909) published *L'Archéomètre*, an enormous work intended to be a comprehensive key permitting a survey of ancient culture.[14] The *Archéomètre* attempts to assess the real value of each philosophical, scientific or religious system and its place in the universal tree of science or tradition. Its geometrical system comprises different concentric zones of equivalents which each contain a respective messenger or medium of information: colours, planets, zodiacal signs, musical notes, letters and numbers. Its centre is formed by four superimposed equilateral triangles filling a circle and forming twelve tips, with each tip being ascribed a specific colour. According to the French Master, Vittones' architecture can be 'played' by the colours Violet/yellow-Green-Red/orange-Violet (if we were to use the key of Fefaut) and by the colours Blue/green-Red/orange-Violet-Blue/green (if we were to use the key of Cesolfaut).

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[8] Plato, *Theatetus (Θεαίτητος)*, Penguin Classics, London, 1987.
[9] Plato, *The Republic (Πολιτεία)*, Penguin Classics, London, 2007.
[10] Plato, *Meno (Μένων)*, Akasha Publishing, Fairfield, Iowa, USA, 2009.
[11] A. Saint-Yves d'Alveydre, *L'Archeometra*, Ed. Acacia, Milano, 2009.
[12] B. A. Vittone, *Istruzioni elementari per l'indirizzo dei giovani allo studio dell'architettura civile*, Editrice Dedalo, Roma, 2008.
[13] P. Quattrini, 'Progettazione Armonica', in *Musica ed Architettura*, Edizioni Nuova Cultura, Roma, 2012.

[1] I prefer using the verb 'to say' instead of 'to write' as Plato's *Πολιτεία* is written in the form of dialogue between Socrates and his pupils. It is well known the great importance that Plato (like Socrates) gave to the verbal teaching in detriment to written books. As written word is always static, the dialogue is a way to engage the intellect of the people who are discussing.

[2] It is said that Pythagoras by chance passed by a brazier's shop where a smith was pounding out a piece of metal upon an anvil. By noting the variances in pitch between the sounds made by large hammers and those made by smaller implements, and carefully estimating the harmonies and discords resulting from combinations of these sounds, he gained his first clue to the musical intervals of the diatonic scale. After taking note of the weights of the hammers, he returned to his own house and constructed an arm of wood so that it extended out from the wall of his room; at regular intervals along this arm he attached four cords, all of like composition, size, and weight. To the first of these he attached a twelve-pound weight, to the second a nine-pound weight, to the third an eight-pound weight, and to the fourth a six-pound weight. These different weights corresponded to the sizes of the braziers' hammers. Pythagoras thereupon discovered that the first and fourth strings when sounded together produced the harmonic interval of the octave, for doubling the weight had the same effect as halving the string. The tension of the first string being twice that of the fourth string, their ratio was said to be 2:1, or *dupla*. By similar experimentation he ascertained that the first and third string produced the harmony of the *diapente*, or the interval of the fifth. The tension of the first string being half again as much as that of the third string, their ratio was said to be 3:2, or *sesquialtera*. Likewise the second and fourth strings, having the same ratio as the first and third strings, yielded a *diapente* harmony. Continuing his investigation, Pythagoras discovered that the first and second strings produced the harmony of the *diatessaron*, or the interval of the third; and the tension of the first string being a third greater than that of the second string, their ratio was said to be 4:3, or *sesquitertia*. The third and fourth strings, having the same ratio as the first and second strings, produced another harmony of the *diatessaron*. According to Iamblichus, the second and third strings had the ratio of 8:9, or *epogdoan*. Levin, 1994.

[3] The key to harmonic ratios is hidden in the famous Pythagorean *tetractys* made up of the first four numbers (1, 2, 3, and 4) which in their proportions reveal the intervals of the octave, the *diapente*, and the *diatessaron*. Ferguson, 2008.

[4] "*ἔστιν γὰρ χρόα ἀπορροὴ σχημάτων ὄψει σύμμετρος καὶ αἰσθητός*." Plato, *Μένων*, 76.

[5] "*ἐπώμεθα τῷ ἄρτι λόγῳ, μηδὲν αὐτὸ καθ΄ αὑτὸ ἓν ὂν τιθέντες: καὶ ἡμῖν οὕτω μέλαν τε καὶ λευκὸν καὶ ὁτιοῦν ἄλλο χρῶμα ἐκ τῆς προσβολῆς τῶν ὀμμάτων πρὸς τὴν προσήκουσαν φορὰν φανεῖται γεγενημένον, καὶ ὃ δὴ ἕκαστον εἶναί φαμεν χρῶμα οὔτε τὸ προσβάλλον οὔτε τὸ προσβαλλόμενον ἔσται, ἀλλὰ μεταξύ τι ἑκάστῳ ἴδιον γεγονός: ἢ σὺ διισχυρίσαιο ἂν ὡς οἷον σοὶ φαίνεται ἕκαστον χρῶμα, τοιοῦτον καὶ κυνὶ καὶ ὀτῳοῦν ζῴῳ* ". Plato, *Θεαίτητος, 153-154.*

[6] Alberti, 1987.

[7] "[i] *numeri musicali son questi, uno, due, tre, quattro* […] *Di tutti questi numeri si servono gli architettori comodissimamente, presigli a duoi a duoi, come nel disegnare il mercato, le piazze e gli spazi scoperti, nelle quali cose si considerano solamente duoi diametri la lunghezza e la larghezza: ancora gli pigliano a tre a tre, e se ne servono per disegnare il luogo da sedervi pubblicamente, e la sala del consiglio e simili. Ne' quali similmente fanno corrispondere la larghezza e la lunghezza, ed all'una ed all'altra di queste vogliono che la altezza corrisponda a proporzione conveniente*." Alberti, 1966.

[8] Quattrini, 2012.

[9] It is extremely important to note that while Blondel used the pentagram with the Bass, the Contralto and the Soprano key, Vittone used the hexagram of *Canto Fermo* with *Fefaut* and *Cesolfaut* key.

[10] "*…spiegare il rapporto che hanno le parti di questa Base [Attica] con le voci di un Tuono Musicale Perfetto, che per più facile intelligenza esporrò in termini di Canto Fermo. Stanno i membri principali che questa base compongono, tra loro come i numeri 10, 12, 15, 20, de' quali posto, che il primo, cioè il 10, che l'altezza rappresenta il Toro superiore è […] corrisponda […] alla voce più grave, la quale sia* ***re*** *di* ***d la sol re****, il secondo, cioè il 12 rappresenta l'altezza della Scozia […] corrisponderà al* ***fa*** *di* ***f fa ut****, il 15 altezza dl Toro inferiore al* ***la*** *ovvero al* ***re d'a la mi re****, e finalmente il 20 al* ***la****, ovvero al* ***re*** *di* ***d la sol re*** *[…] sicché disponendoli in scala di Canto fermo le dette voci coll'ordine, che alle membra della Base corrispondono, si troverà essa esprimere questa cantilena.*" Vittone, 2008.

[11] By the Oxford Dictionary online, synesthesia is 'the production of a sense impression relating to one sense or part of the body by stimulation of another sense or part of the body'. This means the impression is personal and different for each person.

[12] "*I violini, i bassi gravi e particolarmente gli strumenti a fiato* [del *Lohengrin* di Richard Wagner] *incarnarono allora per me tutta la forza di quell'ora di prima sera. Vidi nella mente tutti i miei colori, erano davanti ai miei occhi; linee tumultuose quasi folli si disegnavano davanti a me*." Kandinskij, 1989.

[13] Kandinskij, *ibid.*

[14] The term archéomètre comes from the Greek αρχης-μετρον, the measure of the Principle (from αρχης principle μετρον, measure).