

Music and Physics – Connectors and Parallels

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Biography:

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Abstract:

Music may be defined as a mathematics of affections. Originally a branch of mathematics and philosophy, music unites mathematical structuring elements and the most abstract and affective expression of man. But it is not only to mathematics that it is related in such an apparent manner. More and more music shows a brotherhood of blood to physics, choosing issues common to both these spheres of knowledge as the focus of its attention.

Mathematics of affections

Addressing music in present times, when the cultural industry rules in such a wicked manner, implies the risk of talking about things so different that it would be very difficult that an extraterrestrial being possessing a minimum intelligence level and even in a routine visit would classify things he heard here as part of the same branch of human knowledge. In his enterprise, he would certainly lose plenty of time facing a huge amount of mediocre and unpretentious doings - two adjectives which are rather problematic to good art: the first, involuntary; the second, under the responsibility of the "artist" himself.

Anyway, if we consider as *music* that speculative, pleasant activity, yes, but which is at the same time essentially investigative, experimental in nature, the radicalism of which stands above all on the dialectical relationship between the new and the revisitation of the old in a new context, we should recognize that, since such field of knowledge exists in a considerably autonomous manner, it has always been connected to its close cousins (maybe brotherhood would be exaggerating): Mathematics and Physics. From the earliest times, when Pythagoras expressed his view concerning *the harmony of spheres*, until contemporaneity, when physicists themselves appeal to musical constitutions to solve problems of physics and the universe, the degree of relateness between music and science is remarkable and evident. It was actually a physicist, Brian Greene, who recently stated: "Historically, music has provided the best metaphors to those who want to understand cosmic matters" (GREENE, 2001, p. 155).

We should also admit, however, that the approaching between music and science is based on metaphor only as its most superficial connection. The binding structures that interconnect both spheres of human knowledge - music and science - are supported by bases much more profound than sheer analogies. We are dealing here with connectors rather than mere parallels. However, there is a substantial difference: among the numerical and conceptual elaborations anchoring musical structures there is a share of affective tensions which is not less fundamental - and for some even more important,

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which penetrate a complex and half-conscious intricacy constantly oscillating between invention and calculation, intuition and reason.

Thus, I usually define music - and here it should be well understood: music, which is *speculative* (using a term by Zarlino, in the early 1558), *radical* (as wished Theodor W. Adorno), *maximalist* (as I wish) - such as a *mathematics of affections*.

Such a definition does not intend to take away from science the emotion inherent to scientific investigation. Not at all. It is necessary to recognize, nevertheless, that between the diffuse emotion which irradiates to the international scientific community when a solution is found to an equation which remained unsolved for centuries, as occurs from time to time in mathematics, and the concrete and direct drive due to listening to a genial work, which enters the psyche of the receptive listener with as much profoundness as it will last, as a past life and unique experience in the structure of his memory, there is a potential difference: to feel emotion in science means to be partially sure that another step was taken towards the assertion of one's first intuition, while feeling emotion in music means to face the perplexity of what will be understood only as time goes by. In this last case, it is intuition, now acting as a factor of receptive perception (not as much active as when conceiving music itself), which unleashes the game of experience.

The notion of *transgress*: saying yes to many truths, and no to lie

But where is the genetic factor that unites music and science, especially physics?

In this context, it will be necessary to recognize a certain "gradient of action efficiency" going from the political sphere to that of artistic making, and passing, halfway, by science. The great German musicologist Carl Dahlhaus once said that, unlike politics, where the inefficient is nothing, in short, in the history of music a work from which nothing has developed may be significant (DAHLHAUS, 1978, p. 340). Therefore, while in politics a mistake can be translated as something unthinkable, as far as every political action needs immediate efficiency to produce any effect, in music, instead, a work could have been conceived without causing any immediate consequence whatsoever, but germinate only in a future phase of styles that come to be outlined as years go by. Halfway, we may place science, which in its insatiable search for meeting the target ends up facing a mistake, which, as the irreverent product of "chance", may point out new paths and, thus, new solutions.

In this sense, science stands to politics as music stands to science. If the notion of *progress*, so fundamental in politics, is threatened in those areas of action where mistake is an admitted potential component of some rightdoing, it becomes, in science and above all in arts, what I usually call *transgress*. Thus, progress should not at all be seen as something dated or overcome - an easy standing point, akin to the dominating ideological inertia and, I shall say, a very reactionary view that overtakes the present petty bourgeois mentality -, but instead as potentialized in a notion of "quantum" nature, where distinct solutions are given for ordinary problematics, without making a choice for language regression in its essentially evolutive propositions.

Thus, musical language further outlines evolutions as clear as necessary. By overstressing the importance not so much of mistakes, but - let us make this precise - moreover of the mishappens which also occur in science, music points out, since the remotest times, to a non-linear evolution of language facts that support composition throughout the evolution of styles.

This situation may be compared to the arborescence process: branches of multidimensional trees manifold into unending distinct blossoming, each one of them being evolutive in its particular manner, so that distinct and seemingly far apart branches bear fruit in trees placed elsewhere, in an atypical combination arising from a particular esthetic option issued from the complex branching that is the artist's path itself, and considerably determined by the soil quality (not by the territory's!) where it finds its nutrients. A Stockhausen-branch added to a Berio-branch can bear fruit in me, while this same Stockhausen-branch may associate to a Boulez-branch to bear fruit, for example, in Philippe Manoury. Descartes has defined philosophy as a tree: its roots would be metaphysics; its trunk, physics itself; and the branches, all other sciences. If such a vast wood can serve as a metaphor for the creator, the composer will have to alternate his role as a gardener, more attached to earth and to what is within his reach, as well as a bird which, in the free flight of intuition, can set foot on many branches and from every site, overview the land from a different angle.

If Werner Heisenberg signaled the fact that every word and every concept have but only a limited range of applicability (*apud* CAPRA, 1982, p. 45); if Merleau-Ponty used to define truth as another name for sedimentation (MERLEAU-PONTY, 1975, p. 329); and if Roman Jakobson stressed the dramatic nature of the antinomy present within very inside of each linguistic sign, where the significant relates to the signified without ever being it integrally (JAKOBSON, 1985, p. 53), such visions on physics, on philosophy and on linguistics disclose a profound identity to a likely and only truth: that there are countless truths, but that lie, in science as in linguistics as in music, is singular.

From this arises the considerably easier task of identifying what is bad in art, while what is good simultaneously translates, moreover, as something almost undecipherable. From that come forth both the perplexity before a genial work, in as much as boredom arises before the ephemerality of an implacable and doubtlessly mediocre deed. In this lies a certain similarity between art and politics, as paradoxical as it may sound: the inviability of a peaceful convivence with anachronisms, dead trees or involutive, regressive branches which reject light and get incrustated deep under earth.

If in the one hand, as Greimas brilliantly remarked in his semiotic chart (GREIMAS/COURTÉS, 1979, p. 32), truth, as a conjunction of *being* and *seeming*, joins the secret of what *is*, but *does not seem*, on the other hand, the lie, which is a conjunction of the *seeming* with a *not-being*, joins the falseness of what *neither is nor seems*.

Progress has not been buried; it was only transformed and potentialized. But here I do not refer to mere unlucky transgression. I do not simply "transgress": I trans-gress. *Trans-gressing* is therefore necessary.

Simultaneities

Both the evolving process of language sounds performed by a child - named by Jakobson and Morris Halle as *stratification* - as much as the assertion held by Biology, since Darwin, that the universe may be described as a system in permanent (r)evolution of increasingly complex structures developing from simpler forms, an assertion proven by the thermodynamic laws in physics - concerning the conservation and dissipation of energy in a given process - point to an eulogy of *complexity*, or said in musical terms, a growing and, luckily, unattainable apogee of *simultaneities*.

This is indeed what distinguishes speculative music from the “light” forms of music, called “popular”, and which are, in short, entertainment music. Along the history of western music, compositive thought went along a pathway of an increasing simultaneity of events. Even in the seeming simplicity of elaborate melodies, there is the unending search for evolutive processes taking place at different levels of listening, independently and concurrently. In this lied the poetics of a Luciano Berio, for instance, who searched for a *latent polyphony* in the melodic line of his *Sequenze*. To apply a term from the poet Edoardo Sanguinetti, so dear to Berio, we aim here at a maze of multiple entrances and exits, carefully intertwined by the composer, without exercising absolute and unilateral control over the perceptive result, echoing the intuition of the physics of the superstrings, for which the microscopical fabric of the universe constitutes a multidimensional maze, richly composed of twisted chords continuously vibrating. In this also lied the potential for openness, as formulated by Umberto Eco in *Open Work (Opera Aperta)*: not in the casuistic operations of pretense “chance”, but in the multilateral potentiality of experience even before the seemingly most “closed” object. Such is the definition of *maximalistic* poetics in composition (as I would come to define it in 1983).

Maybe the closest proximity between maximalism in composition and the Physics, who proclaims complexity as its motto, is the link connecting Einstein's relativity to that relativity which presides over the temporal processes in certain works of speculative music. Differently from entertainment, to which music performs the utilitarian function of a cushioning backdrop on the grounds of a uniform, catatonic temporal grid, in radical music the time model and the easy parameterization of metrics are, by principle, absent. Rhythmic perception gives way to another perception, essentially *lasting*, which prioritizes the extension (no matter how ephemeral it may be) of sound as data of its esthetic essence. One more reference to Descartes, to whom the essence of matter is extension. In the core of such attitude towards sounds, what vulgarly seems to be entertainment gives way, consequently, to an *intertension*. When the intention is not to *intertain*, let silences be heard!

The problematics of decompositions

The issue of simultaneities reflects both on the macroscopical level as in the micro-universe of matter and, in the case of music, of sounds. The wave patterns of probabilities proclaimed by physics more recently, especially through the superstrings theory, show that subatomic particles must be understood not as minimal entities, but rather as interconnections between increasingly subcutaneous aspects of the materiality of things, its weft constituting the fabric of events in the universe: contextures of interdependent aspects.

There could not possibly be anything more attuned with the vibrations emanating from music than this systemic view of physics. Berio himself had already said that a sound has no importance whether considered regardless of a context. It may be that there is some interest - and there is always some - regarding its particular weft, apart from any synthatic contexture, but sound only deploys meaning when contextualized in a musical fabric through the interplay with other sound objects. Nevertheless, not only at the level of its “externalization” does sound acquire meaning and sense. In its very internal constitution we already notice how much its constitutive aspects - frequency, range and duration, all conditioned to the energetic evolution of sound along time and resulting in its global perception known as timbre -, which are articulated in perceptive regions more or less autonomous, are strongly related among themselves.

There lies one of the healthiest contradictions in music making: the dialectics between global sound perception and the particularized perception of its subsidiary aspects. Since the birth (or consolidation) of musical notation - the process of *notational* transcription should not be mistaken by the compositive elaboration process itself, which we may call *scripture*, as opposed to mere writing -, musical composition went through the path of sound representation, at first attached to verbalism, which would account for the prosodic aspects of language. Pitches, durations and, much afterwards, intensities came to be written autonomously, as elementary constituents of sound. In a highly abstractive exercise, such an articulation has allowed, despite its being based on the interdependence of these attributes, the concomitant elaboration of perceptive plans that accounted for the distinctive aspects of the rough, concrete experience of listening to sound as a wholeness of sound parameters. If, on the one hand, this compartmentalization of sound allowed the writing techniques to evolve, it encouraged the illusion, on the other hand, that such aspects could be thought of as absolutely independent towards one each other.

The apogee of such disconnection of the sound attributes, which occurred during the phase of integral serialism in the beginning of the 50's, allowed for an increasingly responsible and totalizing awareness towards sound and composition parameters, as well as it led, paradoxically, to works in which the control over sound phenomenon itself was lost, so overwhelming was the pretense interdependence of sound constitutors. Strictly saying, ultra-articulation led to syntactic disjointing of composition. However, notwithstanding the prevalence (at least apparently) of calculation over intuition, the acquisitions concerning the organization of musical material were unquestionable, and even irreversible - from the standpoint of a radically speculative music: sound *decomposition*, though problematic, proved to be totally necessary in regard of musical (re)composition.

In this sense, Karlheinz Stockhausen will define the *Dekomposition des Klanges* (sound decomposition) as one of the essential criteria of electroacoustical poetics (STOCKHAUSEN, 1978, pp. 360-401). Having recourse to studio devices, electroacoustic composition actually aims at the same decomposition of sound targeted by musical writing itself, though using more limited representational means, as it has always done and still does, in order to rearrange it and recompose it afterwards, bearing in mind the interactivity between its minimum components. Amidst such an investigation process, at some given moment, all decomposition stops to give way to distinct dimensions of a same constitutive element, releasing its potentiality into the realm of action/perception of another attribute, before which it reveals itself as essentially *interdependent*. The Cartesian extension that lets envision matter essentiality reveals itself, here, as a transference phenomenon. In this sense, the very notion of *entity* stands out in the speculative musical context, namely when referring to the endless possibilities of *harmony*: as *interconnection fields*, structured in aggregates sometimes prevalingly synchronical (accords), sometimes prevalingly diachronical (modules, profiles).

Continuum

In the core of interconnections arises a pervasive doubt: what is indeed this interdependence between pretensely autonomous sound attributes?

Einstein's physics had already proclaimed, upon the insertion of time in the three spatial coordinates of 3-dimensionality, that time and space are so intimately linked that they end up forming up a four dimensional *continuum* called "space-time".

In the universe as it is interpreted by physics, as much as in the world of sounds as we perceive them, the "regionalization" of attributes which constitute the macro objects does not exclude but, on the contrary, presumes a continuous transition of the action scopes or perception scopes of such microstructural aspects. In music, this fact became accessible to composition awareness when Stockhausen formulated the so-called theory of *Musical Time Unity* (cf. in MENEZES, 1996, pp. 141-149). After performing *Kontakte* (1958-60), Stockhausen noticed that the accelerated rhythmic impulses, once having surpassed the limit region of approximately 16 impulses per second, would enter the perceptive territory of pitches, just as frequencies, perceived as "musical notes", became rhythms whenever they were slowed down at their most extreme.

The finding that still today astounds great many of the musical community, has represented a huge advance, not only regarding the elaboration forms of the musical substance, but also in the manner of *listening* to the sound in its most distinct perceptive states (*Gestalten*).

The radicalization of this process has led Stockhausen to expand his observation field. Beyond the frequential dimension, also the perception of specter "colors" (timbre) is included in sound innerbound plunge, much in the same way as within the limits of rhythmic dimension the time extension is organized into formal blocks, giving way to the perception of musical forms. So we come to the following conclusion, which is as obvious as it is surprising: the *continuum* interconnecting space and time gives way, in terms of perception of sound constitutions, to that which *slips* from form into timbre.

Perpetuum mobile

It would be a conceptual illusion to circumscribe the continuing character of perception to those perceptive regions which acquire a certain autonomy due to the very fact that they constitute "regions". Physics states that the smaller the region where a subatomic particle is confined, the quicker this particle will be impelled to movement. The proportionally more frantic agitation of a particle in relation to the reduced scope of its action implies a sort of exuberant "quantum claustrophobics" and, consequently, a continuing mobilization of the minimal elements of matter.

This phenomenon reveals that there are no ecstatic structures in nature, and that the universe is organized, both in microscopic and macroscopic levels, as a continuing, uninterrupted cosmic dance, which the theory of superstrings interprets as a *perpetuum mobile* of vibrating chords.

No matter how risky it is to assert, loud and clear, a definite esthetical posture, right when judgments of value are not at stake, it is evident that, if we are willing to tune in the strings of this wide vibratory state which naturally unites the physics of the universe to the universe of sounds, we should aim at a *directional* organization of the musical structures. Any poetics circumscribed to an ecstatic listening, thus putting direction to death, becomes apart from the last word in modern physics and, as a rule, in terms of world view - or to put it more precisely, in the phenomenological comprehension of the "leaves of world" which make up the fabric of the universe.

When Einstein states that mass is but a form of energy, a conclusion proven by essays on high-energy collision processes physics where it was observed that matter particles were

destroyed and created, but their mass transformed into movement energy, and vice-versa, he did nothing more than handing out a physics model totally in tune with the most relevant conceptions in electroacoustic music concerning masses as sound properties when spotted through listening, somewhere in the space of sound pitches. In music, masses - as wished Pierre Schaeffer - are potentialized into *profiles*, the same way as subatomic energy movements get intertwined with the transformations of particle mass transformations.

Thus, some 20 years ago, when I formulated a possible definition of an updated poetics of composition, enunciating the formula according to which "listening is hearing, and living is walking over *directions*", I pointed the relevance and the esthetic modernity of the directional phenomena. To the death of *directionality* in music, foolishly stated by minimalist postures, we oppose a radically *maximalistic* attitude, aware of the *perpetuum mobile* and the transformational character of sound energies.

Space: active and relational

The concept of movement is relative; so says the physics of superstrings; so said Einstein's relativism. But relativity is not restricted, as we know well, to the notion of movement: space itself is relative. And furthermore, it is nonetheless *active*.

This assertion goes back to the theoretical duality which involved thinkers like Newton or Leibniz. Differently from the British physicist, Leibniz stated that space did not exist in itself. The existence of space was possible due to the existence of things in the world. Without things, there would be no space. Thus, space mediated worldly things as much as it depended on them in order to be unleashed as a more or less autonomous notion. More than relative, space, in Leibniz conception, is essentially *relational*.

On the other hand, as Greene properly observes, the linkings between gravity, accelerated movement and curved space led Einstein to understand that the presence of a mass makes the space fabric to become curve. Space would not be a simple passive "arena" where the events of the universe are staged, but instead it would rather be a relational *agent* conditioning the perception of these same events.

Both the relational aspect of space and its active capacity for perceptive conditioning can be regarded as vital factors in a pertinent electroacoustic poetics: *composing space* means acknowledging its synthatic potentialities, interdependent with the matters themselves. If, without the existence of any mass, space in physics is flat, in music space does not even exist without sound. And beyond this seeming obviousness, space without movement, though existing, falls short from being acknowledged.

Polarizations

The proven Einstein's thesis, according to which objects move through space-time following the shortest way or, to be more precise, through the less resistant way, finds a parallel in and is strongly connected to the gravitational force displayed by certain frequencies in given contexts, which Edmond Costère has called, accordingly, the "sociology of pitches". Costère speaks of a "law of the shortest way" (COSTÈRE, 1954, p. 15), pointing the attractive potential of atomic intervals of a given pitch tuning system (in the case of the tempered system, the half tone), which puts forth a clear *polarization* feeling, reassuring the *cardinality* of listening agglutinating poles.

The notion of polarization has been many times mistaken with the unilaterality of classical tonality, but in fact, it presides over both the procedures of gravitation around the main tone in tonalism as well as over the hearing natural trend to detect such attractive potentialities in more complex harmonical contexts, as long as they are essentially non-statistical.

It is thus starting from an awareness of the polarization phenomenon that a responsible and potentially fruitful speculation may and must take place concerning the structural organization, always updated, of what unfolds as a supreme attribute of sound, from the purest (sinewave) up to almost the most complex one (excepted only in this context, the white noise, due to its probabilistic and totalizing structure of frequential space): the perception of its location, no matter how averse a sound can be regarding any *tonicity* in the wide range of pitches.

Maximalism and time suppression

One of the most extraordinary contributions ever made to understand complexities as motto of a radical attitude regarding sound listening, has been the formulation by Olivier Messiaen concerning the "laws that perfectly summarize the lived duration" (MESSIAEN, 1994, p. 10):

Feeling of present duration. Law: in the present, the more time is full of events, the more it will seem short to us - the more it is empty of events, the longer it will seem to us.

Retrospective assessment of past time. It is just the opposite of the preceding law: in the past, the more the time has been full of events, the more it will seem long to us now - the more it has been empty of events, the more it will seem short to us now.

Under many angles, this formulation on behalf of complexity has already been detailed in some previous writings of mine. Though, it is a curious thing, in this context, to understand it from the standing point of its relations regarding more modern physics. According to all our deductions issued from the diagnostics that allow us to understand the incredible, though up to now unattainable magnitude of light speed, we draw the following conclusion: the more a particle approaches light speed, the *slower* it becomes from the point of view of an onlooker. According to Einstein's formulations and those of the special relativity concerning the division of movement among distinct dimensions, which in most circumstances lead us to the conclusion that the greatest part of an object movement occurs in time, and not in space, it arises that the more dimensions have the leaves of world - and the theory of superstrings supports that there might be more than 20 of such dimensions, the 4 dimensions we know being only the most tangible ones, according to our world comprehension/perception -, the slower will be the events in the universe.

Since white light is, as we know full well, a mix of all colors, hence there is a multiple simultaneity of sound events which we perceive as being shorter than it is in fact, and which becomes closer to light by means of a "colorist" perception, at the same time as it gets farther away from the somber diluting poetics which irradiate but a few reflections only. Thus, it will tend to be, in the memory of its past experience, paradoxically longer and longer. Memory extension is here (con)fused with temporal *rallentando*. If the appraised suppression of the very idea of time arises, while listening, from the interest on colorful intricacies that such a complexity provokes on speculative listening, and if the sensation of lived time is substantially reduced, the pronounced enlargement of a significant event in

the memory frame makes us understand well the real significance of such a formulation: good music is close to full-fledge light.

Perfection may be the target, but it is unattainable

Einstein had claimed that all objects in the universe are always traveling through space-time at a constant speed - i.e., light speed. But the multidimensionality necessarily slows them down. It is as if each and every object were rendered equal, hypothetically, to the quality of that supreme mix of all colors, but since it is inserted in the world through more dimensions, its speed "is split up" and never actually reaches light itself.

The conclusion, both esthetically and according to the stand point of physics, is implacable: if an object traveling at light speed throughout space does not leave any speed available for its own movement through time, becoming absent and light-years away from our most worldly aspects, we will come to realize not only that light itself does not get old, but also that at light speed time does not pass. Also, within the scope of complexities, absolute suppression of time and the approach to *lux aeterna*, even though they are and have to be aimed at in every work, are not possible, whether humanly or worldly. Full-fledge light is, therefore, unattainable.

Luckily or fatefully, however, an illuminated work is not restricted to light itself, and in art, the process means are always more significant than purposes themselves. In art the first ones do justify the latter. The *intention of work* is revealed in the core of the very work in progress, as being more important than its bare appearance, and from that aspect emerges the importance of the *musical gestures* which, as light beams, point out the unattainable perfection through the bias of *directionalities*.

It is in such a context that the fragmentary motto of Anaxagoras (ANAXÁGORAS, 1966, p.66), who with a simple phrase so wisely predicted phenomenology almost 2500 years before its remarkable statements were formulated by Edmund Husserl and Merleau-Ponty - bringing us to the "reduced listening" supported by Schaeffer, and by the electroacoustic music also -, reveals all of its contemporaneity. In the world of life (*Lebenswelt*), no light can be completely full-fledged:

"What is shown is just an aspect of the invisible".

São Paulo, on September 2003.

Bibliography

ANAXÁGORAS. *Fragmentos*. Buenos Aires: Aguilar, 1966.

CAPRA, Fritjof. *O ponto de mutação*. São Paulo: Cultrix, 1982.

COSTÈRE, Edmond. *Lois et styles des harmonies musicales*. Paris: Presses Universitaires de France, 1954.

DAHLAUS, Carl. *Schönberg und andere*. Mainz: Schott, 1978.

ECO, Umberto. *Opera aperta*. Milano: Tascabili Bompiani, 1962.

GREENE, Brian. *O universo elegante*. São Paulo: Companhia das Letras, 2001.

GREIMAS, A. J.; COURTÈS, J. *Sémiotique: dictionnaire raisonné de la théorie du langage*. Paris: Hachette, 1979.

HAWKING, Stephen. *Breve história do tempo ilustrada*. São Paulo: Albert Einstein, 1997.

JAKOBSON, Roman. *Essais de linguistique générale*. Paris: Les Éditions de Minuit, 1963.

_____. *Poetica e poesia*. Torino: Einaudi, 1985.

MENEZES, Flo. *Música eletroacústica: história e estéticas*. São Paulo: Edusp, 1996.

_____. *Atualidade estética da música eletroacústica*. São Paulo: Editora Unesp, 1999.

_____. *Apoteose de Schoenberg: tratado sobre as entidades harmônicas*. São Paulo: Ateliê Editorial, 2002.

_____. *A acústica musical em palavras e sons*. São Paulo: Ateliê Editorial, 2003. No prelo.

MERLEAU-PONTY, Maurice. *Sobre a fenomenologia da linguagem*. São Paulo: Abril, 1975. (Os Pensadores, 41).

MESSIAEN, Olivier. *Traité de rythme, de couleur et d'ornithologie*. Paris: Alphonse Lédur, 1994.

PRIGOGINE, Ilya. *O fim das certezas*. São Paulo: Editora da Unesp, 1996.

SCHAEFFER, Pierre. *Traité des objets musicaux*. Paris: Éditions du Seuil, 1966.

STOCKHAUSEN, Karlheinz. *Texte zur elektronischen und instrumentalen Musik, band 1*. Köln: DuMont, 1963.

_____. *Texte zur Musik 1970-1977, band 4*. Köln: DuMont, 1978.

ZARLINO, Gioseffo. *Le istitutioni harmoniche*. New York: Broude Brothers, 1965.