WAVELETS, PULSE ANALYSIS, AND THE THIRD DERIVATIVE OF TIME

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Summary

Wavelet analysis allows time multi-resolution, besides being an efficient filter for signal processing and denoising. Here we conjecture the possibility that the own mechanical movement of bodies acts, through the three successive differential orders, and by virtue of the resonances that these generate, as a selective filter of the statistical background noise. From this possibility, new considerations for biological information, emergent systems and control arise, as well as for time analysis in general. It follows a philosophical discussion about the location of this analysis in the context of general knowledge, including topics as fractional calculus, nonholomic systems, etc.

Keywords: Emergence, causality, evolution, transient motion, wavelets, pulse analysis, Samkhya, third derivative, fractional calculus, impulse, time.

Background

The sanguineous pulse reading has been the main procedure of diagnosis in the ancient medicines. For the modern scientific standards, these procedures have been considered, at best, like qualitative and empirical approaches, if not plainly rejected as groundless. Nevertheless, it is clear that the pulse is a perfectly quantifiable dynamical signal, and, therefore, we would have to be able to translate the qualitative descriptions in quantitative and verifiable terms. Pulse continues being the more faithful global indicator of the health and state of organism, and if the modern clinical analysis cannot give rational account of the information that it contains, it would also mean that it is incapable to accommodate the most elementary facts of life.

In previous writings [1, 2], I have tried to relate the categories of the Ayurveda and the Samkhya philosophy to the principles of Newton's mechanics. Basically, the three humours, *kapha, pitta* and *vata,* and the corresponding and more general modalities, *tamas, rajas* and *sattwa*, can be respectively superposed with that defined through the first, second and third Newton's laws -inertia, the force or acceleration, and the balance between action and reaction- with the condition that always exists a relevant time between the action and reaction –that is to say, these are not strictly simultaneous. Of course, all known real systems require a time of reaction; but being this time different for any of them, it happens to be considered accidental or miscellaneous. Nevertheless, this meanwhile between action and reaction is indispensable to at least have a minimum intuition of cause, beyond the description of a general balance, which is what the ordinary equations of dynamics establish for stationary systems. The third principle, in this context, is equivalent to a sensitivity term between the action and reaction.

Principles apart, the form of the pulse, as the doctor perceives it, is an additional component not described in the usual oscillographs, although now this is fully recordable. We had talked about that specific form like an elusive quintessence difficult to grasp; and in that respect, we spoke very

vaguely of pseudo-derivatives and the measurement of the impulse considered like unit of force per time. In physics, the term "impulse" is equivalent to the integral of the force with respect to the time; nevertheless, in this context we wanted to introduce other considerations with respect to the specific form of the pulse profile, the variations of thickness in response to the pressure, the contractile impact of the heart, etc. Of course, we would like to remain within purely mechanical parameters.

The third derivative

The three principles of the Ayurveda and Samkhya philosophy can be matched with the characteristics of the temporal series and their graphs; but even so, we remain without having a direct and intuitive understanding of what the third element, the sensitivity of the system, could mean. The simplest possible answer would be the third derivative with respect to time, that is to say, the rate of change of the force or acceleration: $d3s/dt3 = d2v/dt2 = da/dt$

The first speculation on the possible relevance of third derivative in mechanics is as late as 1962. W. O. Davis et al [3] conjectured on their possible applications to systems with transient states, far from the ideal, stationary state –impacts, the entrance of a rocket in the atmosphere, and other phenomena with violent rates of change. But, in fact, the discontinuous application of forces is the norm, and not the exception, for most of the observable phenomena. The physicists and the engineers have preferred to ignore the pertinence of the third derivative or the control of the acceleration, considering it as the option of the operator –this is, like an external component of the system.

Davis approach can be applied not only to sudden impacts and exceptional transient conditions, but, more generally, to driven oscillators with a period of application of the force minor than the critical time of the system.

The signal of the pulse involves impacts inevitably, having pauses as much after systole as after diastole. Therefore starting conditions of the signal and, presumably, a critical time or times; but appearing here control, homeostasis and stability conditions implicitly, nobody will say in this case that the third derivative values refers to something external to the system. Besides, and in a different dominion, the critical time of action is also recognized implicitly in hydrodynamics and aerodynamics for Mach or Reynolds numbers.

In certain conditions, the application of the third derivative offers quite unexpected solutions. Since “Davis mechanics” does not admit the simultaneous action and reaction –in the same way that Samkhya doesn’t -, or, said another way, the moment of a real object cannot change instantaneously and independently of the magnitude of the applied force, the existence of a Critical Action Time (CAT) is to be observed for each system. Admitting a time delay factor, one could interpret that the conservation of the energy during that lapse obeys to a net contribution of the environment of the system –in order to conserve that energy momentarily, indeed. All this sounds too exotic, if we don’t repair in the fact that we are trying to make commensurable two very different types of description. In parallel, for the logic of the Samkhya or the Ayurveda it is required that the third principle, *sattwa* or *vata*, -in fact, the first one of the three in its own order of causality, it is the *most direct* expression of the interaction with the medium or environment. That is to say, both logics agree outstandingly, and they do it since they do not look for the idealization of the events that they try to describe, and even though their description can be largely incomplete.

In addition, the systems with transient states and a critical time delay for the action ordinarily generate resonances –transformations between kinetic and potential energy, which are amplified in as much the denominator tends to zero. Even being quite small, this component never vanishes absolutely, which allows to explore a much more ample spectrum of relations in terms of series and resonances in an undefined medium. That is to say, it allows another type of relations between phenomena of very different order. The new set of resonances appearing in the Davis

equations are determined by the relations between the first and third derivative, and their damping, by the coefficient of the second, equivalent to the mass. Possible hyperbolic solutions also may have importance, but they would take to us too far now.

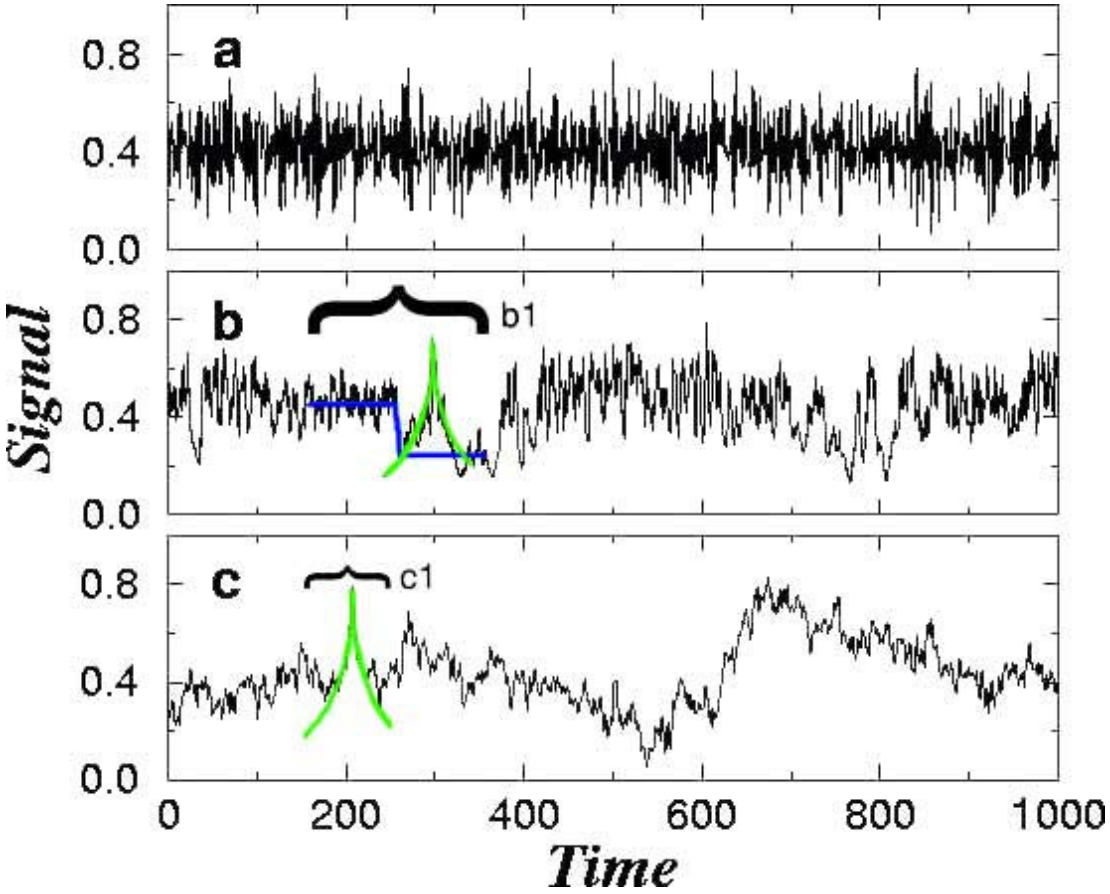
Arthur Young's Theory of Process

The following who spoke of the importance of third derivative was the American engineer and thinker Arthur Young. Young proposed a highly simplified scheme, but with sense, in which the position, the speed, the acceleration and the control -the derivatives of zero, first, second and third order- conformed a circle map of four moments, "unconscious action", "unconscious reaction", "conscious reaction" and "conscious action". This scheme also is very similar to the one of Samkhya, since for this philosophy the movement and the mind would happen in the three last ones, being the first or the position an indispensable assumption, about which, like about consciousness, nothing with sense can be said –being on the contrary the condition of the rest.

Young belonged to that line of maverick thinkers and generalist like Buckminster Fuller, who considers the present specialized sciences as completely incapable to give account of the most fundamental and basic facts of life. Young argued reasonably enough that without the inclusion of a third derivative –the control-, we could not explain anything of our daily life, like driving a car, for example. This is quite clear, but, being already in the scope of the external activity, they remain somewhat dissociated of the internal dynamic processes. But do "internal dynamic processes exist? By self-definition, dynamics is the science that studies external variations, reason why the question can be reversed. Without doubt, Young would have find better arguments in the dynamic analysis of the pulse, although at his time did not exist tools to register its more specific form faithfully. In fact, Samkhya, being the philosophy of Yoga, is nothing but the most basic description of the control mechanisms.

What Young describes is a process that –as in the sanguineous pulse, or any evolutionary motif of Samkhya- is subject of sedimentation. That is to say, a conscious action with the time happens to be conscious reaction, and even unconscious reaction in many cases. Samkhya describes this like the transformation of the *gunas*, the three basic modalities or principles we deal with. And although these transformations seem to have a continuous and infinite spectrum, they follow one another according to a logic sequence and proportionality.

Young himself was perfectly aware that, even being the third derivative important, which one obtains with higher order differential terms are not but subsequent divisions of time *more geometrico*, remaining the real time of the events undefined. He appealed for that reason to the idea of different times nested one within another, an idea that in a more technical manner arose about that very years and became increasingly popular later with the introduction of fractal patterns and correlations on different scales in the analysis of time series. This type of correlations with self-similar time structure appears, for example, in the graphs of the ECG; but the modern histograms usually study long intervals, with time records about one hour, whereas a typical traditional pulse reading takes a minute. Without doubt, self-similarity can be found in these more reduced intervals, although it is not necessary to think about its infinitesimal character, as many have come, inevitably, to speculate. The successive application of three differential orders leads naturally to question if their values give us some clues on these different time scales or similarity orders.



Wavelets and new techniques of time series analysis

This leads us to mention the new modalities of analysis of temporal series that have emerged since the arrival of the computers. It is known that until the last decades the harmonic or Fourier analysis was the only reference in this dominion. The harmonic analysis only yields the spectrum of frequencies by means of sum of motionless sine waves; that is to say, it is independent of time and global with respect to the interval in question. Therefore, it has great relevance for waves with simple dependencies, like light and sound in homogenous media, and its relevance decrease in as much the periodic behaviour of the system presents complex dependencies and bonds, as well as characteristic singularities.

In order to cover this void new modalities of analysis have emerged, like wavelets analysis with time multi-resolution; this one in turns admits many different criteria of election, depending on how the mother wavelet is defined. Indeed, one of the most interesting aspects of wavelet analysis is that it allows to grasp discontinuities in higher order derivatives, besides to fit well the particular features of the series (since the different derivatives admit different signs simultaneously, and the speed can increase while the acceleration diminishes, et cetera, this provides additional criteria for resolution). That is to say, it allows a local analysis with a great versatility in the resolution. Today, wavelet analysis is routinely applied in the more varied fields, from data compression to seismology or partial differential equations, and being medicine and physiological signals one of their main fronts; otherwise, the field is in continuous and accelerated expansion.

Wavelet analysis, by means of selection of criteria, take contact with self-similar fractals and iterative analysis, through other techniques of functional approximation, as radial basis functions, et cetera. Although we don't want to enter in the arsenal of modern tools, an appropriate estimation of the magnitude and rank of information that can render a signal like the one of the pulse is needed. The analysis of wavelets also allows a connection with the p-adic analysis and ultrametric criteria in general: these are important whenever the possibility of hierarchic structure with layers or levels of information arises, and being this case of the pulse according to the understanding of the traditional medicine. In the study of biological signals it is crucial to understand what is dependent and what independent of the temporal and space scales.

Otherwise, wavelets analysis is itself an optimum information filter, tending to reduce the distinct and relevant information to its minimum dimensions. Reciprocally, it is also an optimum filter for denoising, that is to say, to filter the irrelevant part of the signal. Therefore, it is already giving a close estimate on the distinct and characteristic amount of information –"highest personalized information", as modern medicine claims in its publicity- that the pulse signal produces. This deserves to be noticed, because modern medicine is prone to conclude that the pulse is a too *poor* signal in terms of information, and therefore ineffective for the diagnosis, whereas, on the contrary, the practitioners of the traditional medicine complain and struggle with a signal considered in practice too *rich* and subtle in its continuous variability for the judgment, even provided that a sufficient sensitivity has been developed. It is so obvious that the modern medicine has underestimated the volume of possible information of this signal, as it has not make the effort to extract it and to stand at its proper complexity level. Simple numbers can tell us conclusively the amount of possible states involved and the correlative capacity of resolution for the diagnosis – whenever we grant to that information a structure of global character, and not the mere rank of a signal about the cardio-circulatory apparatus only.

Discussion

Although for the modern medicine it is almost impossible to conceive that the signal of the pulse can contain the main relevant information for the diagnosis, we don't have many doubts about it. Common sense itself is in favour of this affirmation, if we forget for a moment all the theoretical devices that we have, either to explain the information of the pulse, or to explain the organism in chemical or reductionist terms. By common sense we understand nothing else than the postulate, if not a simple fact, of the unity of the organism. Therefore, we will not insist on *the possibility* of a satisfactorily deep diagnosis of the state of the health by means of the pulse, but rather in its statute and its more elementary interpretation.

The three principles of the Samkhya and the Ayurveda are to the description of something alive just like the three principles of Newton are to classical mechanics; that is to say, they are the most simple and irreducible in its own level. When the Chinese medicine talk about *yin* and *yang,* also assumes a vacuum or mean like a third element that relates both. However, our endorsement of these three principles with the three derivatives is a pure speculation, and perhaps it does not have the smaller justification.

What is to be known is if we can describe the three principles of the Samkhya –which literally means *analysis*, after all- in a *deductive* way in relation to a dynamic system like the pulse, or if we can only reach an *inductive,* heuristic and approximate quantification of them. Lacking experimental studies in this direction, the question is not trivial at all. Nevertheless, the same philosophy of the Samkhya describes the three *gunas* like interdependent agents, which never can be separated. But, perhaps the three principles of mechanics can be separated? Nevertheless, we are speaking about very different things. The three principles of mechanics are axiomatic in nature and independent of any measurement, and the three principles of Samkhya are already included in the empirical and measurable data. Samkhya, in addition, talk about concrete causality, and mechanics

not; Samkhya defines the time fluctuations within and from the interior of a system, and mechanics only defines univocally metric of an external space. Finally, Physics is an activity about prediction of events external with respect to the observer, and Samkhya, being Yoga philosophy, takes care of the internal control of the present by the own subject. So great difference and so great parallelism is what makes fascinating this field of study, still to begin with. And although the clinical analysis of the pulse is widely independent of the fundamental physics, is worth the trouble to make one short reflection on the principles or foundations of Physics. On the other hand, it is evident that the main interest of Physics for the human curiosity is just what fails to explain, namely, life and subject.

A very striking feature of XX century physics is its specific dualism. In eighteen century XIX, with the study of electromagnetism and including a Maxwell and Lorentz, a new level for the question arose about the relation between inertial and accelerated systems, charges and fields, through an underlying medium or ether. Indeed, it was at stake the redefinition of the three principles of mechanics, on whose general validity nobody doubted. The adoption of relativity indeed supposed the refusal to that possible redefinition, adopting conventions of measurement for stationary clocks that made any consideration about the medium or its variability unnecessary. That is to say, the "fourth principle" of Newtonian mechanics, none other than the absolute time or global synchronization was consolidated and reinforced. A modest gain in the predictive frame was obtained, at the cost of ignoring other multiple possible variable conditions. Both extremes conforms the poles of the physics activity; but the increase of the number of variables intrinsically compromise the viability of the predictions. Nevertheless, the problematic of the medium emerge one time and another in the different levels of fundamental Physics, either to specify what the inertia is, or for the mass, or to determine the energy of the vacuum, et cetera. The same problem arises when we asked ourselves, in the most ingenuous and legitimate manner, what makes a particle to "know" that cannot go faster than light; as well as when we ask for the origin and reason of the so called fundamental constants. Then and not before arise, in a natural manner, questions related to control. What shows to us another way, that the dualist scheme of present physics is incapable to describe true causes, in any intuitive sense that we can understand. We cannot expect from this scheme something that it cannot give; and present physics, by its structure, cannot yield nothing else than dispersed masses moving randomly in time by forces equally opaque –just like in the days of Lucretius. Its outline does not give for more, and we fill up the rest with our fantasy.

Be worth this to see that the introduction of a third derivative not necessarily is a trivial subject; in fact, it turns to introduce in other level the questions related to the mean and the frame of reference. Only that in most of the occasions, and specially coming from the perspective of physics, could seem doubtful and little intuitive its necessity, unlike the "ingenuous" questions about the medium and the reference. In the temporal analysis we have better fortune, because always is allowed the reference to the sine or harmonic waves, independent of the movement, although sometimes decompose it exemplarily, as it happens in the case of sound.

The wave of the pulse and its sound are very different things, as it is the spectrogram of the series of the mechanical wave and the spectrogram that its sound produces. We tend to imagine the third derivative like pure brute force or impact, although in fact what indicates is only with what rapidity is the force applied, its degree of availability in temporal terms: again, the most realistic form to conceive the control, in any of the possible levels. Nevertheless, it happens that this component seems barely relevant for the time the beat has arrived muffled to the wrist, having lost the greater part of the profile of the impact of the heart. Nevertheless, a great part of the sound that can be perceived with a microphone comes from that contractile impact, propagated in addition faster than blood itself. Many questions arise on the relations between the acoustic waves and the propagation of the sound with the compression wave as it is perceived with the fingertips.

Evidently, the sensorial capacity of a *vadya* or doctor that reads the pulse is not out of human ordinary scope, but it is highly amplified by the training. In addition to that sensorial capacity, a greater training for the inference and the judgment is still required. In spite of all this, it is not easy to state a defined limit to the sensorial capacity when synesthesy processes take place, as

in the case of the *vadya*; in particular, a synesthesy or association of the senses of hearing and touch. Then, it seems indispensable an explanation of the relations between the aspects properly acoustic and those more mechanical of the pressure wave; among other things, because it is very important for the doctor to take a reading at different levels of pressure. But also because we run the risk of underestimating the modulator role of the sound in the organic, from the indiscernible background noise to the more located resonances. Fortunately, wavelet analysis has as the limit case Fourier analysis and therefore includes it; and simultaneously, wavelet analysis is a fine filter for denoising; therefore, there are not greater impediments to grasp the main theme of these relations, still deeply mysterious. It is not necessary to remember the fundamental role of the sound in the classic Indian conception, or that within it space itself is not but the medium in which the sound propagates.

In anyone of the approaches we can try to translate the three principles of the Samkhya and the Ayurveda to quantitative terms, whether deductive or inductive, a mean between action and reaction must take place –because is in that mean that life takes sense, as each sentient being can feel it. It is difficult to think that this mean is reduced to a mere ratio, like for example, the one that can exist between the systole and diastole intervals, even though this ratio contributes proper data; evidently, and by the own irreducible definition of *gunas*, there must be much more than this. Otherwise, an etiological or causal monitoring would not be possible, nor would exist any possibility for a hierarchic structure of the information available in the pulse. The interpretation of the *gunas* in terms of the three derivatives could be erroneous, but it allows explore certain possibilities, like the relation of the resonances with the stationary aspect of the sound spectrum of these same waves, in an attempt to close the circle of the four possible aspects. Of course, we can contemplate also the speed and the acceleration with respect to that stationary background, et cetera.

It happens that the definition of the *gunas* cannot be more elementary; in fact, not even some precise definition exist, but a simple qualitative characterization, and even this one is usually supposed in the classic texts. Precisely because they are so elementary, we can hope to fit them in a perfectly natural way in a deductive description, or otherwise they are not deductible at all and then we only can infer them indirectly. A half way definition does not seem probable. Without a doubt, and even assuming we are talking about real things and not about fictions, the second option would seem more logical. One would be the first surprised in the case that qualitative principles could admit deductive character; that they admit a quantitative correlation, seems trivially certain. And nevertheless, we have repeatedly affirmed that the Samkhya philosophy demands a specific causal frame, in the same way that dynamics prevents it or makes it trivial (Poincaré). Let us emphasize that Samkhya is a theory of the *temporal* fluctuations, without any appeal to the space or a frame of reference. Therefore, lacking experimental evidence, we can only think that a great void to cover in our temporal metric exist, contrary to the great profusion of metrics for the space and the space-time in modern science. It is not possible to underestimate what can fit in this great void.

Finally, it is necessary to return to take in consideration other factors in the pulse diagnosis giving additional information. These are mainly two: the variable pressure with the fingertips, and the correlation of the information of the pulse in both wrists. The role of these two factors is completely different.

The modulation of the pressure in three different points of the wrist, at superficial, medium and deep level, remains as a heuristic approach, which otherwise can imitate simple adjustable pressure sensors perfectly. The intention of this is to grasp better the subtleties of the form of the wave, its thickness, which is not recorded in the usual esphygmographs. Naturally, this is very useful to obtain more information, and has no counterpart in the usual mathematical tools of analysis of time series. Somewhat humorously, it could be said that the doctor sets out empirically his own partial differential equation, alike as a mathematician deduce the evolution of a variable while maintains the other variables constant. In fact, what the doctor attempt to grasp with these three changing levels is a more focused reference for the three humours, *pitta, vata* and *kapha*. Some will be tempted to say that this is all the mystery of these three principles, although we think

that this is to confuse causes and effects. The state of the three humours is an objective fact, independently of the form of measurement. But, precisely because the importance of this additional information cannot be underestimated, it is necessary to follow it in its consequences. The three gradual levels of the pulse are not a separation of the principles –being this impossible also by principle -, but one more index of their relation. And it agrees to say that, doing without for a moment the immediate characteristics of the dynamic profile of the pulse, these three levels and the three principles find a logical and full correspondence with the three foliations of the embryological development -endoderm, mesoderm and ectoderm, with all the ramifications here implied.

As far as the differences of the pulse between both wrists, some doctors consider them, and some others not. Again, for the western modern medicine it will seem nearly impossible that such differences, if they exist, can have the least significance; but for the modern medicine, even the whole human bilateral symmetry is a biological coincidence. The alternation of the breathing in both nostrils, with a clear periodicity, is well reported. In general, it is hard for us to imagine significant differences between the pulses of both wrists; but it is less difficult to conceive significant differences in *the sound* of both pulses, as, for example, can detect accurate microphones disposed to this effect. And, with the sound, the dissonances also. The detailed record of these differences, including its possible periodicity, is a subject that could leave us even to algebraic questions; let us say only that the difference between both pulses corresponds in the most general manner with difference between the vegetative and the voluntary –but here in the measurable frame of time series. A subject like this never has been properly tackled, in spite of its great implications for cognitive sciences and the study of time itself.

The spatial symmetry hides a dynamic asymmetry. This asymmetry must have substantial correspondences with the decomposition of other organic functions in their extremes: the inspiration and the expiration, systole and diastole, the relation between the arterial and venous circulation. Both extremes express also in the most direct and immediate manner how the higher functions constrains the lower –voluntary means -, and how the lower functions constrains the higher ones – vegetative roots. These are the two main constrains, by will and by state, fully intertwined, in addition, with the dissipation and the maintenance of the unity of the organism. These two extremes find their natural correspondence with the first two principles of Samkhya, inertia and activity, and being the third the indicator of their relation. It is really surprising that so elemental aspects have not found its place in a measurable and experimental frame. Even we emphasized in a previous essay how this is fully and globally linked with the *cognitive* difference between both brain hemispheres.

In addition, the correlation between both pulses, *indicating simultaneously the two ends of the arrow of organic time*, the past and the future, helps us to define a potential or gradient for the union of the three humours or principles, and this is completely necessary since the moment that the indissoluble union of the three principles in any individual is itself, before any other thing, a gradient or reactive slope. This allows us to save immense amounts of work in the laboratory at the time of identifying the nature of the three principles in the empirical via time series. Also allows us to extrapolate past or future conditions, although it is to see with what degree of precision. All it inclines to think that, for a complex evolution like the one of an organism, the "retrodictive determinism" is much more feasible than "predictive determinism" proper of Physics. On the other hand, it is surprising that modern medicine tries to acquire predictive determinism, being this one quite senseless in this area. That is to say, in medicine, like in many other fields, the "prediction" is reduced to a diagnosis in which we must suppose that the future conditions will be similar to the present and past conditions. But it is known how to estimate these past and present conditions? Not, except for the most trivial cases. It is much more "revolutionary" to be able to understand what it happens and really has happened than to predict what it is not understood.

R. M. Kiehn has dedicated a great part of his life to show how the irreversible and non-equilibrium systems, as well as their entropy, can be described without statistics, by means of coordinate free methods of exterior differential forms. Considering the ambiguous and precarious

character of all the statistical treatments on the entropy, it is an extraordinary achievement, which would have to lead to many later developments. Kiehn has stressed repeatedly the mathematical viability of the "retrodictive determinism", questioning that predictive models are the only way to understand nature. Hardly the main one, we would add. Saving the distance between the dynamic description of the systems and the profiles of their temporal series, we think that Kiehn's descriptions of continuous evolution in topologic dimension 4 could fit and describe in the most compact form the reality of the changes of the pulse in the long term, but the experimental verification of this would take whole generations. And when we say more "compact", borrowing the term from topology, we are thinking also about the irreducible form of body aging, with the added dimension –literally embodied- of time. Since reversible systems have a zero torsion component, and irreversible ones a component with a positive value, it is conceivable that this vector, equivalent to the arrow of the time, would be also related to the Critical Action Time implied in third derivative of time.

Finally, it is inevitable to remember that the pulse reading is telling much more than the beats of the heart. In fact, the most of the signal, in quantitative terms, is related to the stomach and the associated activities of assimilation, and not even to the heart, that plays a smaller part in the amount of blood. The heart propels the blood, but it does not produce it. Indeed, modern physiology, that so much has studied the mechanisms of mediation in the organic homeostasis, would have to conceive easier the polysemy of a signal like the pulse. William Harvey knew perfectly that the bad performance of an organ obstructs the sanguineous circulation locally and secondarily affects to the general circulation; something so evident that many of his successors tend to forget. Even in the most elementary analysis of the sanguineous pressure, we observed at least four factors: the volume of ejection, the total volume of blood in the circulatory system, the flexibility of the arteries, and the vascular resistance, that is controlled by the autonomous nervous system. Therefore, inexcusably, different organic levels are involved, but an acceptable key to articulate them of elementary form is not found. The only postulate is the unit of the organism –and the first thing we would have to undertake seriously. For the traditional medicine, the problem of this type of diagnosis is not its mere possibility, but its difficulty with purely inductive methods.

A crucial aspect to evaluate the pertinence of a third derivative is the identification of the Critical Time of the system and its relation with third order variations and their associated resonances. In the case of the pulse, it can be thought that the critical time is the time interval of the beat –or, at least, is the first relation coming to the mind. The relation between the third component and the background noise must find its equivalence in the temporal perturbation of the series. That is to say, the more the control component is fitted, the more fitted will be the relation between beats and even between the two phases of each beat –what it does not imply always more regularity. The time delay can vary also, and its variations can be decomposed in average component and a fluctuating component subject to autocorrelation. Obviously, the functional character of this third element has to be demonstrable, or at least, congruent with the general evolution of the series. It has to play an active role in the maintenance of the stability. Therefore, also must give account of a part of the random components that always appear in these series –of the most essential part of it, indeed. In other words, the resonances of the three derivatives in the pulse series must show a causal feedback loop with the cardiac activity, therefore being directly relevant for cardiology also. The third order gives us the more close measurement of that which mediates and is interposed between the action and reaction along the cycle or the interval. Immediately arise the question about in which interval is effective this fitness, and to what extent has validity in the direction of the past or to the future. About this and many other questions only the experimental survey will decide.

If the third derivative has not found universal application still, it is partially due to the infinity of possible critical times for so many other systems. Nevertheless, it is this same thing, the proper time of each system and its sensitivity to the environment, which is to define. On the other hand, many cyclical processes have in principle a source of continuous periodic perturbation, as for

example, the weather with respect to the daily and annual period; it could seem then that does not make sense to apply a third order to them. Yet, we hear the media and even many meteorologists talk about an "acceleration" of the global warming, when at the other hand we are experimenting some of the coldest winters. If that supposed acceleration exist, it would have to be with fluctuations, and from that we could gain conclusions on to what extent the climatic balance is affected with respect to its capacity of control, name it the capacity of interchange –whether with outer space, or with its own thermally active internal mass. It is really very difficult to think about real changes without dimensions of impact, and thus we talk about the impact of the human activity on the climate also. If so, we would have to be able to measure it. We believe then that the third derivative is always the most general index of the control in a system, but only the experimental data of the different systems must decide about its possible relevance. It will be necessary and of great interest to apply the tools of dimensional analysis to discover similarities and irreducible aspects of systems with a relevant third order.

Definitely, we see the third derivatives with resonances as the most generic form of temporal interface –of contact or transition between possible behaviours or states. They are intimately related also to the theory of phase transitions with critical points, but here we only consider temporal indices, doing complete abstraction of the underlying dynamics. That's to say, under a relatively simple feature, complexity is implied. Besides, with the term "phase transition", we understand something much more general than the term usual in physics of states, and we leave its outline for later works.

The idea is that the emergent surface of a complex system finds the main index in the relation of the three derivatives. It must be so, if we understand as "emergence" a significant change in the relations between a system and its environment. Since all real things show complexity and simplicity only remains for idealized closed systems, what we get this way is the generic index of the deviation of a system from its closed and idealized mode, unable to create novelty. So we can transcend the sharp dichotomy between causality and organization –between artificial hierarchical criteria and a purely formal and devoid dynamic causality.

In this context of wavelet analysis and higher orders, it seems quite logical to ask for the role that here could play the fractional calculus, with non-integer or arbitrary integrals and derivatives. Even today mathematicians are far from consensus with respect to the geometric and physical meaning that fractional calculus can take, although works as the one of Podlubny [4] proposes this one like an approach to the local time of a system, in contrast with the absolute time usual in physics. The fractional calculus arose from the developments of Liouville and Riemann, although already Leibniz in 1695 stated that its adoption "*It will lead to a paradox, from which one day useful consequences will be drawn*". Naturally, fractional calculus may be connected with wavelet analysis, and even in its more explicitly analytical form, as polynomial splines and the derived fractional splines are; in addition, the fractional derivatives are not determined by the local behaviour of the function, but by the whole dominion of interest, completing the circle to return from the local to the global behaviour. The fractional calculus is being applied now to problems of control, probability, diffusion, viscoelasticity and hereditary mechanics with memory of states, as much for stationary and transient systems. Transient resonances must have fractional relations and bonds. Therefore, everything we are saying on a third differential order and its interpretation can and must put itself under the light of the fractional calculus, that naturally obeys to questions on temporal metrics and fluctuating, inhomogeneous times. Anyway, we must recall that fractional calculus does not support a simplistic interpretation in terms of geometrical fractals, although, of course, many relations can be found. On the other hand, both fractional derivatives and transient states allow important connexions with the Riemann zeta function, as was showed since 1975 by Keiper and by Pavlov and Fadeev, respectively. Besides the interpretation in terms of resonances, the same local-global relation we notice between wavelets analysis and fractional derivatives brings to us closer to the core of the zeta function.

The fact that fractional calculus has not admitted until now a physical or geometric interpretation only could be surprising for those who consider the development of modern physics like the unique possible and the natural one. Indeed, this very fact is indicating in another fashion to us the void of modern physics with respect to time and the temporal metrics. Before we have talked about to "dualism" of modern physics; another way to see this dualism is its recognition of two types of fundamentally different magnitudes, scalars and vectors, incompatible in its representation. As Gustave Le Bon already notice a century ago, it does not exist any good reason to think that cannot exist other kinds of essentially different magnitudes, not less fundamental; however, it is indeed through higher and arbitrary calculus orders that these other magnitudes, forms of energy and behaviours have to be outlined. What is really arbitrary is to think that with two integer differential orders we have exhausted the possibilities of nature. In addition, if we were able to physically interpret this extension of calculus, it is perfectly possible that we not only accede to much greater degrees of diversity in nature, but also to a greater simplicity and unit. What we call resonances already are a connexion between this two so different kinds of magnitudes, and will show continuity aspects where we can see separate things only, and, on the contrary, separate things in evolutions considered continuous now. In a really unified frame, the same fundamental forces would be derived effects more than causes –and also "differential sections" of a much more vast temporal evolution. But we think that it is not possible to come to such a level without a specific approach to the problematic of time in mechanics.

P. Fiziev and H. Kleinert, [5] for example, give us a new anholonomic action principle for pure rotations around a fixed point of a body –Euler equations- *without reference to stationary systems*. Non-holonomic systems are those which are path-dependent, a car for example, and besides the usual control or differential degrees of freedom, the history of the systems must be known. We will use this for an example later. Transient systems, resonances and anholonomic behaviour can describe each other, when the naïve application of hamiltonian action principle fails. This also must yield powerful connexions between chaotic behaviour and number theory –elliptic integrals, modular forms and so on, because the number system seems not to be sensitive to anholonomic conditions, but anholonomic systems are sensitive to numerical conditions. Anyway, there is much to find in the always *momentary* condition of nature.

Vacuum, information and other metaphors

It seems that if there were something able to transmit all the shades and subtleties implied in this type of diagnosis, it had to be the sound; but the limitations of the sound like source of information seems evident. The frequencies are very low in relation to many levels of activity, the ubiquity of uncorrelated white noise, et cetera. Nevertheless, all Indian literature has insisted in this respect, although its notion of sound ignores almost all the features of modern acoustics. In its conception, the sound is not only independent of any space scale, but the same waves create the space. This connects with the well-known differences that we have find between the dynamics of objects in the space and the Samkhya like description of time fluctuations. It does not exist either, of course, the smaller consideration of the noise like statistical phenomenon.

The science of the pulse diagnosis is called *nadi vigyan*, examination of the channels or ducts. What the ducts or channels transmit is just the sound, or what it is understood like that in this non-spatial conception, but phenomenal perception. The Upanishads makes an empirical and testimonial enumeration on the different levels of noise or background sound –no distinction is

made between both- that are audible in the own body and beyond it; and this same gradation is one of the canonical forms to describe the union process in which the Yoga consists. It turns out natural to contemplate all this process like a noise-filtering process, and reciprocally an identification of the fundamental patterns.

Beyond details, we think that any thing that is moving is filtering in real time the background noise: with the condition, it's clear, that the movement has an articulated component, that is to say, a third derivative of time with resonances. This would be applied in the first place to the pulse, but also to infinity of real systems. The ubiquitous 1/f noise could fit in this context, if it really allows some general explanation.

Any kind of temporal analysis contains in its nucleus its own uncertainty relations. It is not possible to know exactly the frequencies in an exact instant of time. Heisenberg's uncertainty relations, far from being a fundamental principle of nature, are only a consequence of the limitations of the Fourier analysis as a mathematical tool. Today are working routinely many devices, like optical microscopes, that get around this last uncertainty subsuming it under a much more general set of uncertainty relations –just in the same way that the harmonic analysis is only a limit case for wavelet analysis [6].Observations much below the wavelengths are made diary and the only limit is not theoretical, but depends on the technical capacity to filter the noise sources. Since we see to what extent modern theories are conditioned by the mathematical tools available, it is easy to see that we are in a silent revolution that will have very far-reaching consequences. Be enough to think that until now the so-called "classical time analysis" was fully independent of time itself. In other words, only now we are beginning to penetrate in the temporal dominion.

Anyway, what we touch here is the superposition of two types of systems apparently different: an articulated mechanical movement generating resonances, and a statistical background noise. This last one includes all kind of random motion. The question is to what degree of accuracy both, movement and noise, can interfere to each other, and yield an additional precision. Naturally, all this has to do with the critical time of the system.

All the cells –not only those of the heart- pulse and have articulated motions, reason why we can even apply an analogous treatment to them. This is equivalent to evaluate the global reactions of a cell in relation to the underlying medium, including the bifurcations of the cellular division. The study of the cellular pulsations, for example in cell culturing, is walking its first steps right now.

Resonances are not an exotic phenomenon; among other things, we hear thanks to them. In fact, they exist always and everywhere, and the only question is to know to what extent and in what frame can be relevant; when they converge towards the stability and when they generate divergence or dissonance. On the other hand, the articulated motion, motion with impacts, is the norm and not it exception. In fact, they are the only event to which the discreet processes can be attributed, and not to any arbitrary measurement of quantization, that since we have seen, arises from the harmonic analysis and its time-independent criteria. If we are technically beyond these limitations, it becomes an absurdity to grant them an absolute character. The real world is made of articulated contacts, not of "emissions" and "absorptions" of ghost massless particles, suited only for the convenience of the physical predictions.

Already Descartes, in the first days of kinematics, tried to develop the idea that all movement is rotation, and therefore, acceleration. With these attempts was also related his program of vortices mechanics. Today one tends to see these ideas like clumsy prehistoric, previous attempts to the arrival of the "true" Newton's mechanics; but the question is that both mechanics implied completely divergent points of view, and didn't go in the same direction at all. In order to begin, the vortices can be so complex dynamic systems that not even today the mathematicians fully agree about how to define them. They also admit to be considered like objects with intermediate properties between waves and particles, a quite important feature. Decisively, they also imply accelerations of accelerations and torsion components, which also complicate enormously the calculations. It could be said that the vortex is the simplest and archetypical form of complexity

itself, and therefore, the first to be avoided in a predictive frame for "fundamental" physics. Until Descartes, and even although this one inaugurates the subject-object dualism, there is serious interest to think about the real causes of the natural events; since Newton, the decision is made in favour of the general balance equations in order to prediction. Naturally, if all movement is acceleration, it must have rates of change in the acceleration to give account of the phenomena – local transitions. Still today there are physicists like Gennady Shipov trying to develop the Cartesian principles, who even has been able to unfold a whole arsenal of general equations with physical sense.

Without a doubt, a third differential order makes more complicated the calculations, mainly if one thinks about high energies and highly non-linear events. But, on the other hand, gives us more general indices in a different direction. Anyway, in comparison, the modelling of these ideas in a system so lowly non-linear as the pulse would have to be a child's play. Let us propose an analogy to outline what can describe the pulse diagnosis.

In a "Cartesian" car, even when we travel at constant speed, there are acceleration variations. That is to say, even though the speedometer seems to be fixed, there are opposite forces being compensated: the force of draft of the motor and the friction of the road and the air resistance. But if we make sufficiently exact measures of the action of those forces, we would see that they never really compensate each other, and therefore accelerations and decelerations take place constantly (So far, I have taken the purely kinematic example from Shipov). In this feature, we see that there is no real inertial system of reference. In addition to this, we are free to accelerate the automobile, imposing other additional conditions to the fluctuations of the acceleration at constant speed. It could be said that the fluctuations produced at constant speed are characteristic of a certain car traveling on a certain ground or pavement; and that those fluctuations will change at different speeds, giving us a more complete profile or spectrum of possibilities. The acceleration, the speed changes, will still give us a more exhaustive profile of these fluctuations, and they will allow us to know more of that black box that the car is. As far as the third element, the optional use of the brake or the accelerator, it seems to be independent of the car, although not of the ground. If we are measuring all it from the outside and without knowing the circumstances, we have a black box within another black box within another black box: the ground, the car, the driver. It is already difficult to say something about each one separated, not to say about the relations among them. The driver sees things that we do not see, and in addition, nobody is in his head.

Then, let us suppose that there is no head, no driver. Or that the driver must move without seeing, in complete blindness, being able to listen until the minimum detail the noises, resonances and responses of the car at every moment. Let us suppose, in addition, that it have not to deal with other cars and traffic, having enough with not to leave the road. Without a doubt, the car would go with an extraordinary care and slowness. And if the car were in addition very fragile, the "driver" would make an effort to optimize his response to each new signal: the smallest curve would be noticed in a lapse of time, would accelerate when leaving it, et cetera. Road, car and driver would be revealed in a same signal. The purpose and the aim, the intentionality, become included in the adjustment to the given conditions –here, as much internal as external. Without the least paradox, the objectives have some sense in as much as they are not arbitrary –we are not entirely free to choose them. Think well in this.

This is a metaphor of the life; mainly from her initial, more stuttering phase, than it is so difficult to imagine for us. Only that the ground is much more varied than what the linear figure of the road could suggest to us. Life is blind, but it is inconceivable without sensitivity. Life, also, arises in a cavity, but not a static one, but a cavity in motion, alive itself. Its own motion is a filter of the environment. Everything we see now or that we believe to see, previously has been felt and attempted in the dark. It has happened in the cells, and even in the tiniest molecule; and they had not reached here without that feeling, attempting activity. If Prigogine said that matter is blind in equilibrium, but out of equilibrium sees, we would say that matter in resonant conditions is still blind, but hears and listen.

The present evolutionary theory, that so much has fought to prevail, can take refuge peacefully in its statistical background to avoid any description of real time evolution. In the analogy of the car calls the attention the slowness whereupon everything would have to take place. But, does somebody ask which can be the perception of the local real time for a cell or a molecule? The third derivative gives us the index of that time.

There is too much discourse on biological programming and information now. However, the information processing –in real time, again- indeed demands that the reaction of a system is *unequal* with respect to the action that receives; this is, it does not take place –it cannot be concrete and local- within the framework of Newton laws with an absolute time like global synchronizer [7]. In other words, the information, that we use to consider so concrete, not even can occur within the framework of modern physics; it is supposed and superposed like a simple metaphor. Only a Cartesian mechanics of the kind proposed by Shipov, describing locally the transition between inertial and accelerated systems, could generate and process information. This should be a warning. Therefore, taking into account the different angles, not even has been considered the problem of life, no matter how much one speaks about "information".

Let us look at this closer. Classical physics can make the transmission of information possible, but cannot make it univocal –Poincaré's conclusive argument [8] on that the general dynamic equations with extremal or stationary principles admit infinite causal interpretations. Then, one can appeal to the thermodynamics and quantum mechanics, which governs the interactions of atoms and molecules. The consensual thermodynamics not only cannot create information, but, in addition, destroys it. Quantum mechanics, on which all kind of mythifications proliferate, is a *linear* theory; it is curious how little this essential characteristic is stressed. In addition, the reversible aspects are emphasized and the irreversible aspects are mainly ignored. Therefore it is incapable to generate information. What remains then to make possible the creation and even the mere *univocal* processing of information? Information itself, devoid of any physical reality. Moreover, information is measured in purely quantitative terms and with total independence of the time of processing involved. And when this one is taken into account, like in the microprocessors, a clock cycle is used completely analogous to the absolute time or "global synchronizer" of classical physics. It is easy to see, therefore, that nobody at all knows about what is physically speaking when the concept of information is applied to Biology: its explanatory value is in the same metaphysical and indemonstrable level that the vitalism and the "intelligent design". Information is a purely external concept, requiring for its processing other equally external concepts like the design, the synchronization, the statistical selection, et cetera, that in addition are not mutually compatible to each other. Do not look for the logical combination of all these elements, because it does not exist. The information is for present science a concept as void as the concept of causality, but still more confused, because it is ubiquitously patched in one's own interest with the notion of chance and randomness. To say that the world is caused by the causality is not to say much, mainly when we consider that causality necessarily remains to define, as in the case of physics. But in the case of information it is still worse, because to the information concept a specified and univocal character is supposed, and certainly the things don't improve adding to them the chance and randomness, the concept of the unspecific itself. Then, somebody comes to us saying that we have our origin in "Chance and Necessity", with capital letters added: brave and precise answer. Neodarwinism does not risk nor explains more than creationism, having only more scientific pretensions.

And all this is fatal and unavoidable, because without a specification and local definition of inertia, the whole physics evades the dominion of the reality. In other words, remains *unphysical*. By the same, the "physicalist" explanations of the mind remain equally *unphysical* and equally void of real content –they belong to "parallel worlds". Hume's criticism on the concept of causality, as well as the much more refined from Poincaré, are valid for the type of causality of modern physics, that is the emptiest causality possible; but they gradually lose its validity in other dominions, like for example, the redoubled analytical version of the Samkhya that we are proposing. That is to say, not only it is not contradictory to consider the causality and the emergent properties of an object

together, but it is *necessary* to precise the dominion of causality itself. Even Standard Model physics must appeal to phase transitions with emergent properties to define its ground and the rules of the game, not to mention the properties of any material; although, surely, it does not do it without arbitrariness. But this has very little to do with the levels of causality and emergency that we propose here, based only on redefining the effects of inertia at a superior level by means of a third differential order: with dimensions of *impulse*, to give it the right name.

The election of the inertial reference frame is *the only* theoretical bet of western physics, not only since Galileo, but already from Copernicus himself. And by the same, there is no way other to close the arch of its proposals and to give them content that the local definition of inertia, the definition of the inertial field. This is the bottom of all this matter, and the latest thing that whoever who allows himself to think can grant as a matter of course. Without it, not even we can know what means the word "mechanical"; with it, we would enter directly the problems of control. And thus, for example, theories like Shipov's one, which does not need any of the fundamental constants, must set out necessarily the problem of the control of the local metric space. Of course, and as theories like the one of Shipov or Heim shows, all the interactions and equations of the well-known physics can be rewritten and reinterpreted with other criterion of the fundamental dimensions, having the same quantum of action the dimension of angular moment, and not to mention the relation between "stable" particles and their resonances. From our view, we could do without the underlying physics and just observe a still causal evolution in other levels. But it is necessary to say in addition that the lack of definition for the inertia is entirely parallel to the lack of definition for the memory for the present cognitive sciences. Both, in effect, have a natural correspondence. And, as the naive example of the Cartesian car discovers to the most elementary analysis, the question arise on the conservation and destruction of states and the accumulated record of the car in its present mechanical state, considered like the present dynamic response. However, in that test of response, the structures, those "frozen contingencies", are no more than the same present dynamic response, and any other thing can be ignored as a contingency, that help us to solve nothing. The background is the response, because the response is the unique thing that makes perceive and suppose a background to us. What can be applied to the "structures", also can be applied to the memory and its ghosts. The structure is a stabilized dynamics that it has to destabilize itself to return to be noticed. Therefore, which can be predicated of inertia and the memory can be predicated of the notion of structure and consequently applied.

The mere manifestation of inertia is the most immediate form of *orientation.* There is no un-manifested inertia, otherwise we would not ask about it. In other words, inertia is not a principle or something reducible to a point or state, but the more elementary *relation*; that's the notion of the so-called Mach's principle. In this sense, already it is an emergent property, more than an automatic derivation of the causality. Therefore, it will yield as much information as we know to extract to it in a given circumstances. Any fast enough change in the acceleration has a momentary inertial yield that does not follows from the second derivative directly, but indirectly in conjunction with the other two: this *transient* margin is fundamental in order to explain many things. In Shipov's Cartesian vehicle, inertia and the apparent constant speed are irreducibly informative, because inertia implies the control. In our extended version of the same vehicle, the "external" control of the conductor is not arbitrary either; the control does not depend here on doing what one wants, but on the measure in as much the circumstances can be appreciated, responding to them with the smaller possible interference. Sensitivity is the capacity to perceive inertia: that sensitivity is all the immediate information that we have. To interfere more is to lose "immediate information" and control. Nothing of this is contrary to mechanics and to the simplest reason, and we only add an additional level of information. From this new level, other uncertainty relations are derived. Naturally, all this seems equally valid for our own behaviour, and as an elementary corollary can be added that losing the fundamental information and the control by means of our interference, also we lose autonomy and freedom. The same Cartesian vehicle is a clock of the local time, which can become more explicit using like clock an appropriate type of gyroscope. The third derivative of the

time, the control of the impulse, gives us an index of the anisotropy and non-homogeneity of the environment, as a *necessarily oriented* system perceives it; an index also of its own time in terms of information –of effective processing of information.

It is quite curious that all type of anomalies, largely verified in the laboratories, but without possible place for the constituted and constructed theories, has to do in one way or another with this third differential order, and not with "collateral" or "hidden" "perturbations". Even discounting the great percentage of spurious cases, the amount of literature on the subject remains immense and amazing, waiting for a theoretical frame to give it some more sense. This is only another indication of the clearly non-trivial character of the third differential order.

Machines seem mechanical to us because we have synchronized its parts avoiding as far as possible undesirable effects, like frictions and resonances. Their design is a time-binding cutting of functions to be optimized. Even so, the own life of a machine and its duration depend to a great extent on these factors, in addition to the use suffered. Nature has used since the very beginning and without beginning these perturbative elements like a constructive principle, and this is the main reason, in the long run, of the enormous difference, even starting from identical principles. But these "identical principles" are often completely opposite, because of the incommensurable criteria of isolation or relation with the environment: Nature often unites many things that we separate, and on the contrary. Unlike the engineers, physicists and mathematicians, the honest Nature laughs at the analytical difficulties, and makes an indifferent use of all she has within reach. By the way, there exists a strong relation, somewhat antagonistic, between friction and resonance, but the interesting thing is that we can treat the resonances in a better defined temporal frame, doing without a good part of the always ambiguous statistical elements. One thinks that not a single beat of a heart is automatic, except for our ignorance. Terms like "random", "automatic" "inertia" are too void still today, and indeed what we are doing is to look for a frame in which they can mean something.

The great historical irony is that Descartes, creator of the modern dualism of body and mind, proposed a physical theory opposed to that dualism and with potentiality *avant lettre* to reconcile it and to reduce it to a nonsense; whereas the physical monism derived from the success of Newton's mechanics, opposite to the Cartesian mechanics, has turn out to be the consummation of the success of dualism in fact.

Talking about the fathers of modern science, it is inevitable to associate our Cartesian car with the celestial mechanics and the planets. The measurement of the gravity in this same Earth has an experimental uncertainty associated of more than a part in ten thousand, and being this only the most conservative average estimation. The oscillations seem random, but applying the proposed criterion, it seems possible to filter a good part of this noise and to deduce relevant factors. If the tiniest particle needs a time reaction, how could we believe that the enormous planetary masses have to react instantaneously without absorption. In addition to void, this is completely irrational and it is only based on our blind faith in the "naturalness" of classical mechanics. But the absorption of these reactions or jerks must have a close relation with the fluctuation of the values of the gravity and the mass separately, remaining the product constant and being observed the orbital regularity of Kepler's laws. Cassini's fourth degree ovals, toric sections, also can be related to all this. We don't need to stress the relevance of this to find a *real* link between quantum and classical mechanics. Once again, in order to maintain the fiction of a universal constant, we are ignoring the precious local information.

Returning to the diagnosis of the pulse, our subject is to what extent a relatively slow movement but with a component of resonances can differentiate the background noise, to filter it. Although it is evident that a *vadya* must resort to the inference in a very ample degree and at different levels, which we want to know is to what extent all this can have a deductive support. And although the considerations on the underlying mechanics are not absolutely necessary for the purpose of diagnosis and understanding, it helps to see their pertinence in the most fundamental

level. Not only time, but the space and the inertia themselves are private of content and reduced to a passive paper in modern physics. All the complex and real systems have a relevant third differential order, and only in the idealized scheme of the "fundamental forces" this third element is excluded necessarily and by definition.

It is to be noted that the third derivative has a *strictly physical* meaning; surely this cannot be said of higher differentials orders, which could only be interpretable like resonances within the resonances already present in the lower orders. Since the third derivative implies a conditional relation between the external environment and the internal states, the third order must mark also a physical limit in the capacity of filtration and absorption of the statistical background noise. That is to say, whichever be the degree of non-linearity observed in the relation of the three time derivatives, they define *the limit of physical causality* of a system, and everything beyond this limit must be considered as *physically random*.

We would go further to affirm that without this kind of resonances the memory and the same inertia would never become manifested, and that this manifestation always exist within a critical time that really is the specious present of the system, its real time. And if inertia already is the first manifestation, further only the unmanifested remains, not to be necessarily confused with the non-existent. Thus, for example, the three derivatives of the pulse signal would have to give the simpler possible "radiography" of the present state of the organism, in its own feeling and sentience, without excluding at all the existence of many other "radiographies" of the same order that can be taken for the same moment, be they an electroencephalogram or a measurement of the electrical conductivity of the skin. This is inevitable, if we take into account that the three derivatives must yield always a coupling index with any other possible section of the system.

There are good reasons to think that if these notions find their justification in the analysis of a signal like the sanguineous pulse, they also will find some rank of application for the processing of other types of signals; since we spoke of very fundamental and basic concepts of the temporal analysis. The question is, today and always, but with the new means at our disposal, to find the natural articulation of the own time of a system –and to give it a sense and interpretation as rational as possible. Any system in motion is filtering the background noise, which is simultaneously inside and outside: be the system the global climate and the atmospheric evolution, or of the fluctuations of the stock market. Of course, each of these systems has its own parameters and conditions, which to a large extent are totally unrelated. But, precisely, of most interest is this little they can have in common –this little could weigh much. But we insist again on the probability, not very intuitive for the usual thinking, that a greater understanding of general aspects in this ground does not imply automatically a greater predictive power. If we don't understand this circumstance, we won't understand the meaning of all we have spoken. Let us see a bit clearer.

All we know and we assume that in the long term the stock-exchange behaviour cannot be predicted –thought nobody who plays resign himself to it, since we know also that, in spite of the huge number of random or *uncontrollable* aspects, there are present tendencies too that finish in *logical* conclusion –"logical" mainly when the facts already have happen, but not as much before. Think about a stock-exchange collapse. But the question is that in the tendency the *control* component is contained, in the same way that in the variables of the pulse is contained the reaction of the subject and its relation with the environment. It is exactly this which we think that can be considered in an *explicit* manner in the analysis of the temporal series. However, it is exactly this which the companies in their stock-exchange policy or the economic authorities are *implicitly* making. That is, they try to exert the control as much as they can and they try to avoid being controlled as much as possible. Naturally, this has very delicate margins, and in this consist the political sensibility in order to take measures. The economic news continuously speak to us about the speed of the growth, and its acceleration or deceleration. In addition, all we speak about the effect of the economic measures (more or less arbitrary or necessary) in terms of *impact*: "the impact government's measures", etc. Also in the boards and councils is discussed endlessly on

"how to articulate" the measures and "how to manage their impact on"…the others. Government itself is not another thing than this kind of control; neither politics in general nor the economic policy in particular. The elementary dialectics of all this is reduced to the *conviction*, nobody knows to what extent justifiable, that when the more control, the least possibilities are of being controlled and have to account. On the other hand, accounts with the future are the most difficult to render, although this is almost the unique thing proposed and sold. In short, and to be brief, I believe that it is possible the objective control and monitoring of the measures of control and monitoring of those that exert them optionally and arbitrary. We can control the control. To obtain this would be much more "revolutionary" than to try to predict future itself, a future whose prediction already comes included in the sale package. Control is measurable and then controllable also. But this does not lead to an infinite regression, because time itself imposes restrictions over this as a limit of the interaction with the environment. Then, control must be explicitly expressible in any kind of complete balance. Beyond the usual predictive horizon, technical paradoxes like the efficient market paradox have a partial, but concrete solution.

I think that to pass with all the consequences from the second to a third differential order is literally equivalent to going from the world of *prediction* with inexplicable but efficient causes at a partial level, to a world of *control* with explicable causes and an efficiency or use of global type. Really, this control gravitates towards self-control. The great paradox at present, clearly visible for everybody, is that prediction is pursued in order to get more control, but even so we are losing the control in an increasing incontrollable way. The subject is so general, that I do not believe somebody can consider it a chance. Beyond the predictive "causality," a whole world to explore exists, but surely not a whole world to exploit.

This is a general and philosophical essay, and we cannot expect much more precision; in any case what is written is enough for those who want to research it. It can be said that, if our proposal makes sense, the only thing we do is to introduce a third grammar element in the habitual grammar of dynamics, which only have two cases presently, this is, verbs and predicates with rigid connections. The introduction of this third element is equivalent then, and within the simplification of the case, to the introduction of the subject in dynamics. I am already hearing the angry protests; in particular, the protests of the so-miscalled "reductionists", that, nevertheless, hold much more immodest pretensions, as the creation of "intelligent machines" or the "strong artificial intelligence". Had they called it Automatic Intelligence instead of Artificial, nobody had taken it seriously. But here we are speaking of much more elementary and simple things. The discourse of modern science only seems to be able to enunciate phrases of the type "to eat potatoes", "come back tomorrow", or "natural selection"; at least, in terms of sense, and in spite of the fantastic technical sophistication reached. And that is in the most generous cases, because often verb and predicate are confused by the expeditious procedure of turning them equivalent. Thus, in spite of the super-specialization, everything leads towards a fatal confusion of planes, and the specialists are the firsts who exploit this ambiguity and confusion.

Any movement expressed in three differential orders maintains the possibility of a linguistic equivalence, and, in addition, of many other analogical translations or reproductions. This, that seems completely dispensable in modern science, is of decisive importance to open to the subject other possibilities in the knowledge and its use. And, in addition, modern sciences cannot either do without that analogical component, as it shows Poincaré's argument on the absence of univocal causes in mechanics. Naturally, to introduce a third grammar case does not imply automatically to take the grammar to a high level of refinement, but at least a completely new form of articulation is reached. In addition, everybody knows that the third element always has been playing hide-and-seek in all type of discourses, and in all the scientific discourses also. But the case is that precisely the transient motion is the only motion that can demand univocal causes, or, anyway, it is the one giving the closest approach to it.

The Indian theory of language makes a decisive distinction between the articulated and unarticulated languages; we will continue finding this distinction and relation in any approach to the motion like nature's language. We have already written in other places that surely is not a metaphor to speak about the language of nature, and that, on the contrary, the most probable is that human languages are a poor metaphor of the edenic language of creation.

One can ask finally why so simple ideas, if they have some substance, have not found already a rank of application. It is necessary to respond, on the contrary, that they must be substantiated before any application, and this is not the case yet. We still move in a ground of conjectures. Nevertheless, a decisive fact is that the temporal analysis has not begun to be really temporal until these very last years. I think that nobody still is aware of what this really implies, existing such differences between the spatial analysis and the analysis of the crude, uncut temporal evolution. It happens that these new tools just forged still are exercising their wisdom teeth with inherited problems, without repairing in their independent potential and still trying to formulate their own questions. That is to say, the modern temporal analysis already is the answer to a question still not formulated. And it takes work to find a place in it to that question, among other things, because it raises a matter of a completely different order, very against the grain of the unthinking formulas and the routine thought.

The modern theory of the control and the stability incorporates the mechanics on the one hand and on the other makes a discretionary use of statistical tools; but its mechanics is of course a mechanics of stationary, closed systems. The external relations of the closed system are mainly statistical, and this often applies for a great part of the internal components. Therefore, it is easy to see that an approach like this continues having enormous limitations and loopholes, and still more if we apply it to biological organisms. By definition, a live organism cannot be a stationary system. Then, our only hypothesis consists in to affirm that the *transient* component of any dynamics makes its own statistical selection, a selection whose reach has to be measurable and valuable. This is the only source of natural selection –and of any possible evolution, as the Samkhya already stated thousands years ago.

One is the first harbouring doubts on the universality of this phenomenon, wishing criticisms and attempts to demonstrate the unviability of its operation. In addition, I will not conceal that this hypothesis is *only* based on my personal conviction that it is impossible to give account of a single beat of a heart with the whole arsenal of mechanics and statistics available yet, and that the physiological structures only a-posteriori "explain" the real behaviour, but eliminating the essential. It would seem that it cannot be an argument more fragile than this; it is fragility itself. But it can happens also that mechanics itself is extraordinarily fragile at the time of facing the gross, uncut temporal evolution, eliminating what gives it the specific robustness, that is the own robustness of real beings and the world we observe. The coupling of pendulum clocks in a wall by means of resonance noticed by Huygens is really the first example in modern science of *natural and real, spontaneous synchronization*, in opposition to the abstract and arbitrary global synchronization or absolute time of Newton's mechanic; but the phenomenon was known since time immemorial through musical instruments, as for example, tubes of flutes and organs.

The development of a theory based on these new principles necessarily must have important limitations in the predictive dominion. This is good itself, in the sense that it indicates to us that we deal with something real. Not the prediction, truth is important to us. In addition, modern theories like the synthetic theory of the evolution does not have the smaller predictive value, nor either retrodictive value, and hardly could touch real time and present evolution, and even so it seems that many people take it seriously. As we have already said in other occasions, the only reason why these people take it seriously is the void of mechanics with respect to the univocal sense of the causes. In less extent, this is equally valid for modern cosmology.

Let us finish with a consideration in the symbolic dominion. Motion with three differential orders and inherent resonances that are related to the background noise finds a natural analogy with the sense, both indicative and physical, that the Vedas grant to the syllable AUM. As it is known, the sacred syllable, being an inarticulate sound, is also the seed of all the articulated sounds and their coupling, as well as the background in which they finally fuse with. A way is intended to allude, through the physical sound, to that which drives it across and transcends.

Conclusion: What can we expect of pulse diagnosis

I hope that the third derivative and their implications will turn out to be a key to go beyond the labyrinth of specialized sciences which have kidnapped the common reality. Because within those specialized sciences there's no longer hope for somebody, except for the experts themselves.

We believe to have given sufficient arguments to make possible to conceive the informative richness of the signal of the pulse and its relevant synthetic character. We believe also that with the technical tools now routinely available the degree of resolution of the relevant information can be achieved in only a few months of laboratory work and with diminutive expenses. Moreover, some fundamental correlations could be verified, specified or refuted in a matter of days. In any case and since the beginning it is to be observed that the measurement and correlation of the three principles includes necessarily different levels of interpretation, which nevertheless must be congruent. This is not a deficiency, but an intrinsic virtue of this approach –in fact it is the only thing that could make sense in the level of complexity of an organism.

As far as the question of what can we hope of this type of diagnosis, we return to the image of the car on the road. The renewed pulse diagnosis would allow us to recognize with very reasonable clarity: a) the road travel, or in other words, the vital vicissitudes of the journey; b) the mechanical state of the car; c) the behaviour of the driver in relation to both previous elements. But this is only what is to be expected of any rational and reasonable medicine.

Let us say that, at the most, the modern biomedical model is able to diagnose point *b*, that is to say, "the mechanical state of the car", and being limited by its own nature to make suppositions devoid of any functionality on the other two extremes. The subject only exists outside, to convince him, and his circumstances can be only considered accidents.

Present medicine cannot define with any criterion an optimal degree of health in a certain context and term; the advanced pulse analysis, yes, would have to be able to consider with great accuracy the relation of our present state with the optimal, but realistic, possible one; to define comprehensively the landscape of the health in the most direct, intuitive and irreducible terms. Anyone would have to be able to check itself in house, knowing and comprehending the matter. Each personal optimal, like the body, mood and mind of each one, has absolutely concrete limits and restrictions. The "unlimited health", like the "unlimited freedom", only finds its natural place in the advertising.

Since now there are so much work and effort in the evaluation and description of the aging process, let us say that the pulse analysis must be able to give a *functional and objective* global measurement of the degree of disorder of the organism, that is to say, of the entropy, but understood quite independently of the statistical criteria. Is there something similar now? In addition, must be able to show the difference between reversible and irreversible imbalance, within a defined context and period of time. This is fundamental also. Besides, the criterion of these estimations does not emanate from a horizon of predictions, but from the organic potential of the complexion of each person and his accumulated history. Who said "personalized medicine"? No need to say that the so-called genetic information of the individual, an aggregate of construction materials, can not report individual history nor its interaction with the environment either.

Let us say in addition that the study of the pulse in a really analytical frame would allow fast tests of collateral effects of medicines, much more resolvent dynamic tests of effort and a robust bridge with cognitive sciences and psychology, to mention only a few. It would have to transform our most intimate understanding of time processes and, first of all, of we ourselves. Samkhya always was the analysis of the temporal fluctuations, independently of the arbitrary divisibility of the space. In as much we develop an authentic theory and practice of control passing through the filter of the *person*, and not merely the individual, we will escape the control of anonymous powers, always hidden behind the opacity and the unintelligible character of the world, and the so often false pretension that they hold a "technical" knowledge of superior order. The exercise of the control is, mainly, which they hold.

We are in the Age of Control.

25 January, 2006

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