Introduction to the Proceedings of the 8th "Complexity-disorder" days: Tribute to Fernand Braudel and Jean Delacour

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Abstract. This introduction to this pluridisciplinary meeting is mainly devoted to celebrate two exceptional pluridisciplinary scientists. Fernand Braudel was simultaneously a historian, geographer, sociologist and economist. The neurophysiologist Jean Delacour was open to other disciplines from philosophy to physics. Braudel's global point of view of history created new fields in human sciences, paving the way for new active research. For instance, the emergence of the very singular development of world-cities remains to be well understood from detailed network analysis in order to find the driving process of such an emergent deep localization. In a similar way, Delacour's physiological evidence for unconscious mind resulting from energy saving during sleep remains to be explored in details both for humans and for animals with expected consequences for managing neural networks as well as for quantum computing, and for poetry. The papers of this meeting are shortly introduced.

1 Introduction

Instead of fustigating the current lack of pluridisciplinary works in research, a sad reality, it sounds more positive to emphasize some early rare works integrating successfully several disciplines. Such examples sound stimulating for the future and are already rich of potential applications. This remark gives us a good opportunity to introduce the works of two famous previous specialists of pluri-disciplinary works in research: Fernand Braudel (1902-1985) and Jean Delacour (1935-2005). Since pluridisciplinary works of such sizes are not so common in the present scientific literature, the very short present revisited recall of their works can be fruitful to the present large research community which can follow these 'precursors' way and reach realistic goals.

2 Fernand Braudel, a 'rebel' researcher

Fernand Braudel was an historian, geographer, sociologist and economist of immense skills, a real creator, out of standard ways, with a lot of success. In other words, he was a great researcher who paved new ways and some of them still remain open. During his long career he produced three masterpieces of which original viewpoints strongly changed human sciences. Some of his singular viewpoints are already introduced at school from the very beginning and at all levels! His earliest work was at a very uncommon scale, at the scale of the classical world, far beyond the usual history of nations. It introduced what is now called "Global history" or "World History". By complementarity, his extended research also introduced effectively a very local picture: "Micro-history".

2.1 His masterpieces

Braudel's thesis [1] dealt with the very large and unusual scope of the whole Mediterranean world, as it was after the discovery of the New World. In this thesis he used the careful method of "Les Annales" school, i.e., took into account a very large amount of data in order to derive a synthetic and scientific global view without any anecdotic feature. The lack of such anecdotic features was a central point of his method. For instance, the reference to the Levante battle was strongly discussed and finally introduced only because it was a very significant event. This strict selection of only the main points allows comparison with hard sciences. Such unusual large-scale research introduced the so-born "Global History" also called "World History", largely developed up to now and already largely taught in educational programs everywhere in the world.

His second masterpiece [2] was devoted to the main transition from farming livestock herding to industrial era, as observed all over the world, and practically in Europe. This full transition of the common way of life lasted during several centuries, step by step. In his work, the careful study of the world economy evidenced the central part of just a few successive "world-cities" which dominated by turn the world, each one during a long period. This observation was obtained from a careful analysis of economic data, in a very accurate way. The newness of this result revealed the main part taken by just a few cities and not by nations and countries, as usually expected. So, Fernand Braudel

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evidenced the very unexpected local nature of the world economic activity, driven just by a city during a long period. Such an original thesis was developed from a very detailed study of economy. The cities which lead the economy in the world were, successively: Bruges, Genoa, Venice, Antwerp, Amsterdam, London, New York, each one for a rather long period lasting over about one century. The numerical proofs given by economical observations are clear and demonstrate this feature without any possible contest.

The last Braudel's masterpiece remained unachieved but was published [3]. Here the newness of this research was to give a full history of France and of its detailed evolution, through ages, with, as usual for him, the use of a considerable amount of information in order to reach main features. This new approach of a single nation over its whole history enabled him to show how the two main transitions between hunting-gathering, farming and industrial era, occurred practically step by step. By means of this rather traditional approach of a single country, he revisited the details of these major social general transitions, with new results on the development and on the step-by-step growth of preindustrial activity.

2.2 Some of his main points

Quite many interesting points of his work deserve a careful read and questioning. Here, I selected just a very few ones, according to my own feeling. Many other points deserve also attention.

He showed that the first general transition from hunting-gathering to farming livestock herding was everywhere stabilized by the occurrence of a multiform religion. He noticed that, in the next era, after the transition, this multiform religion loses its stabilizing character of the hunting-gathering society and becomes just a social institution because of its remaining historical weight and powerful structure.

This "religious" stabilization of medieval societies is confirmed by the study of the complex Indian social stability as observed by Europeans, a work achieved by Sanjay Subrahmanyam [4]. These remarks reinforce the value of the classical Dumezil's basic social structure of the medieval era: a network based upon the triad, knight-priest-worker [5].

From his enormous work on the whole world history, Fernand Braudel observed the generality of serfdom and slavery, in space and time, everywhere and at any time [2]. Quite obviously the beginnings of his career as a teacher in Algeria and in Brazil gave him early strong evidence of this dramatic event with a deep emotional feeling. He confirmed later carefully such awful facts from complete observations. This not so known feature remains to be revealed by all kinds of media.

About world-cities, Fernand Braudel underlined the emergence of Amsterdam with the help of the new powerful V.O.C. (the Dutch East India company), as an efficient "city-world". This preeminent position occurred during the transition towards industrial era, just before it, with the creation of the first Bourse in the world (1530-1608) and quite later finished with the Batavian Revolution (1783-1798) which seemed to initiate the French Revolution [2]. So, the Golden Age of Amsterdam (1585-1672) sounds to be in fact quite longer than this strict period. It lasted up to the French Revolution and the beginning of industrial era. This pre-eminence results also in an artistic translation of this new society self-painted in detail, in action. This new social art differs in its themes from the mythologic and religious traditional painting themes. These economic and social successful changes created a new fashion, a new way of life which was soon propagated all over the world by means of this artistic testimony.

Fernand Braudel's careful analysis of the progress of the industrial era in London and Great Britain showed that the complex innovation process involves the practical cooperation of quite many contributors and the occurrence of many steps in a very collective long way, in order to obtain a single new result [2]. For instance, the creation of the famous Watt's steam engine involved numerous successive technical improvements issued from many people. This provides a very good example of collective innovation which can be dealt with in museum as well as in teaching.

His detailed study of progress in agriculture led him to review the use of crop rotation in Europe which evidences a lot of local variations, as a function of climate, i.e., of locations [3].

The city growth during industrial era, with the correlated increasing needs of the city for more and more different food in abundance, gave interest to the four resource rings of the economic von Thünen model of an isolated city [6]. In such a model the growth of the four rings of a city during the city growth leads to special successive structural city rearrangements. These city rearrangements occur according to the optimal economic benefit which arises from these activity changes. Some parts of old ground structures remain unchanged up to present times even after quite many successive partitions of the ground with the track of past. So, the structure of a city and its evolution are shown to result from these basic economical rules issued from the ground value at a given time and its evolution during history and city growth.

2.3 His heritage

Quite obviously his enormous work and his open view over history, geography and economy are quite fruitful, and some of his results are already introduced in education and more generally in all kinds of information. Here just a few proposals for future applications of Fernand Braudel's immense work are underlined because of their general interest.

As a conclusion of his careful social analysis [2], the classical triad knight-priest-layman [5] of agricultural era must be turned into the trio businessman-economist-worker at the industrial era. As a matter of fact, economy plays in this industrial era, the main stabilizing part of the new society, the part which was taken before by religion. Economy stabilizes the industrial era by means of the stimulation of human desire. Concretely these desired objects are realized from a series of industrial transformations, and a large amount of industrial work. Let us notice that the final stabilization of the industrial

era by desire is quite opposite to the previous stabilization of the agricultural era by religions. In the past, religions stabilized human societies just by restricting the individual desire.
This new picture of the main society components introduces a sight which needs to be more developed. It brings a new synthetic view of society where here so-called economists mean simultaneously economy advisors of different kinds including lawyers and labor unionists as well.

The question of generalized slavery all over the world [2] must also be developed, first in history. These results must appear in more general information media such as literature, theater, movies, museums and all media in order to be well known by all of us. This information must completely change our minds and will bring to all of us a real freedom! So, it cannot be neglected, this is a main task to be developed as soon as possible by all means. There is a need for more detailed data which can be used later in different ways all over the world in order to evidence this very basic feature.

The new approach of world-cities [2] deserves also to be taught at different levels. And Europe as a new emerging cluster of nations, is a good frame for such an approach. The interesting connection between these main world-cities and the growth of related arts must be developed in exhibitions, museums as well as in teaching.

The very localization effect leads to the preeminence of different successive world-cities. This singular point defines also a research topic of interest, even now with the wide scale and fast communication via internet. Such a localization effect remains to be studied and validated in our new conditions. It seems that the reason for such a localization comes from the need of a very compact geometric structure of the restricted network of economically active people, an oligarchy. So social studies of these networks in Harrison White's style [6] sound to be useful in order to understand this very strong localization effect which occurred several times in several sites. The example of the emergence of Amsterdam as a city-world evidenced several main characters of this unique city: - its well-known large experience in large scale trade, i.e., both contacts, ships and sailors, - its exceptional experience in intensive farming and management of such farming with a high technical level which revealed to be efficient in far east countries such as Indonesia. So more generally, the emergence of city-worlds sounds to be linked with the conjunction of several exceptional abilities at the same place.
Quite similarly the nice results obtained about the very complex nature of innovation, as a collective activity more or less localized [2] must be developed in all media in order to stimulate that kind of fruitful activity everywhere for improvements. Here such a pluridisciplinary work is forced by economy, i.e., the need for a practical result.
About crop rotation [3], it must be noticed that more pluridisciplinary researches would be always useful. As a matter of fact, the optimization of crop rotation is a question of experimental observation, of "trial and error" process for a scientist using a low-scale test experiment. Fernand Braudel did not realize that point. This point confirms the interest of a real pluridisciplinary work, if needed. In this case, such tests were probably done somewhere and these experimental sites must be found.
The von Thünen's model of cities [7] was discussed by Fernand Braudel in the framework of city growth [3]. This very interesting geometric topic explains the occurrence of four successive rings of agricultural resources for a city. When the city grows, the values of the land used for these necessary activities change. So, previous agricultural lands are sold for new activities and the rings split and move away. So, the whole city structure is renovated step by step. Smaller and smaller parks and gardens still remain in more and more renovated cities, during city expansion. Specific fractals [8], geometric repetitions at different scales, i.e., more or less self-similar geometries occur during these successive partitions. This theme was recently observed and modelized by many authors from different disciplines, i.e., from mathematics and physics to history and geography, with comparison with physical models [9-14]. A rather similar feature occurs for growth of medieval cities with the progressive change of old city walls into streets and boulevards leaving the path for new parts. So, the present city geometry results from several historical changes which introduce a high level of complexity. This is one more proof of the practical efficiency of Braudel's work for many disciplines.

This short list just gives a very few examples of what can be developed from the original Braudel's work. Just as noticed before, it must be added that Braudel's work involved many disciplines, with a deep approach. So, Braudel paved the way for future research and activity in many domains.
Before to leave that topic, a few words about the historic context of Braudel's work must be given. Fernand Braudel started his work between the two World Wars, when the local opinion was mainly split between a left side, close to communists and a right side close to catholic church. As a pure scientist, he followed his own way, far from this national splitting, as a "rebel" to such a splitting. Practically he worked at an international level, i.e., with several international contributors, finally in conformity with the basic idea of the world history. His success was also to contribute as a searcher to a new social organization at the world size after these two World Wars.

3 Jean Delacour, an open mind

Jean Delacour was a philosopher, a biologist, a neuro biologist and a psychobiologist, with a lot of skills, in our moving world. At the beginning of the twentieth century, the context of neurobiology was dominated by two recent results, two Nobel prize winners who strongly oriented the future research, paving the way for applications. This introduced a new complex framework for several sciences.

3.1 The context of neurophysiology

Ivan P. Pavlov received the Nobel prize in 1904 for the discovery of what is now called Pavlov conditioning. The stimulus-response SR mechanism was underlying this general conditioning. It led to a simple mathematical model and then to behaviourism [15], an abstract view of the brain behaviour largely developed later. Further progress has been triggered by computer developments and their applications.
On the other side, Santiago Ramon y Cajal received the Nobel prize in 1906 for his discovery of the neuron and its connections. This result founded the experimental neurophysiology. Experimentation on neurobiology was now possible and active. Quite many detailed observations followed, on humans as well as on animals.

Several intellectual connections between biology in general and hard sciences were proposed such as behaviourism already quoted. Mathematical derivations of natural structures issued from the initial work done by d'Arcy Thompson [16] have also been active. For instance, the research for basic structures achieved by R. Thom [17] from general dynamic considerations gave large hopes of a general connection between biology and mathematics. So, neurobiology and human mind analysis became very attractive for sciences, from many points of view, including different competing disciplines.

Neurons have both long ranged and short ranged connections by means of axons and synapses. So, their interesting and complex network properties were well studied in humans and in animals at different levels, in brain as well as in nervous ganglia. It was observed quite generally that electrical and chemical neural excitation processes occur with a strong non-linear threshold between rest and firing. This was a strong step towards a simple modelling of neural excitation.

This strong non-linear threshold effect of the excitation process of neurons allows a simple binary representation such as excited/at rest, or a little bit more complex representations by distributions of a few discrete states of excitation. In other words, neurons can be represented by Ising or Pott spins because of these few discrete states. Then the different neural connections correspond to different spin couplings as it occurs in magnetism. Spin magnetism gives rise to well-known memory effects and even to long term memory effects, which act up to very long times as it occurs in rock magnetism [18], or in magnetic tape memories. This basic memory effect is quite similar to the long-term human memory achieved by neurons within brain. So, the comparison between neurons and spins, between mind and magnetism was quite obvious and was early developed [19, 20]. These first papers have been followed by so many papers since fruitful applications to artificial memories and their practical consequences sound as possible new ways for efficient computer science.

The progress of computer science even enhanced the competition between brain and computer, with the hope of fruitful biomimetics effects. So, neurobiology received early a high level of scientific pressure from the community for quite many reasons and hopes.

3.2 A few Delacour's works

Trying to develop the links between the physics of magnetism I was involved in, and the strange world of Delacour's neurobiology, I met Jean Delacour in the eighties. We firstly started to develop a neo-behaviourist model of brain memory [21]. Our early model was close to Landauer's model of memory without organization [22]. This common work and approach gave us the opportunity to organize diverse published pluridisciplinary meetings, at the national level as it occurred for our memory model [21], as well as at international level. These meetings involved many contributors from different fields. For the international meeting, with D. Mercier, we developed a comparison between long ranged synaptic connections along axons and spin-spin dipolar interactions in magnetism. Dipolar interaction was known to induce a spatial organization in magnetic domains [23] and thus to rather stable structures. The neural basis of this comparison lies in the connection restriction which forbids that all neurons be connected to all neurons, just because of the enormous wiring volume required by so many connections, i.e., axons and synapses. Practically the realization of a realistic wiring volume requires a strong selection rule with a statistical r^{-3} power law for the possible connections between neurons lying at a distance r from each other, in order to save space for neurons and their necessary feeding conditions. This very low statistical power law, and the existence of excitatory as well as inhibitory connections, i.e., of positive and negative connections between neurons, are quite similar to the valid law for the magnetic dipolar interaction between spins. This remark was developed later [24]. This fruitful basic comparison leads to nice memory effects.

During his whole career Jean Delacour followed such a synthetic way, integrating many contributions from different disciplines. A lot of review books are issued from his synthetic work, with his personal progression from a behaviourist point of view and later his biological realization of awareness [25-30].

3.3 Delacour's contribution to the mechanism of unconscious mind

In ref. 27, after considering both philosophical studies and experimental results, Delacour brings a decisive argument about the biological evidence of unconscious mind. Unconscious mind appears with dreams, i.e., during sleep, when the brain energy consumption is severely restricted, i.e., with a low neural activity. Within sleep, neural thresholds are moved in order to obtain this strong reduction of energy consumption which is required for rest and repairing. So, a general lowering of neural activity is reached. In a

quite parallel way, energy saving in artificial neural networks is also a quite concrete request [31]. So, this simple biomimetic remark sounds already to be useful for future computer applications by means of a nearly random derivation of neuron thresholds in order to save energy.

Another point concerns inhibitive connections which are quite essential for consciousness and action. These inhibitive connections must be mainly at rest during sleep for energy saving. This rest opens an unrestricted way to fancy, out of usual bans. Such freedom is a well-known property of sleep activity from direct observation.

This reduction of neural activity and of energy consumption during the phases of sleep can be controlled experimentally by means of cerebral activity maps. Central parts of the neural activity are not strongly affected by the general neural threshold shift and remain active for basic functions, but many other parts of the brain are probably nearly at rest, because of the strong threshold change. For these "auxiliary" parts, the distribution of thresholds is probably random, and also strongly varies during time in order to optimize the energy distribution all over the brain and over the central nervous system during the sleep. Thus, at a given time during sleep, an unconscious mind occurs with quite fewer effective connections than the fully awaken mind, so it is then a restricted unconscious mind with low inhibition. As a matter of fact, this restricted unconscious mind must change frequently during sleep time, since some active neurons must become later at rest while some neurons previously at rest become activated. This process balances a global low neural activity equilibrium over the brain during the whole sleep time. So, a lot of parallel different restricted unconscious minds must appear at different times during sleep. This access restriction at a given time forces the instantaneous unconscious mind to use approximations, transpositions, indirect ways, in making consistent representations, dreams when using only "active" neurons at this given time. Such an uneasy, indirect way of representation reconstruction was already noticed by Freud from his large observation of the content of dreams [32], which reveals to be quite indirect.

Curiously this reference to Freud's work recalls us that early Freud's opponents to the existence of the unconscious mind, were already using the argument of rest to invalidate the existence of an unconscious mind [32]! This delicate topic of the existence of the unconscious mind is now solved by the detailed physiological observation of the neural activity which proves without contest the existence of a multiple unconscious mind.

This multiplicity of the unconscious mind suggests a comparison with clinic reports [33] which noticed multiple non-conscious states of mind in the different steps of coma or in nearly automatic behaviour. This status is different from the multiple unconscious minds but it reveals the full complexity and multiplicity of mind.

Quite numerous remarks and suggestions arise from this direct biological proof of the multiple restricted unconscious minds which appear during sleep. Firstly, for a child and specially a very young child, life experience is quite lower than that for an adult and thus child dreams must reveal a quite simpler structure than adult's dreams because of the lack of experience. The simplicity of children's dreams was already observed directly by Freud [32,34] from intense psychanalytic observation. This remark is fully consistent with the notion of a multiple unconscious mind which depends on experience.

A second remark derives from the fact that animals also sleep during more or less time, and evidence some dreams as suggested by observable "unconscious" motions. So Delacour's remark means that there is also an unconscious mind for animals in the sense of a general reduced brain activity during sleep. Such animal multiple unconscious minds can be also directly observed by means of cerebral maps of neural activity, as noticed by Delacour [30]. This notion of animal unconscious mind was already suggested by Freud himself [34]. And the topic of animal unconscious mind remains still attractive [35] and deserves observation as well as the topic of animals' superego, which appears as observed from their collective behaviour.

Another remark about the human multiple unconscious minds leads us to consider recent actual questioning about quantum world. As a matter of fact, the probabilistic nature of quantum physics leads to many paradoxes such as the classical one of Schrödinger's cats. For solving this paradox, the idea of parallel universes proposed by Hugh Everett [36] and still recently commented [37] seems curious but finally sounds to be very similar to the multiple unconscious mind which results from a series of random draws of the active neural network. Such suggestions could be useful for deriving efficient and energy saving quantum computers.

There is also a well-known strong connection between dreams and poetry and literature in all languages. The pleasure of poetry comes mainly from rather unexpected, uncommon links it reveals, in a dense way, to the readers exactly as such unexpected links appear in dreams. So many attempts of direct connection between dreams and poetry have been achieved since a long time by means of the work of an unconscious mind. This was the case of the "automatic writing", with an obvious reference to Freud's psychanalysis. This automatic writing was used in order to generate an original creative process where unconscious mind was the processor. Here too the concept of sweeping multiple unconscious minds, seems useful to understand this detailed mechanism since during dreams and sleep, many connexions are inefficient, and so indirect, unexpected connexions are used in a very original and unexpected way.

Quite obviously this evidence of a multiple unconscious mind has a lot of consequences which still deserve attention and pave the way of future research in different ways and disciplines. A central point consists in observing the complete dynamics of the cerebral maps during sleep in order to follow these multiple unconscious minds.

4. Conclusion: introduction to the contributions.

The evolution of the new Covid-19 pandemic crisis brings a lot of complexity and disorder on the medical point as well as on the social point, and even at the government level which must perform the best choices. It generates problems at the individual level as well as the global level. This main theme is developed in the following according to different points of view, different levels by different authors.

1. First on the medical point, Varret, Martin and Varret try to understand the successive propagating waves of this disease by means of current models. So doing, they are forced to improve these models step by step in order to fit with accurate data, here from France. New parameters are introduced to deal with this complex behaviour.

2. Dealing with government, law and its practical application in justice, Joubert shows the multiplicity and complexity of recent new disorders: terrorism, yellow vest protesters and of course Covid-19. He gives numerous examples of such hard politic situations with a very high level of instantaneous complexity and he also gives examples of justice and law difficulties. As a conclusion he demonstrates that such difficulties strongly deserve a special basic scientific analysis in order to reach a convenient and consistent treatment of such future problems.

3. Grossetti's paper deals with the social impact of the Covid-19 pandemic propagation. First this propagation induces in all countries a large increase of extra duties for the health system. And since contacts must be severely restricted in order to avoid a tremendous increase of propagation and finally of deaths, different levels of lockdown have been required during long times. Because of such successive severe lockdowns, a persistent complete change of the usual way of life occurred for quite many people. Such an unexpected arrangement is quite new and unusual. So many troubles occurred at an unexpected level. This sociologic analysis is reported on a very large sample taken at three different times in order to distinguish long term effects. And finally, a true social transition appears.in these data.

4. Another challenge of complexity is dealt with in architecture by Truyman and Truyman. Their goal consists in organizing life in space, and more generally in extreme conditions, by means of a convenient architecture fitted for human workers, a real challenge! The principle of their architectural biomimetic model follows a long building tradition, which consists in copying the resilient property of nature as already done in many places and times. Different preliminary views of space houses and space engines illustrate their work about living and working in such extreme conditions. New structures appear issued from the animal life!

5. Biological systems deal with a very high level of complexity and noise which are treated at different stages, at different steps. Thus Pastor, Beurier and Thomas-Vaslin propose here a holon model with communication at various scales of living organization. Their goal is to obtain a valid model for biological systems such as neural ones. This purpose is formalized through dynamical systems driven by degenerate statistical models. From a detailed study, they find that statistical inference theories offer functional and structural redundancy and open prospects to model fractal-like holarchies, via networks of communicating degenerated automata. This opens the path to feature the numerous properties of the immune system.

6. In teaching books it happens that some errors are made even by the most famous authors. Quite obviously such flaws introduce a high level of complexity for learners! And this is an indirect proof of the true complexity of nature. When looking at such examples, Viennot shows that these mistakes are often due to the research of an excessive simplicity in the author's demonstration, neglecting the real problem complexity. This is shown in different examples of pitfalls in physics problems and specially about capillarity, a classical topic easily observed, but a rather complex one. As a matter of fact, capillarity produces nice geometrical effects but involves quite different competing interactions which are not so easily solved.

7. By means of Quantum Field Theory, Vitiello considers the spontaneous breakdown of symmetry in physics in a general way and then derives the Goldstone theorem. This powerful tool enables him to obtain complex symmetries such as crystalline ones as well as fractal ones which occur in many cases of the general morphogenesis. So doing, he obtains a very large view of complexity and disorder in nature within such an unified model.

8. In his paper Pace introduces us directly to the full complexity of nature and life and tries to understand how the complexity of nature evolves from its very beginning, i.e., Big Bang. This so-introduced complete landscape involves all disciplines from philosophy to sociology through physics and chemistry. A main and recursive question concerns the involvement of interactions with complexity and multiplicity and the appearance of successive structured levels.

9. Pomeau and Le Berre deal with the very basic foundation of quantum mechanics which involves the mixing of both deterministic equations as well as a fundamental uncertainty. After an historical review of the very foundation of quantum mechanics, they choose to consider a basic event: a fluorescent atom, with or without electromagnetic excitation and also with different excitations. In a clear calculation by means of Kolmogorov equations, they obtain the solutions to these different problems. These new solutions can be directly compared to experiments. And these solutions are compatible with an Everett's description with multiple worlds! This is a completely new demonstration.

10. Bringuier, for his contribution gives here an alternative version to the famous decoherence model which explains the transition from quantum mechanics to classical mechanics. His argument is based upon the quantum problem of scattering a quantum unit by random fixed impurities. This problem is solved by means of Wigner functions. Wigner functions correspond to quasi-probabilities, i.e., functions which do not follow the requirements for probabilities and for instance can be locally negative. So, he is able to solve

that complex problem of transition between quantum and classical dynamics according to the density of impurities.

11. Vukadinovic and Ben Youssef are interested in non linear effects in magnetic resonance. More precisely they consider a garnet thin film with perpendicular anisotropy which is well known for its sharp magnetic resonance, and they look at domain wall resonance in presence of regular domain walls in the sample. When they increase the resonant power, they observe a new subharmonic resonance at a frequency which is one half of the domain wall frequency. Their careful investigation leads them to derive a precise geometric structure of the domain wall. Such a study paves the way for future investigation of magnonic effects in such high-quality samples.

12 The next paper from Ilisca, Houssais and Ghiglieno revisits the old problem of the catalyzed transition from ortho to para hydrogen. The old solution of magnetic catalysis required now revision because of its huge economic interest, first with the large use of hydrogen in space rockets and more recently as a hope for the use of safe car engines. So, these authors produce a large review of recent experimental and theoretical developments in order to optimize the industrial choices to be done. They find a development of nanophysics which reveals to be quite useful for solving this basic physics problem.

13. Depondt, Huppert and Finocchio consider another problem linked with hydrogen, namely its isotopic effect in all compounds including hydrogen and more generally the effects linked with the quantum nature of the proton. In usual computations the nucleus quantum effects are neglected since nucleus is heavy, but for hydrogen and its light nucleus, such a neglection is not a valid one. So, it opens a new physics since so many molecules involve hydrogen! So, these authors both made a review of experimental data with at least such isotopic effects with hydrogen and also consider new numerical methods which are now used for solving these new quantum computations, with finally a comparison between theory and experiment. Of course, this is a thermodynamic approach and high temperatures and pressures can be considered. Thus, this work introduces the beginning of a very new physics.

Finally, many points of the complexity of nature are discussed in these Proceedings. But, the field of complexity remains open! Durkheim wrote a long time ago that the differences between levels of complexity defined human sciences [38]. This is an obvious proof of uncompleted achievement.

As organizer of these meetings and of this review, I am glad to acknowledge the constant help of the Physics department of University Paris Cité. It is also my pleasure to acknowledge the practical help of three laboratories of this University which are linked to the Physics department. These laboratories are, LIED : « Laboratoire Interdisciplinaire des Energies de Demain », MPQ « Matériaux et Phénomènes Quantiques », and MSC « Matière et Systèmes Complexes ».

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