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From the Electromagnetic Conception of Nature to Virtual Reality Physics

1. Historical Introduction

In this paper I would like to briefly outline some features of the evolution of physics between the XIX and XXI centuries without any aprioristic presupposition of historiographical categories and so to give a new “understanding” of it within the “context” of the forthcoming Third Millennium. Indeed, I believe that one has to overcome a theoretical, abstract historiographical approach, which tries to identify “historical objects” from an “external” point of view. I think real historical understanding needs to consider every discipline as an actual human practice among other interrelated human practices, as part of a self-understanding of historical “effective life” of mankind within the world.¹

From this perspective, physics is a complex of many entangled practices, which have been changing in correspondence with changes of “effective life” within the world. An actual historical understanding of physics is so related to effective understanding of our life and can be important beyond simple obvious disciplinary aims.

Since theoretical practices like (ancient Greek) philosophy as well as science, and have been going to separate themselves from effective life, they have been operating a process of de-vitalisation and de-naturalisation of life. Modern physical sciences were a complex of entangled theoretical, mathematical and experimental practices related to a new kind of life in respect to the previous mediaeval one. The mechanistic conception of nature which was constituted throughout these physical practices was part of a new self-understanding of the “effective life” of mankind within Nature: from the physical as well as from the Nature theological point of view, Nature was reduced to a machine, to inert, passive matter devoid of any “active power” (any active power, other than God, would limit the omnipotence of God) and of any soul as a dead, non-living thing. The mechanistic conception of Nature prevailed over the previous accepted “vitalistic” perception of Nature, which, related to the ancient myth of the “Great Mother Goddess”,² involved a living relation with a living Nature, full of active powers as well as guided by a World-Soul.

¹ HEIDEGGER (1995).

² NEUMANN (1956).

Indeed, this mechanistic conception of Nature, related to the ideal of knowledge as *mathesis universalis*, can be understood in terms of a technical pre-understanding of Nature as an object of dominion and exploitation for effective human life:³ this needs Nature to be considered as a non-living machine just to avoid any ethical involvement, this needs a mathematization (quantification) of Nature.

This historical, particular, contingent, mechanistic configuration of physical practices can so be understood in relation to a different self-understanding of secularised “Christian” life after the Protestant Reform,⁴ but also in relation to the prevalence of some (“father”) archetypal images of collective unconscious of mankind over other (“great mother”) ones,^{5,6} in which the violence of the fight for life as our primitive experience of being-living within Nature is in some way condensed in a form of pre-understanding. Indeed, by a historical analysis of Kepler’s works and of part of the so-called “scientific revolution”, Wolfgang Pauli has started to show that physical theories and the related “mental representations” could have their roots in archetypal images of the collective unconscious which have been investigated by Carl Gustav Jung. For example, there were geometrical archetypal images which could have determined the mental representations and the cosmological and physical theories of space, time and Nature: Kepler’s geometrical images are still related to a mixture of the “father”, “great mother” and “trinity” archetypes operating in the history of mankind, but Newton’s as well as mechanistic images of space, time and Nature seem to derive from the dominance of the “father” archetype.

Modernity, as well as “scientific revolution” which has characterised it, has therefore ancient, hidden, unconscious, mythological, irrational roots in “effective life” behind its conscious, rational surface *episteme*.⁷ Between the XVIII and XIX centuries there was a turn from an *episteme* of *representation* in which there was a high fidelity biunique, transparent, mirror relation between experienced world/experimental practices and mathematical-geometrical language to an *episteme* of *formalisation* and *reconstruction* of experimental practices by the mathematical-analytical (differential and integral calculus) language. This does not happen in correspondence to a trivial, simple, mathematization of the so-called “Baconian sciences” (regarding electricity, magnetism, heat, etc.), related to a generic “quantifying spirit” of *Enlightenment*. There was a profound turn toward absolutization of a formal mathematical “reason”, disentangled from representational constraints: there was an “epistemologization” of mathematical analysis which replaces geometry as dominant language.

This historical process, which in some way completed the “scientific revolution” as well as the project of rationalisation of Nature of the *mathesis universalis*, corresponds to the mythical, totalitarian transformation of scientific *reason*⁸ that can

³ GIANNETTO (1999).

⁴ HEIDEGGER (1962).

⁵ JUNG and PAULI (1952).

⁶ NEUMANN (1952).

⁷ FOUCAULT (1966).

⁸ HORKHEIMER and ADORNO (1969).

be exemplified in the *Laplace's Demon Mechanistic Myth*: indeed, the “epistemologization” of mathematical analysis at the language level of scientific practices corresponds to the “epistemologization” of mechanics at the hierarchical disciplinary level among scientific practices. However, it is clear that behind these rational changes in the *episteme*, dominant only at the “conscious” surface of the knowledge ocean map, there are changes in the *Kulturseele*, in the “unconscious” (removed, archetypal) background on which scientific (mechanical) practices genealogically have their roots. Scientific physical practices too cannot be reduced to inert, dead structures within a global mechanistic view; they have “living” interrelations within a historical “world of life”, in relation to effective life.

Since the end of the XIX century to the first part of the XX century, there have been deep revolutions in physics. At the end of the XIX century physics was no longer mechanics only, but other physical disciplines had been developed: thermodynamics and electrodynamics. These new faces of physics produced also other different conceptions of Nature: the mechanistic conception of Nature had to fight with a thermodynamical conception of Nature, with an electromagnetic conception of Nature and also with an “energetic conception of Nature”. All these three new kinds of conceptions of Nature were indeed dynamic ones in opposition to the mechanistic idea of Nature as an inert and passive machine.

The electromagnetic conception of Nature was based on the idea that the ultimate physical reality is the dynamic electromagnetic field. It was elaborated starting from the Giordano Bruno's anti-mechanistic perspective, which was formalised by Leibnitz: every “monad”, that is every constitutive part of Nature, must be considered as a living, animated, dynamic one. Monads are characterised by *vis viva*, corresponding to the actual kinetic energy. The Volta-Galvani debate was on the existence of special kind of animal electricity as characteristic of any living being. When Volta showed that animal electricity was nothing else than electricity, two conclusions were possible: life is nothing else than inert and passive matter, or otherwise matter itself is not inert and passive but living just because characterised by the same electricity of life.

This was Johann Wilhelm Ritter's (1776-1810) perspective, which was shared by the whole German, romantic *Naturphilosophie* (Franz von Baader (1765-1841) was the first with Ritter to develop this conception).⁹ From such a perspective, through Oersted's experiments and within the idea of the dynamic unity of Nature, after Maxwell's system many physicists had developed the electromagnetic conception of Nature: in particular, among others, Hendrik Antoon Lorentz (1853-1928), Joseph Larmor (1857-1942), Wilhelm Wien (1864-1928), Max Abraham (1875-1922), Henry Poincaré (1854-1912).

In Poincaré's 1905 works, the connection between the relativity principle and the electromagnetic conception of Nature gave rise to a new relativistic field dynamics. Special relativity had been derived from an electromagnetic conception of Nature: mass is not the measure of a primitive property of inertia and passivity of matter, but

⁹ GIANNETTO (2002).

is related to the electromagnetic field energy, to the effect of electromagnetic self-induction. In 1906, Poincaré wrote a paper, entitled *La fin de la matière*, in which the end of materialistic-mechanistic determinism was outlined.¹⁰ However, Einstein restored a mechanistic view for the new dynamics and the scientific community followed this more conservative perspective. Even quantum physics had been developed by the interplay of the new thermodynamic and electromagnetic conceptions of Nature.

However, also in this case there was a restoration of a more conservative point of view. Only the more evident effects were on the technical side: from Volta's pile on, electromagnetic energy was entrapped and used as a new more powerful tool to dominate over Nature. The electromagnetic conception of Nature was reduced to a new kind of technics, non-mechanical *Gestell: das elektromagnetische Gestell*, that is an electromagnetic net or web in which mankind too cages earth. Artificial lighting had been starting to envelope the earth.¹¹ It was the beginning of a historical process by which we are now going to miss the physical view, the natural perception of the night sky, to miss the stars and the Milky Way which in the past had been the constitutive archetypes and symbols of our souls.

Anyway, in the XX century (deriving from the fight of the different perceptions/conceptions of Nature as partially represented by the "zero"-map at the end of this paper) chaos, relativity and quantum physics have been destroying the mechanistic conception of Nature: the complexification of experimental instruments and related practices – to amplify and to extend the dominion over Nature for a wider exploitation of it – paradoxically has revealed a fundamental indeterminacy and unpredictability of Nature which makes impossible any human control, any ultimate rationalisation and mathematization of it.³ Here, physical practices have shown the need to change the technical pre-understanding itself of effective human life within Nature, on which they have been based for the last two centuries.

However, scienceworld is no more a marginal realised abstraction, is no more detachable from lifeworld in any way, they become more and more entangled: scienceworld is going not only to modify lifeworld but also to replace it. In this world situation, physics (science) is no longer one human practice among others. Physics has been changing the face of our planet and has been playing a guiding role in our technology-dominated societies.^{12,13} Science (physics) has been replacing religion in the "ideological" role of the material and cultural structure of our societies, in the way of dealing with life and Nature. Science is our "generalised medium of communication". Thus, the deep implications of the physics revolutions on the self-understanding of our effective life within Nature have been removed, and the mechanistic conception of Nature is still alive within the scientific community and our societies.

¹⁰ POINCARÉ (1906).

¹¹ SCHIVELBUSCH (1983).

¹² HEIDEGGER (1954).

¹³ MARCUSE (1964).

This is not all. Another, perhaps deeper, revolution in physics has been coming in recent years and it is related to the computer.

2. The Computer Revolution in Physics

Informational technology is changing our everyday life, our lifeworld even at a material level. This is the effect of a part of a new science: optical fibers, artificial intelligence, computer science, cyberspace virtual reality, complexity sciences, etc.

Science has been changing. Science is no longer Galilei's and Newton's science. It is no more Einstein's and Bohr's science. The physicalistic paradigm is surpassed. Science cannot be reduced to physics as the ultimate level of knowledge, just as the various sciences cannot be modelled on physics.

Physical methods have been changing. There is no longer a mechanical method or a pure experimental method. Thus, reductionistic methods die. Experimental method cannot be used for much of the theoretical physics of elementary particles and in this case scientists ask only for a logical and mathematical consistency criterion, that is for the internal consistency of a theory.

In some cases, there is also need for an inter-theoretical consistency criterion. The elementary particle theory is strictly bound to theoretical cosmology and vice versa. Computer simulation method is going to replace experimental method to deal with these cases. Even a pure mathematical method is no longer suitable: in many cases the computer simulation method is going to replace it too. Now we are waiting for partially replacing computer simulation and experimental methods with a cyberspace virtual reality method. This is going to replace the ideal, thought experiment method of argumentation, to realise thought experiments as such.

Scientific practices and disciplines have been correspondingly changing themselves and in their mutual relationships: there is no longer the old "trinity" of physical kinds of disciplines, theoretical physics, mathematical physics and experimental physics. Now, we have at least also a fourth kind of physics: computer simulation physics. And we are going to have a fifth kind of physics: virtual reality physics. Computer simulation physics is going to become the foundation level of theoretical and experimental physics and at the same time is going to be replaced by virtual reality physics.

The three maps at the end of this paper schematise the evolution of experiment, the evolution of physics and the evolution of the subject of scientific knowledge. In the transition from natural experience to real experiments and from oral natural language to written mathematical language, the technical instrument and the mathematical "instrument" play the role of the subject of scientific knowledge of Nature, which is reduced to an object of experimental and mathematical manipulations. Not only is theoretical knowledge separated from effective human life, but also the language and experience of Nature have been separated from effective life: human life is so alienated from Nature which is so reified.

Indeed instruments are related to conditions of possibility of knowledge, different one from the other and different from human ones; they have also different

limits. In the same way also mathematical languages constitute different conditions of possibility of knowledge and different limits. The problems of experimental and mathematical practices to deal with particular kind of physical processes have led to the computer becoming the new subject of scientific knowledge simulating experiments, mathematical calculi and theoretical models. Also in this case there is an alienation of effective human life from the experience of Nature.

Now the "paradigm" is the *episteme* of computer simulation of mathematical and experimental practices, but we are going towards an *episteme* of virtual realisation of mathematical and experimental practices. However, computer virtual reality is very different from computer simulation.

We can look at these changes also considering artistic practices and general life practices. We live in a computer-dominated world. The computer is the actual subject and material support of knowledge. Indeed, the computer metaphor is going to spread over every conceptualisation and to become dominant: minds, living beings, intelligence, the universe and God have been conceived as computers.

Thus, after the breakdown of the old mechanistic conception of Nature in quantum, relativity and chaos physics, a new form of it is rising: a computer mechanistic conception. Truth is reduced to what a computer can contain or perform, and is going to become what a computer can virtually realise. And being reduced to being a virtually computable quantity. This is the self-understanding of our effective life within a world where all is embodied with the more sophisticated, violent, human technics: we live within *das elektromagnetische Informationsgestell*, within the information-electromagnetic net/web in which the earth too is caged. This is the actual trend or the forecast of a future trend.

However, there are signals pointing toward another direction of evolution which show us that this computer mechanistic conception of Nature is only the residual ideology of this kind of technology-dominated life and does not actually work. Computers must be considered "intelligent", living, evolutive and temporalized (there is irreversibility of computation), indeterminate and unpredictable (quantum and chaotic computers) beings and this paradigm has to be turned upside down.

Computers are able to simulate complex processes and to solve complex problems which modern physics is not able to solve and which appear in sciences like biology, sociology, etc., – which have to deal with evolving, historical patterns (but physics too, indeed)^{14,15} – because they do not use the standard sequential mathematical technics which have been characteristic of modern science, the modern *mathesis universalis* and indeed the modern way of thinking.

Indeed, computers use a new kind of parallel, evolutive, mathematical techniques,¹⁶ which do not deal with geometrical objects, numbers or (differential, integral) equations. They are neural networks, genetic algorithms, simulated annealing, cellular automata,¹⁷ artificial life. They are named intermathematics¹⁶

¹⁴ PRIGOGINE and STENGERS (1979).

¹⁵ GIANNETTO (1994).

¹⁶ BAILEY (1996).

¹⁷ FARMER, TOFFOLI, and WOLFRAM (1984).

because they are a sort of a neutral interlanguage beyond the specific human mathematical languages. They do not abstract life in numbers or evolution in equations, they no more model Nature by a static, dead, mathematical language. Nature indeed is not a (mathematical) language and we cannot understand Nature by these means. Intermathematics is “artificial” Nature, because we can understand the changing patterns of Nature only by changing, evolving, (artificial) natural processes. The behaviour of particles, waves, quanta, atoms, molecules, matter structures, living cells, etc. has nothing to share with the behaviour of geometrical objects, numbers, algebraic variables, equations. These objects do not move, do not propagate, do no scatter, do not evolve, do not interact with one another. Intermathematics (like, for instance, cellular automata), interact, evolve, are living patterns.¹⁶ They do not constitute an abstract, discursive or mathematical symbolism, but a concrete, living, audio-visual, “natural” symbolism; and in cyberspace virtual reality we can perceive, not only conceive, a world.

We are going to overcome abstract thought, going towards a non-linear, parallel, non-sequential, complex, “multimedial”, non-conscious-dominated, living-thinking. No more (abstract) “images” of the world. We could go beyond the *epoch of the world images*.¹⁸ Science can be more than a mere conception of the world.

It can be shown that a genealogical inquiry on computers and cyberspace leads to Leibnitz’ vitalistic, anti-mechanistic conception¹⁹ and their language related to his binary calculus derives from the “I King” symbolic archetypal image language.²⁰ Furthermore, on the other hand, cyberspace virtual reality is an artificial-natural world into which we can enter, in which there can exist “living beings” without their own violence expressing itself a phagocytation. In this artificial world, we can have, a new *electromagnetic* body of light without material (inertial and gravity) constraints. We can transfigure ourselves. Perhaps, the worlds produced by the more sophisticated, violent, human technology cannot be other than their self-negation and lead us to a non-violent Nature.

Here we can experiment a new world by new conditions of possibility of experience beyond human limits, beyond the limits of the human being as a genetic-historical, empirical subject. Here we can have experience of the world virtually as a butterfly or a stone, as a cloud or a star. Here, as it has been stated,²¹ we have to point out a virtual indeterminacy of the human body, a new way of being within a new world, a new effective life within Nature. The virtual world could be the virtual realisation of our archetypal images of Eden as well as of the escatological-apocalyptic Kingdom of God.²² That is, within cyberspace virtual reality we could have a virtual experience of Nature, a virtual effective life, without any alienation from experience and language. Indeed, there we could be subject of a virtual life and knowledge as a surplus, without renouncing the real experience of Nature in our effective life; and, on the contrary,

¹⁸ HEIDEGGER (1950).

¹⁹ LEIBNITZ (1880).

²⁰ HEIM (1991).

²¹ VIRILIO (1990).

²² DREWERMANN (1990).

stopping to manipulate, to do violence to Nature directly by real experiments and mathematics, just having experience of a virtual world.

Within a non-anthropocentric framework we could realise a new physics of transformations of experience from a human-made reference frame subject to a non-human subject. We could experience the world as a “*quantum* subject”, as a “microphysical subject”. We could experience the world from a *light*, non-material *relativistic* reference frame of light as in Einstein’s dream.

3. Conclusions about Scientific Practices and Physics towards the Third Millennium

At the Threshold of the Third Millennium, now we can make some reflections on the fate of many practices of our human life. First of all, we can understand that the Third Millennium could be not only a conventional – even if very particular – change of numbers in our calendar dates that will bring some problems in our personal computers, but it could reflect actual, epochal changes in our way of life, could be an occasion to change many things.

We all can see that we are living through a sort of phase transition regarding many of our practices, that we have reached a critical “temperature” of our life, of our cultures, of our civilisation so that we have to spend our energies just like “latent heat of fusion”, of a new phase to complete the transition. From this point of view the beginning of the Third Millennium can be really considered as the critical point of this time.

Many of us are involved in scientific practices or in strictly related activities: many of us have been working as science researchers, many others have been teaching science or have been studying science from a historical or philosophical point of view. However, how conscious are we all of the role of science in our societies? How much time have we spent to reflect on our everyday life responsibilities, involved not in exceptional cases as in the construction of a bomb but in our everyday “normal” practice of science?

Already since the appearance of quantum physics where there is no natural law for the single process,²³ but only statistical regularities, where there is no separability between subject and object, the idea of scientific discovery of some separated objective reality to be expressed in mathematical languages has been breaking down from within the scientific practices themselves (beyond mere epistemological criticism). This idea of the scientific discovery of Nature from an external point of view has been showing itself as related to a historical, inauthentic way of self-understanding of life as dominion over Nature as well as over the other human and non-human forms of life (like the so-called “discovery” of America).

By virtual reality physics, indeed, we can no more speak about a scientific discovery of the world, but about a scientific creation of a virtual world. From this point of view science is no longer a theoretical, mathematical and experimental

²³ GIANNETTO (1987).

inquiry for dominion over Nature, but is a form of art, virtual art by which we as part of Nature can understand our historical, singular, effective life better, by which Nature can understand Nature better, by which Nature can “self-discover” its depths.

Already since the appearance of quantum physics where there is a ultimate indeterminacy of Nature, no (mechanical) model of Nature, but only statistical, complementary, partial and “subjective” models of Nature, the idea of scientific model of some separated objective reality, to be expressed by model reasoning in some theoretical, mathematical, experimental, computational models, has been breaking down from within scientific practice itself (beyond mere epistemological criticism). This idea of scientific modelling of Nature from an external point of view has been showing itself as related to a historical, inauthentic way of self-understanding of life as dominion over Nature as well as over the other human and non-human forms of life.

By virtual reality physics, indeed, we can no longer speak about a scientific abstract modelling-reasoning of the world, but about the scientific creation of a virtual world and scientific living modelling-thinking by the world itself. From this point of view science is no longer a theoretical, mathematical and experimental inquiry for dominion over Nature, but is a form of art, virtual living-thinking art by which we as part of Nature can understand our historical, singular, effective life better, by which Nature can understand Nature better, by which Nature can “self-model” its depths.

The implications for science education are very relevant.

There will be need for a new culture of science, related to the new nature of science and of culture itself, which is a new culture of Nature related to a new life within Nature: post-modern physics requires an *ecologization* of science and of science education. Particular students’ preconceptions could be related to specific archetypal images which historically “condense” the indeterminate content of the archetypes and of their superpositions or mixtures in relation to different ways of life, of being within the world. Thus, constructivist and hermeneutical approaches to the problems of students’ pre-conceptions or conceptual changes could be embedded in a wider context of understanding which implies taking account of non-individual, collective unconscious variables and of radical deep differences or changes of the self and of life they involve. Within this new perspective, the problems of students’ pre-conceptions and conceptual changes are to be replaced by education to a new art and a new life because science will be more than a mere conception of Nature.

The idea of physics as a living-thinking art was indeed already explored within Romanticism.²⁴

Virtual reality physicists like artists, or poets could change our perception of Nature as if it could be a sort of “archivirtual-reality of God”, and we could refer to them what is said in the final words of *The Decay of Lying*:²⁵

²⁴ RITTER (1984).

²⁵ WILDE (1899).

At twilight Nature becomes a wonderfully suggestive effect, and is not without loveliness, though perhaps its chief use is to illustrate quotations from the poets. Come! We have talked long enough.

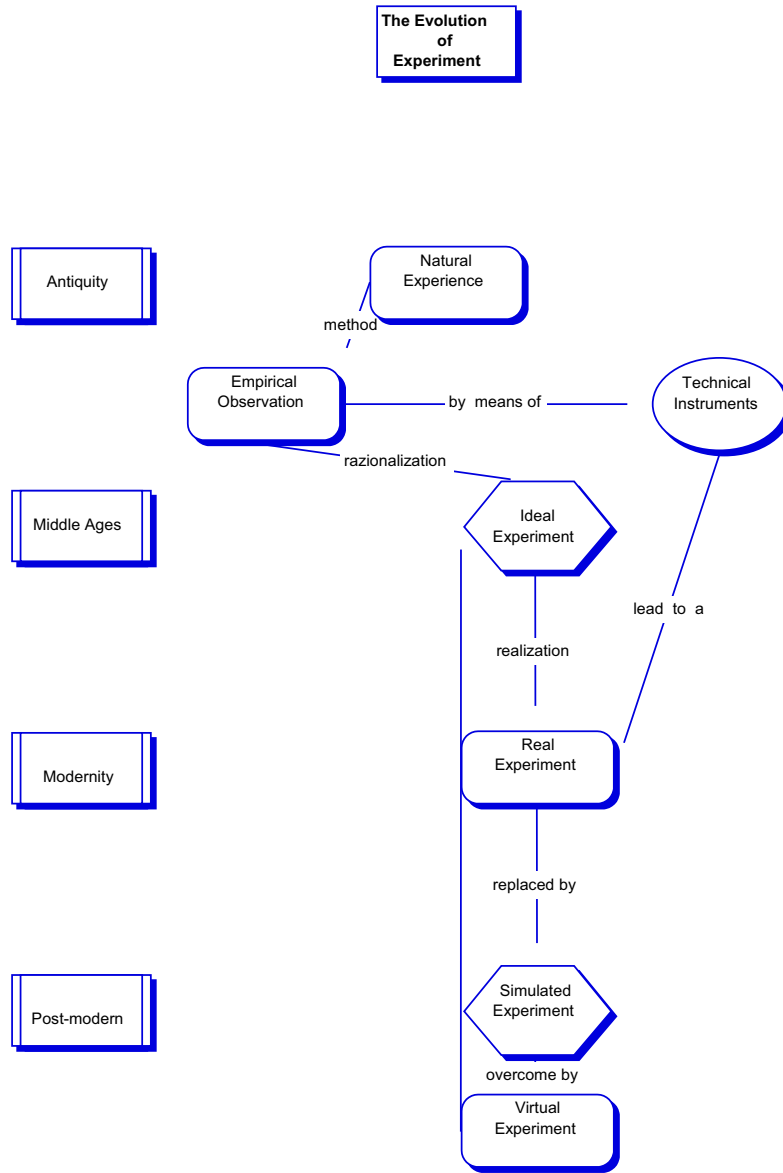


Figure 1

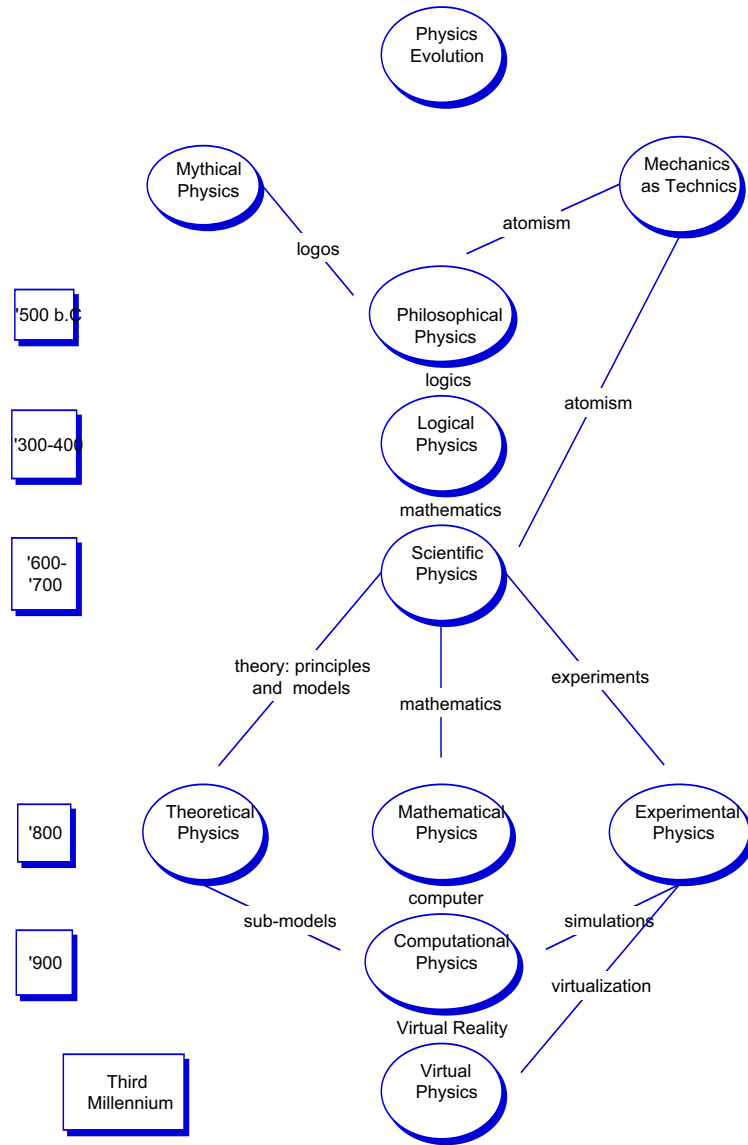


Figure 2

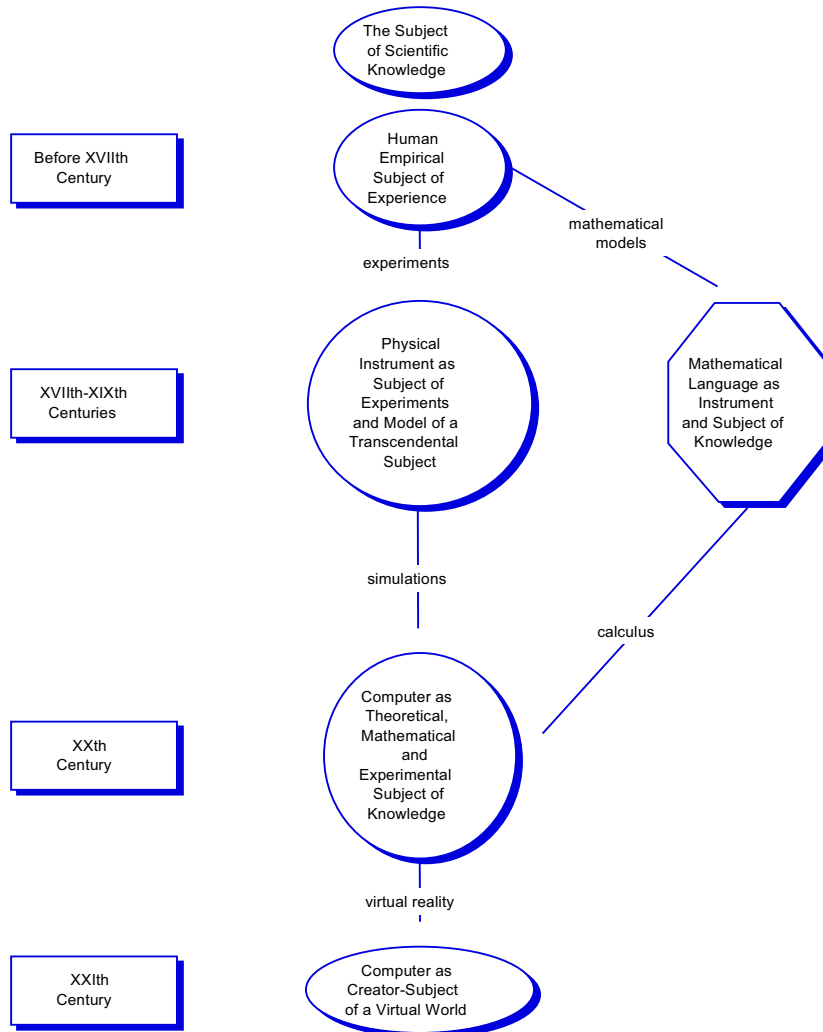


Figure 3

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