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## FIRST SCIENTIFIC REVOLUTION

### GALILEAN RELATIVITY AND NEWTON'S MODEL

Pre-Galilean, Aristotelian Physics considered immobility as steady state of a body experiencing no forces. Under action of force the body was assumed to move at a speed proportional to the force and to return to immobility upon disappearance of the force.

This theory was universally accepted during 2000 years until Galileo discovered that the steady state of a body is not immobility, but uniform movement at constant speed. A body experiencing no forces moves at constant speed in an unchanged Euclidean direction. Galileo called such a body associated with concrete or virtual Observer an "Inertial Referential" (IR). This definition excludes absolute movement of an IR. They all move relatively to one another at constant speeds and none is in any way privileged.

Question arose if concepts and laws describing mechanical phenomena in some IR keep their validity transformed to other IR's and, if they do, then by being invariant or covariant. (A construct is "invariant upon a transformation" when after being transformed it stays unchanged; it is "covariant under transformation" when it undergoes modifications entirely determined by the transformation. This notion of "covariance" should not be confused with "vector covariance" defined in Tome 2.

Within a given model invariant physical constructs are considered as absolute and covariant - as relative.

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Galilean Relativity and Newton's Model are partially based upon an absolute construct, the Galilean SPACE.

Galilean SPACE, in contradiction to the widely spread belief, is 4 dimensional: an event is determined by 1 Time and 3 Space values. It's indeed a TimeSpace, a 4D SPACE encompassing two sub-spaces of our direct perception:

- 1 dimensional Time
- 3 dimensional Euclidean Space.

The confusion attributing "TimeSpace" to Einstein is due to Galilean time and space being incommensurable or affine, while Einstein's 4D continuum is metric "LighttimeSpace" where the Galilean component "time" is replaced by "Lighttime"  $Ct$  having the measure of distance commensurable with the components of Space. (Details in Tome 2).

Incommensurability of Galilean Time and Space excludes the notion of Time-Space interval and, consequently, of a transformation involving the entire Galilean TimeSpace. On the other hand, constancy of speed value and direction among IR's excludes rotation and we are left with two independent translations, one in time and one in space, which accounts for Galilean Relativity being sometimes called "Translational" as opposed to the "Rotational Relativity" of Einstein, which latter term we justify in the chapter "SECOND SCIENTIFIC REVOLUTION".

Let's take two IRs  $R(0,X,Y,Z,T)$  and  $r(o,x,y,z,t)$ , of coordinate origins  $O$  and  $o$ , moving with respect to one another along the common axe  $X-x$  at speed  $V$ .

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Time and space translations from R to r are respectively:

$$t = T; \quad x = X + a + VT; \quad [1]$$

where a is the distance of o from O at  $T = 0$ .

[1] is called the Galilean Transformation. It supports invariant or absolute time and distance, i.e. space.

Indeed, distance DX in R  $DX = X_2 - X_1$ , transforms into Dx in r:

$$Dx = x_2 - x_1 = (X_2 + a + VT) - (X_1 + a + VT) = X_2 - X_1 = DX$$

Intervals of time and space are invariant under the Galilean Transformation, or in epistemological terms,

**GALILEAN TIME AND SPACE ARE ABSOLUTE.**

A Detector moving along X/x at  $u_{Dx}$  with respect to r moves at  $u_{DX} = u_{Dx} + V$  with respect to R:

Speed is additively covariant under Galilean Transformation, which, after a few simple mathematical operations results in the rule:

**MECHANICS ARE COVARIANT UNDER GALILEAN TRANSFORMATION**

Relativity was doubtless Galileo's principal contribution to science. It's rigorous, complete and capable to support most of physics till our days, where it continues to be a valid approximation of low speed Mechanics. Yet, it was not the only one.

Besides Relativity Galileo fostered the deductive/inductive method implying axiomatic falsifiable models in our sense, emerging upon the background of traditional purely deductive, so called "axiomatic" methods,

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whose "axioms" verified exclusively by their "self-evidence" were indeed camouflaged Dogmas.

He restricted inquiry to observable aspects of phenomena, banning speculations about the incognizable transcendental "true nature" which clearly postulates Phenomenology and bans Noumenalism.

Galilean Relativity reached its apogee in Newton's Model. We shall examine it in the light of our fundamental CD polarity (Continuum/Discreteness) and our postulated foundational preponderance of its continuous aspect (chapter "TIME, AWARENESS AND EVENTS").

At the first glance it seems that Newton's model contradicts our continuum preponderance postulate and is founded in discreteness. At Newton's time and for centuries afterwards the fabric of cosmos was dogmatically considered to be corpuscular. Newtonian SPACE was assumed to be compactly filled with corpuscles acting on one another like billiard balls and thus pretending to support mechanics, causality (whatever it could mean) and local action. It's rather amusing to note that with respect to the latter the protagonists of mechanistic dogma overlooked a contradiction: only continuum may admit local action. Granular mechanistic fabric implies action at distance equal to the size of the elementary granule. Now, we don't know anything about the elementary "balls", neither their size, nor their internal structure and behavior. Nobody ever observed them and there are no hints about their basic attributes such as size or mass. They represent an ad hoc "crutch", a hypothetical corpuscular "matter substance",

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introduced in order to formulate a microscopic model based intuitively upon macroscopic billiard. Still, hypothetical or not, this corpuscular "matter" appeared to support reasonably the laws of mechanics.

However, serious difficulties arose with optics. In agreement with the postulate of discrete cosmos, light was mapped as a flow of corpuscles thus introducing an additional ad hoc crutch, a "luminiferous" corpuscular substance. It supported rectilinear progression and reflection of light, as well as refraction (with help of hypothetical interactions between "material" and "luminiferous" substances). In order to account for dispersion, or separation of white light into spectral components, it was necessary to split the "luminiferous" substance into several substances, one per colour, propagating for some reason each at different speed through various "material" substances. One accumulated uncountable ad hoc crutches, all hypothetical and not supported empirically. One grew a habit to add for each new problem some new "substance" which looked more like tautologies than solutions.

Finally, realizing that no conceivable new "substances" could possibly account for such phenomena as diffraction and interference patterns, physicists abandoned the corpuscular theory of light to the advantage of wave theory which, in conjunction with the discrete, billiard-like view of cosmos, ushered in the Aether dogma which dominated Physics till the beginning of the 20th century (see chapter "SECOND SCIENTIFIC REVOLUTION").

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The corpuscular theory fell into oblivion until it apparently resurrected in the Quantum Theory, however at an incomparably higher level of complexity and in a form having nothing to do with rudimentary mechanistic thinking.

Shelving for the moment Optics we shall move to Newton's mechanics. It's based upon 3 laws of motion:

1. In absence of force a body moves at constant speed.
2. Acceleration of a body is directly proportional to force acting on it and inversely to its mass.
3. For every action, there is an equal and opposite reaction.

Let's note that only 2. and 3. are original. 1. is a redefinition of Galilean inertial referentials.

On the other hand, a fundamental concept is missing, that of kinetic energy.

It has been conceived and formulated at age of 16 by Pierrette Paulze-Lavoisier who, astounding as it may seem, fell into almost complete oblivion. Maybe not so astonishing after all: she was a woman; she did not belong to any Academy, none would accept a woman in 17th Century; and married to Lavoisier she was overshadowed by him. Not by his fault. She married him at age of 13 and from the first day became his full-fledged collaborator, which he emphasized at every occasion so that the rare cognoscenti who heard about her call them "Father and Mother of modern Chemistry". But there it is, hardly anybody heard about her.

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Thus, if we consider Newton as founder of modern Physics and perhaps the greatest scientist of history, it's not because of his unconvincing optics, nor of his mechanics, certainly great, but incomplete and amended by a nearly unknown 16 years old girl. His outstanding significance is due to "Gravitation", which we shall further call "Newton's Model".

It boils down to the following Law of Gravitation:

Attracting gravity force between two masses  
 $F(r)=G(m_1*m_2)/r^{**2}$  where G: gravity constant,  
 $m_1, m_2$ : respective masses, r: distance.

Let's return to our basic question: Is Newton's Model continuous or discrete? On the face of it it seems discrete, according to the contemporary mechanistic view of cosmos and to his own explicit statements. However, this assumption leads immediately to paradoxes:

First Paradox: Gravity acts at very large, astronomic distances which contradicts the local action principle of the mechanistic view.

Second Paradox: SPACE (distance) determines the gravity force, while this Force does not act in any way on the SPACE, which contradicts the action/reaction principle.

Both Paradoxes represent facts contradicting dogmas of SPACE being absolute and mechanistic. Questioned about it Newton answered with the famous "hypotheses non fingo" clearly implying that science carries out experiments and orders their results, but does not deal with transcendencies.

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He stopped short of converting mechanistic dogmas to axioms and, once falsified, to drop and replace them. He did not dare to do it under the pressure of his contemporary dogmatism, but clearly distanced himself from them. Closer to us, questioned about founding problems of Quantum Theory, Dirac reiterated Newton's answer in cruder terms: "Shut up and calculate!".

With "hypotheses non fingo" Newton rather clearly formulated what we shall call the Principle of Preponderance of Facts, stating that in case of conflict between facts and abstractions, the latter should be adjusted if possible to fit the former or, else, disregarded.

The First Paradox, Action at Distance in a Discrete Model, is not just a contradictory detail, but an essential inconsistency which casts doubt upon the very base of the Model. Consequently, question arises if Newton's Model was not de facto continuous, perhaps implicitly, against author's own explicit belief in the universally accepted discrete fabric of cosmos.

Indeed, taking the formula of gravitational Force:  $F(r)=G(m_1*m_2)/r^{**2}$ , we may combine  $G*m_1/r^{**2}$  into  $g(r)=G*m_1/r^{**2}$  and define "g(r)" as "Gravity Field in any point r of SPACE.

Then,  $F(r)=g(r)*m_2$  and replacing  $m_2$  with detector of mass  $m_2=1$ , we get  $F(r)=g(r)$  - gravity force exerced by field g(r) on a unit mass in every point r of SPACE.

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Once we replace corpuscles acting paradoxically at distance, with continuous field acting locally in all points of SPACE, Newton's Model becomes continuous as well as consistent with local action and causality; a pertinent foundation of modern Physics, precursor of Einstein's Relativity and of the Quantum Field Theory.

In this perspective, the Second Paradox involves Field rather than Force. Indeed, SPACE being a continuum and force a point event, the original version of the second Paradox is not paradoxical but simply meaningless. On the contrary, both field and SPACE being continua, SPACE determining Field without reciprocal reaction becomes a meaningful albeit yet unsolved inconsistency. It has been finally solved by the General Relativity (see chapter "SECOND SCIENTIFIC REVOLUTION").

Finally, let's recall that a major part in the acceptance of Newton's ideas was due to Euler's re-writing of his entire family of ideas in the language of calculus, which Newton had done so much to invent but largely left out of the Principia.

And who says calculus, means continuity. This argument seals our conviction that Newton's Model was, at least implicitly, the first pioneering continuity based field model which founded and determined the subsequent progress of physics till our own days.

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DESCARTES

Addressing the logical positivists of the Vienna Circle Popper said:

"The empirical basis of objective science is  
\*nothing absolute.\* [1]  
Science does not rest on a rockbed. Its towering  
edifice, an amazingly bold structure of theories  
rises over a swamp. The foundations are piers  
going down into the swamp from above. [2]  
They do not reach a natural base, but go only as  
deep as is necessary to carry the structure. One  
does not stop driving them down because one has  
reached firm ground. Rather, one resolves to be  
satisfied with their firmness, hoping they will  
carry the structure. [3]  
(If the structure proves too heavy and begins  
tottering, it sometimes does not help to drive  
the piers further down. It may be necessary  
to have a new building, which must be  
constructed on the ruins of the collapsed  
structure's piers.) [4]  
\*The objectivity of science can be bought only  
at the cost of relativity.\* (He who seeks the  
absolute must seek it in the subjective.)" [5]

This vade mecum of current rational Epistemology  
could have been written by Descartes:

[1] and [5] are compatible with Galilean  
Relativity armed by Descartes with exact  
mathematical tools: Cartesian Referentials and  
Analytic Geometry which founded calculus and  
most of modern science.

[5] is entirely contained in "Cogito ergo Sum",  
which turned upside down all traditional beliefs  
in transcendental "objective reality" and  
established the preponderance of subjectivity

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in cognition and science. (see "COGITO" below).

[2],[3] and [4] illustrate rational deductive/inductive axiomatization such as it has been conceived by Galileo and completed with Cartesian Doubt or Uncertainty.

Ergo, standing on the shoulders of Galileo, Descartes simply created the concept and the methodology of modern science founding all subsequent rational Epistemology holding till our own days.

Unfortunately, rationality is far from dominating our thinking. First Enlightenment did not entirely eradicate its contemporary dogmatism and soon collapsed under its reactionary assaults. The reaction of Dogmatism went on uninterrupted till our epoch which is dominated by aggressive dogmatic obscurantism out of which try timidly to emerge the cornerstones of Second Enlightenment. (see the chapter "SECOND SCIENTIFIC REVOLUTION").

## COGITO

Descartes' main epistemological concept was that of permanent doubt as source of inquiry, which completed Galileo's axiomatization with uncertainty. When I think about something I sense, perceive, hear, read or infer, I find that it is uncertain. I doubt it and in this doubt find the motivation to clarify it, to inquire. Yet, however uncertain this inquiry, it reposes upon a certain bedrock, I am certain at least that I doubt.

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The adage "Cogito ergo Sum", is a simple corollary of Permanent Doubt, expressed in a concise form meant to serve as motto of the subjective, doubt based epistemology and not to be taken at face value.

He who insists to build an ontological discourse upon the motto "I think ergo I am", should remember that empty copula does not predicate anything, unless tacitly assumed. "John is" does not mean anything, but if you ask "who is tall?", the answer "John is" means "John is (tall)". Tacitly assuming Descartes' epistemology, the apparently meaningless "I think ergo I am" takes on the meaning "I think ergo I am (certain of it)". In other terms, thinking being thematic, I doubt its theme, but am certain of thinking itself.

Insistence to construct and to argue pseudo-cartesian ontologies upon the empty copula of Cogito produced the biggest heap of nonsense equaled only by taking at face value Plato's Allegory of the Cave.

Shelving the metaphysical nonsense and returning to epistemology we see Cogito as motto of rational inference, based on primacy of subjective aspect of observation over the objective, eradicating traditional beliefs in transcendental "objective reality" and remolding Science by founding it in subjectivity.