Mathematicians who can't tell time

Lyndon H. LaRouche, Jr. responds to an inquiry from a reader on a matter of science, regarding Stephen Hawking's discussion of "The Arrow of Time."

May 10, 1997

It was inevitable, and proper, that a relatively minor, but still significant portion of the material published by ***EIR*** has been composed in response to one or more prompting inquiries from among our readers. Such queries frequently announce themselves in the form of "What does ***EIR*** [or Contributing Editor LaRouche] have to say about . . . ?" It is my custom to accumulate such questions directed to me, by the topic to which they belong, and to include a published, blanket response to such batched inquiries in some appropriate setting.

Typical of such incoming communication, is the suggestion, in this case, from some European readers, that the present writer comment upon Chapter 9 from Stephen W. Hawking's 1988 book, ***A Brief History of Time.***[1] That chapter is entitled, "The Arrow of Time"; the response supplied here is focussed upon that chapter.

From my experience with queries and comments from our readers, I anticipate questions along the line: "Why publish a reply on that sophisticated topic of physical science, in this location?" I respond here with a few relevant prefatory observations.

First of all, as the reader will discover, in the course of this report, the issue of time is addressed here as it occupies a crucial place in designing effective economic policies of both manufacturing or other productive enterprises, and of nations.[2] It is the relevance of Hawking's errors to that context, which is the context for this response; but, this intersects a more urgent, general consideration.

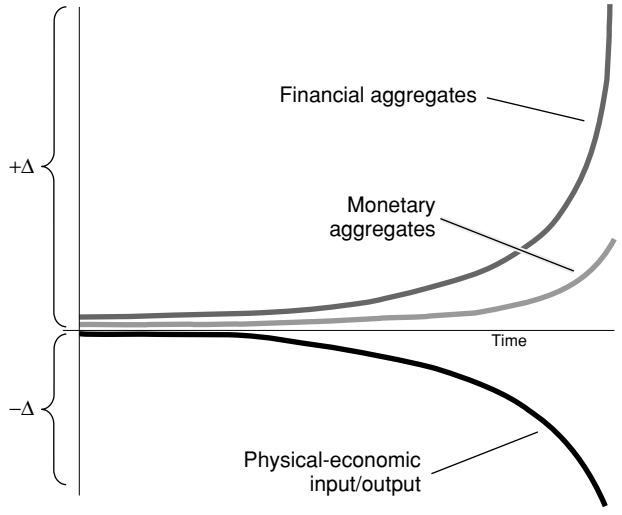
The relevant setting for the appearance of this present article, is the fact, that the entire planet is now gripped by the end-phase of the worst financial and economic crisis in all of modern history. What ***EIR*** has featured as the "Triple Curve" description of the relevant functional relations among finance, monetary processes, and physical economy (see **Figure 1**) depicts the present situation as "asymptotically" converging upon a self-generated boundary condition of the present international financial-monetary-economic system as a whole. The depicted relations among the three curves, have entered the phase in which the steepness of the hyperbolic interrelations among them, is accelerating rapidly. This defines a discontinuity, to such effect, that we must say: "Irrespective of such relatively trivial questions, as 'When does the bust come?,' we can only say two things with absolute certainty: 1) This system can not be saved by any means; 2) The end of the system will come soon, either because we put a ruined international financial-monetary system into government-supervised bankruptcy-reorganization, or, the otherwise inevitable disintegration of the financial-monetary system plunges the economies of the planet into something much worse than a terrible world-wide depression, a prolonged 'new dark age.' "

This means, that either we act willfully to make a sudden leap from the existing international financial-monetary system, into an axiomatically new kind of global economic order among sovereign nation-states, or civilization as we have known it will disappear during the near future, perhaps not to

1. Stephen W. Hawking, ***A Brief History of Time: From the Big Bang to Black Holes,*** with Introduction by Carl Sagan (New York: Bantam Books, 1988).

2. Compare Lyndon H. LaRouche, Jr.'s "Kenneth Arrow Runs Out of Ideas, But Not Words," ***21st Century Science & Technology,*** Fall 1995, with the same author's references to Arrow's remarks on today's Russian economy, "More Nobel Lies," ***Executive Intelligence Review,*** May 31, 1996; pp. 35-36. See, also, Lyndon H. LaRouche, Jr., "The Essential Role of 'Time-Reversal' in Mathematical Economics," ***Executive Intelligence Review,*** Oct. 11, 1996.

FIGURE 1
A typical collapse function



The "triple curve" is a schematic summary of the current process of monetary and financial disintegration of the world economy. While financial and monetary aggregates are growing at hyperbolic rates, the income streams to sustain their growth are diverted from the physical economy, which is collapsing at a corresponding rate.

reappear for two or more awful generations to come. In the domain of physics, the analogous alternative kind of axiomatic change in system which the world is about to undergo, during the months ahead, is associated with a Riemannian shift from a geometry of "n dimensions," to either one of "n+1," or "n–1" dimensions. This defines the policy questions immediately before us, as of a qualitatively different type than any living economist, or statesman, excepting, apparently, the present writer, has been prepared to comprehend, until this time.

Under those very special, present historical circumstances, it is urgent that the present writer share his knowledge of all among those kinds of conceptions which are specifically relevant to successfully addressing the crisis before us all. It is no fault, that these ideas are largely unfamiliar to even most specialists; rather, the unfamiliarity lies in the historically unprecedented character of the crisis now gripping the planet. While the fact that an idea is unfamiliar, is not necessarily a virtue, under this circumstance, any idea worth considering, must tend to be more or less unfamiliar even to relevant specialists. The urgent need is, to make these conceptions familiar, to as many influential circles as possible, in the quickest possible time. The future existence of your posterity, might depend upon exactly that.

Such things are written, not to the purpose of appealing to your presently established prejudices, but to assist you in freeing yourselves from those shackles of prejudice which bind you fatally to a sinking ship, that new British *Titanic,* which is the present international financial-monetary system.

That said, turn to the referenced chapter of Hawking's book. Is the celebrated Professor Hawking competent on the subject of the place of time within physics? No. Are his views worth reading? Does a good police detective consider gruesome evidence bearing on a homicide worth studying?

My response focusses upon the indicated, most immediately relevant portion of Hawking's book. I address the matter in two successive phases. First, I cite and comment upon the clinical significance of each among a relevant selection of remarks found within that chapter. After that, I identify the relevant solution to the problem, which Hawking (1988) had completely missed.

Contemporary brutish 'science'

For this occasion, we must rise, once again, above the banality of formalism, to the higher domain of Leibniz's *Analysis Situs;* we must reference those ordering principles which govern the way in which Hawking was induced, even if without an accompanying conscious intent, to adopt that selection of fallacious, axiomatic assumptions, the which underlies his argument. Hawking is himself a case-study for *Analysis Situs:* To understand where his thoughts swim, we must recognize the boundaries of that fishbowl of contemporary, British radical empiricism, within which they are confined.

Some years ago, Hollywood produced a feature entertainment, ostensibly suited for a pre-adolescent audience, which was entitled ***The Planet of the Apes.*** It came across as an attempted parody of the second most popular, after "Lilliput," among Jonathan Swift's ***Gulliver's Travels,*** the chapter presenting the fabled land where lordly horses' posteriors liberally overshadowed the local Yahoos. This chapter, like all of ***Gulliver's Travels,*** was written as an allegorical representation of the actual mental, moral, and physical degeneracy, the which took over the population of England, during the decades immediately following the 1714 accession of King George I to the newly created throne of the British Empire. That is also the condition to which the population of England has been degraded once more, as the British Mont Pelerin Society's pestilence of Thatcherism has corrupted the present generations of the descendants of the early Eighteenth-Century Yahoos and their masters, alike.

To locate the context of Stephen Hawking's opinions in the most direct and efficient manner, one should narrow the focus of attention, by turning to another chapter of Swift's book, where the mental life of the British intellectuals, now, as then, is cartooned. Swift's chapter devoted to the fictive, floating island of Laputa, is recognizable as real-life Cambridge and Oxford. The merry old brutish intellectual tradition, so identified, points directly toward the heart of the issues posed by Hawking's argument on the subject of "Time's Arrow."

Indeed, the only way in which to understand the present-day antics of Her Majesty's household and subjects, is to begin with a mind refreshed by those insights into the forebears of these present-day unfortunates, as provided by ears of Swift and eyes of Hogarth. It were feasible to present a

From the series "A Rake's Progress," by William Hogarth, 1763. The scene shows mad scientists and other inmates at Bethlehem Hospital, known as Bedlam. "The only way in which to understand the present-day antics of Her Majesty's household and subjects," writes LaRouche, "is to begin with a mind refreshed by those insights into the forebears of these present-day unfortunates, as provided by ears of Swift and eyes of Hogarth."

devastating factual case against the crucial features of Hawking's argument in its own academic terms. However, that approach would overlook the essential point; by situating the facts within the axiomatic framework of his argument, we would be implicitly accepting his "geometry" as the domain in which our refutation were also situated. Thus, we would entrap our evidence within the same mental cage which confines the mind of Stephen Hawking, locked behind the grillwork of his axiomatically positivist delusions.

Now, to the chapter in question. In the second paragraph of the chapter, Hawking writes: "Up to the beginning of this century people believed in an absolute time. That is, each event could be labelled by a number called 'time' in a unique way, and all good clocks would agree on the time interval between two events. . . ." That statement of his, is false.

In this instance, as for all of his statements we reference here, Hawking's critic must allow for the very practical problem, that on matters of punctuation and other counts, the English prose style approved by Hawking's editor, is a long way down the evolutionary scale from Shakespeare. The relevant point for our purposes here, is, that, by this choice of style, he renders himself unable, or perhaps merely unwilling, to use those literate forms of the English language, as typified by Shakespeare's style, by means of which we construct those metaphors essential to communicating what the poet Shelley identified as "profound and impassioned ideas respecting man and nature." Shelley's category includes all of the discoveries of principle existing within the domain of physical science.

Thus, the critic and reader must be cautioned: even in the case Hawking's intention is to supply a true statement, his prose style is so banal, that its representation of certain important classes of ideas is ambiguous, at best. On this account, it may be fairly said, that the cognitive sterility of Hawking's prose style qualifies him as among the "John Drydens" of contemporary British mathematics. That literary sterility, should be recognized by us as an indication of the species-characteristics his choice of prose style imposes upon his utterances as a whole.[3]

However, in the instance under consideration here, even on that impaired level of cognition for which his prose style is best suited, Hawking's statement is plainly untruthful propaganda. The fraud in his statement, in this instance, marks him as a follower of the clock-work hoaxster, Bertrand Russell.

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3. In nothing we write here, do we deviate from compassion respecting Professor Hawking's physical afflictions, nor from our personal admiration of the manner in which he has responded to that challenge. The faults on which we focus here, are plainly rooted in the induced mental habits acquired during earlier years of his life. It is the academic disease of empiricism, not the person, on which the present denunciation is focussed. As to the matter of prose style, the immediate issue at this point, see the writer's treatment of the subject of metaphor, and of the influence of Enlightenment traditions for banning it, and the rigorous use of the subjunctive mood, from the English language, since Francis Bacon and Thomas Hobbes. The same principle of metaphor is the character of all representation of a validatable discovery of principle, in both natural science, and in Classical art-forms. To eliminate it from English prose style is to prevent any intelligible discussion of principle, and to degrade mathematics and language to a relatively sterile, mere describing of appearances.

Contrary to Hawking's indefensible assertion, he knows that the relativity of time is an ancient conception, already known to Classical Greek science.[4] He knows, that the most modern notion of such relativity, dates from Bernhard Riemann's 1854 habilitation dissertation, "On the Hypotheses Which Underlie Geometry."[5] In defiance of those facts, Hawking defers to Russell's widely circulated hoax on that subject. He writes: "Thus time became a more personal concept, relative to the observer who measured it," a close paraphrase of Russell's argument. The significance of his falsifying the dating of "relativity of time," is reflected, in an ironical way, in his next paragraph: "When one tried to unify gravity with quantum mechanics, one had to introduce the idea of 'imaginary' time. Imaginary time is indistinguishable from directions in space." His misuse of "imaginary" impels our attention to the pioneering, Nineteenth-Century work of Carl Gauss, Wilhelm Weber, and Bernhard Riemann.

It must be stressed: Hawking simply lies, when he attempts to lure the credulous into the opinion, that the relativistic idea of "time" appeared first during the Twentieth Century. By virtue of his stipulated educational background, he knows, if only as a simple matter of historical fact, that Riemann was the first, in 1854, to free the notions of "space" and "time" from their Euclidean, aprioristic basis, and to relocate them among all validated principles of experimental physics, as dimensions of an expandable physical-space-time of "n dimensions."

In the real universe, outside Hawking's virtual reality, Riemann derived his discovery from, chiefly, the preceding work of Carl Gauss, on the related matters of biquadratic residues and generalized notion of curvature. There, in that work of Gauss and Riemann, we meet the reality which the "ivory tower" sort of mathematician mistakes for the apparently "imaginary" quality of relativistic time. Hawking refuses to comprehend the significance of the fact, that Gauss and Riemann removed the notion of "Time" entirely from the domain of aprioristic axiomatic assumptions, and resituated it, as a validatable physical principle of the experimental domain of physical space-time.[6] Thereafter, the schoolboy notions of aprioristic time-by-itself and space-by-itself, must be replaced by new roles for time and space, as interacting dimensions of an "n-dimensional," physical-space-time geometry. In this new geometry, the measurement of these qualities is represented, through the relative "curvature" of physical space-time resulting from the interaction among all such dimensions (physical principles). Of these implications, Hawking at least pretends to be unaware.[7]

Immediately following that faulted utterance, Hawking's argument collapses into a run-on, irrational rant: "Imaginary time is indistinguishable from directions in space [which a competent physicist would consider a barely tolerable, but all too ambiguous statement]." After that next sentence, Hawking's thoughts race wildly: "If one can go north, one can turn around and head south; equally, if one can go forward in imaginary time, one ought to be able to turn round and go backward. This means that there can be no important difference between forward and backward directions of imaginary time." *Whew! What a rush of sophistry!*

In the succeeding paragraph, Hawking runs on: "The laws of science do not distinguish between the past and the future." What "laws"? Whose "laws"? Whose "science"? To the extent there is the appearance of intelligible utterance in any of his argument along these lines, it is all untrue. Matters go from bad to worse; "Jonah" Hawking swallows the whale.

He aggravates his error: "More precisely . . . the laws of

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4. Lyndon H. LaRouche, Jr., "Toward China's 21st Century Economy," ***Executive Intelligence Review,*** May 16, 1997; under the sub-head, "The Horizon," pp. 27-29.

5. Bernhard Riemann, *Über die Hypothesen, welche der Geometrie zu Grunde liegen,* ***Bernhard Riemanns gesammelte mathematische Werke,*** H. Weber, ed. (New York: Dover Publications reprint, 1953).

6. The relativistic character of physical space-time was already implicit in Leonardo da Vinci's treatments of the finite propagation of sound, and related treatments of what we recognize, since Riemann's work, as retarded potential for propagation in radiation of light. This method, including the method which Leibniz identified by "*Analysis Situs,*" was at the center of the founding of the first comprehensive mathematical physics, by Johannes Kepler. It came to the surface in Christiaan Huyghens' exploration of isochronicity in the gravitational field. Ole Rømer's measurement of a finite rate of propagation of light in the Solar System, and Huyghens' response to that discovery, led into the demonstration of coherence, by Leibniz and Jean Bernouilli, between isochronicity both in the gravitational field and underlying the refraction of light. The successive work of Ampère, Gauss, Wilhelm Weber, and Riemann on electrodynamics, represented the more or less inevitable advance upon the preceding work of da Vinci, Kepler, Huyghens, Leibniz, et al. The notion that the idea of a "relativistic" notion of coherence among notions of time, space, gravitation, and retarded-potential rates of propagation of light and gravitation, were a sudden, charismatic revelation erupting at the beginning of the Twentieth Century, is strictly anti-historical, anti-scientific, "tooth fairy" stuff.

7. The high priests of British late-Nineteenth-Century and Twentieth-Century opinion about science, included Lord Kelvin's German agents, such as Rudolf Clausius, Hermann Grassmann, and Herman Helmholtz, in addition to James Clerk Maxwell, Lord Rayleigh, and Bertrand Russell. (The great Rutherford was a notable exception.) The common distinction of all of these agents of the British ideological standpoint, is their enmity against not only Gottfried Leibniz, but also against the roles of the central figures of Nineteenth-Century science, Carl F. Gauss, Wilhelm Weber, and Bernhard Riemann. Maxwell plagiarized more than generously from the founding work in electrodynamics, that of Ampère, Gauss, Weber, and Riemann; Maxwell not merely confessed, but bragged, that he had omitted from the work of those predecessors, all of that physics which corresponded to "geometries other than our own." His suppression of the reality of the Ampère-Weber "angular force" from his electrodynamics, for example, crippled scientific progress during the present century to date. [Cf. Laurence Hecht, "The Significance of the 1845 Gauss-Weber Correspondence," ***21st Century Science & Technology,*** Fall 1996; Dr. Remi Saumont, "The Battle Over the Laws of Electrodynamics," and Jonathan Tennenbaum, "Demonstrating Gauss and Weber's Magnetometer," ***21st Century Science & Technology,*** Spring 1997.] The entirety of Bertrand Russell's temporary, quarter-century career in science, until about 1927, was premised upon his stated intent to destroy the influence of Leibniz, Gauss, Weber, and Riemann. Thus, the mere fact that a British ideologue pretends to be ignorant of relevant work of Leibniz, Gauss, et al., may signify that that writer is merely pretending not to know that that undesired reality exists.

science are unchanged under the combination of operations (or symmetries) known as C, P, and T. (C meaning changing particles for antiparticles. P means taking the mirror image, so left and right are interchanged. And T means reversing the direction of motion of all particles: in effect, running the motion backward.)" *Mécanique céleste!* Hawking has invoked precepts of radical positivism, which are admittedly popular in his Laputan precincts, but nonetheless absurd. The Nazis imposed the same sophistry employed here by Hawking; the Nazis called it *Gleichschaltung*;[8] these days, their liberal imitators from the contemporary academic world prefer to roll the eyes upward, in unctuous repetition of the mantra: "generally accepted classroom mathematics."

Thus far, our scan has touched upon two leading clusters of axiomatic flaws in Hawking's account. The first cluster, respecting the notion of "imaginary time." The second, in the discussion of ordering-principles affecting "C, P, and T," and backwards-forwards in time, his denial of the existence of what Leibniz identified as problems of "*Analysis Situs*": the denial that any special ordering-principles beyond the comprehension of ordinary mathematical formalism, need be considered for these cases. Later, here, we shall consider two additional principal sets of blunders by Hawking, before turning to a general refutation of his argument. These additional topics will be, first, the popularized, false notion of "entropy" as "time's arrow," and, second, his hysterical misrepresentation of what he terms a "psychological arrow of time." For pedagogical reasons, it were better to get some of the problems of "imaginary time" and "time's arrow" under control now, that we might focus with better resolution upon the latter two of the four identified topics.

From Eratosthenes through Riemann

Focus upon Hawking's cited use of the term "imaginary time." Challenge the would-be defender of Hawking's observations, to show how the issue of the continued, pathological use of the term "imaginary," among mathematicians and misinformed laymen, bears upon B. Riemann's ridding mathematics of those merely aprioristic notions of space and time met in the work of René Descartes, Isaac Newton, et al. Turn to the matter of the difference between the earlier, crude use of the term "imaginary numbers," to identify roots of negative numbers, and the scientific notion of the origin of such roots, as the latter emerged from Carl Gauss's step-wise development of the principles of higher mathematics, in his ***Disquisitiones Arithmeticae.***[9]

To this effect: Consider the physical significance of such "imaginary" magnitudes which Gauss located later within the domain of experimental physics, as in his own discoveries in astrophysics, geodesy, and electrodynamics. Trace this, thus, with respect to the practical significance of biquadratic residues and curvature, in the experimental domain of physical space-time generally. Situate Riemann's original discovery of relativistic physical-space-time, as Riemann himself did, with respect to these contributions by Gauss.

As the known history of ideas goes, the principle involved is as old as Pythagoras' work, and is a central feature of the mathematics work of Plato and such collaborators as Theaetetus and Eudoxus. Both the notion of incommensurables in general, as implicit in Pythagoras' most famous theorem, and the notion of curvature which such students of Nikolaus of Cusa as Luca Pacioli, Leonardo da Vinci, and Johannes Kepler, associated with reconstructions of Theaetetus' proof for the uniqueness of the five Platonic solids.[10] These are exemplary of the heritage leading through Nikolaus of Cusa,[11] Johannes Kepler, and Gottfried Leibniz, leading into the development of non-Euclidean relativistic geometries by Gauss and Riemann.[12] One of the most conveniently elementary classroom illustrations of the principle of physical space-time comes from a member of Plato's Academy at Athens, Eratosthenes, during the Third Century B.C.

From a pedagogical standpoint, the simplest case for demonstrating the principle underlying the experimental-physical significance of "imaginary" for relativity, is Eratosthenes' astrophysical measurement of the curvature of the Earth along the meridian (see **Figure 2**).[13] If one placed hemispherical sundials at appropriate intervals along a measured distance, from Syene (Aswan) in Egypt, northward, along the astrophysical line of the meridian, into Alexandria, and did so

8. e.g., "brought into line." A currently popular English-language synonym, is "political correctness." In U.S. tradition, this was a commonplace form of lying one's head off, known as "company manners."

9. Completed 1799. Published (Leipzig: 1801). The publication of this work won Gauss immediate recognition and honors throughout Europe. To this day, almost two centuries later, it remains unique in its competence as the basis for secondary and higher education programs intended to bring the student into the realm of higher mathematics. Although Gauss himself preferred to hide his youthful priority, as an adolescent, in discovering an actually non-Euclidean geometry, if we look backward through the entirety of Gauss's life's work, from the standpoint of Riemann's 1854 habilitation dissertation, it should be transparent, that the ***Disquisitiones*** already reflects, indelibly, the principles of that non-Euclidean geometry.

10. The notion of a physical-space-time curvature, of a bounding of the mathematical domain, external to a formal mathematics as such, is the basis for Leibniz's interdependent notions of *Analysis Situs,* "necessary and sufficient reason," and "universal characteristics."

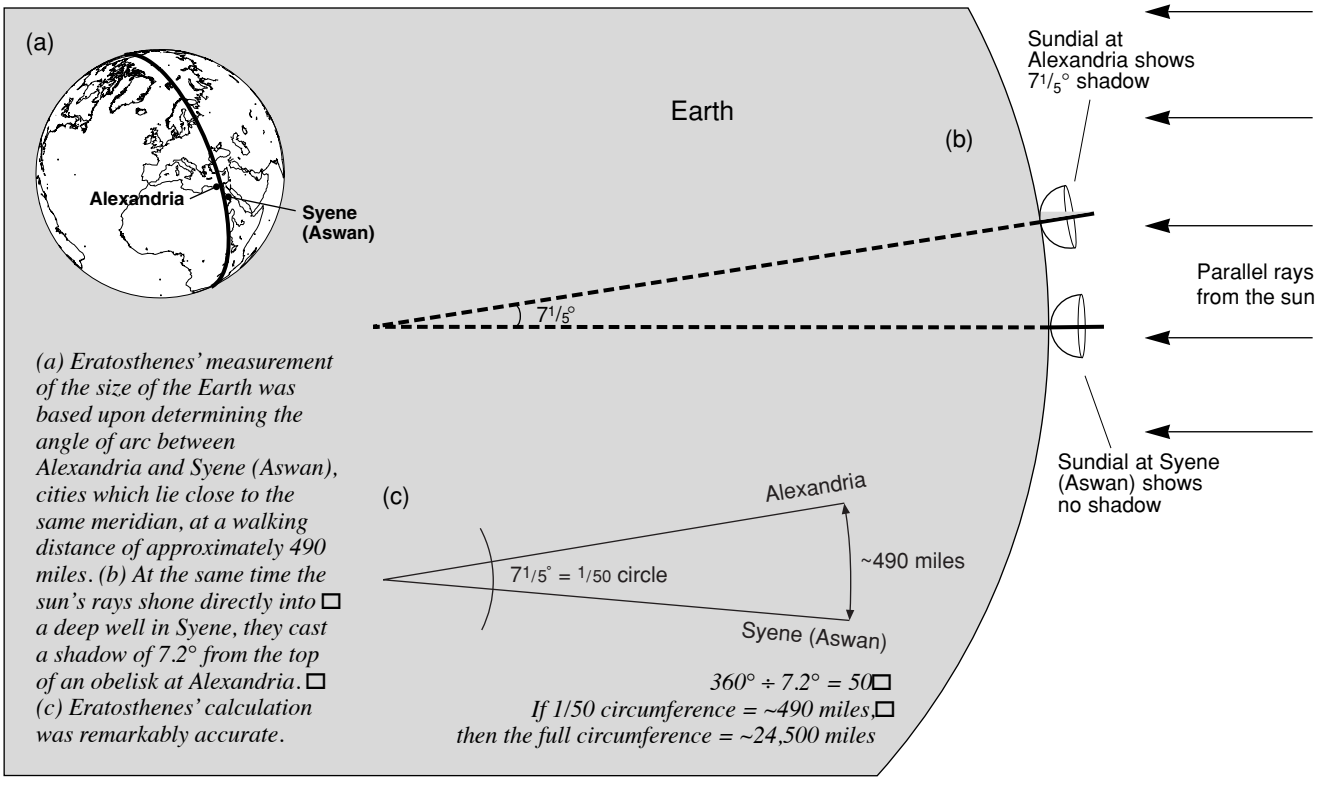
11. The history of the notion of what we recognize as transcendental functions, begins with Nikolaus of Cusa's correction of an oversight in Archimedes' quadrature of the circle (e.g., ***De docta ignorantia,*** 1440). Cusa was the first to recognize the existence of "transcendentals" as a distinct type of "incommensurables." See Lyndon H. LaRouche, Jr., "On the Subject of Metaphor," ***Fidelio,*** Fall 1992. Gauss's exposure of the experimental-physical basis for the "complex domain," through his treatment of biquadratic residues, eliminated the gnostic mystification commonly associated, still today, with classroom glosses on the "Argand diagram."

12. The non-Euclidean geometries of Gauss and Riemann are better described as "non-Euclidean *physical* geometries," to distinguish them from the interesting, better termed "neo-Euclidean" formal geometries of Lobatchevsky and Bolyai. The former are derived from the experimental method; the latter from formal considerations internal to pre-existing mathematics.

13. Figure is from Lyndon H. LaRouche, Jr., "Non-Newtonian Mathematics for Economists," ***Executive Intelligence Review,*** August 11, 1995, p. 20.

FIGURE 2

Eratosthenes' meaurement of the size of the Earth



(a) Eratosthenes' measurement of the size of the Earth was based upon determining the angle of arc between Alexandria and Syene (Aswan), cities which lie close to the same meridian, at a walking distance of approximately 490 miles. (b) At the same time the sun's rays shone directly into a deep well in Syene, they cast a shadow of 7.2° from the top of an obelisk at Alexandria. (c) Eratosthenes' calculation was remarkably accurate.

with the intent of disproving the assumption that the Earth's surface were simply two-dimensional, the evidence produced by the sundials would disabuse one of the notion being tested. The comparison of the discrepancy among the noonday shadows cast by the sundials' pins, shows that only the consideration of a third, "imaginary" dimension to the Earth's surface, giving the planet's surface an approximately spherical character, corresponds to the experimental evidence. In the design of that experiment, that third dimension first appears as a Platonic *idea,* representing a definite magnitude, the kind of ideas which empiricists, and kindred types, prefer to relegate to the domain of the "imaginary."

Gauss's applications of the implications of biquadratic residues, to reconstructing the orbits of asteroids, to problems of geodesy, and to sundry investigations into geomagnetism and electrodynamics generally, represent a continuation of the methods of experimental discovery traced through Plato and his Academy. The "angular force," whose exploration by Gauss's and Riemann's collaborator, Wilhelm Weber, first opened up the domain of microphysics on the atomic and subatomic scale, during the middle of the Nineteenth Century,[14] is an example of the importance of this method, relative to the referenced point of hysterical fraud (directed against the preceding work of Ampère, Gauss, Weber, Riemann) in the work of Maxwell, Bertrand Russell, et al.

We are considering, as the relevant issue immediately at hand: What is the demonstrable nature of the distinction between the kind of unproven, aprioristic notion of "time," which we associate with Euclidean geometry, or with the opinions of Descartes and Newton, as opposed to experimentally-based fact of what formalists misname "imaginary time"? The latter is a notion which had been forced upon science, earlier, by methods associated with the successive experimental discoveries of Huyghens, Leibniz, Bernouilli, Gauss, and Riemann. Compactly stated, the principle involved in defining an experimental-physical notion of "imaginary," as distinct from the unproven, aprioristically axiomatic conceit, follows from the notion of *hypothesis* central to Plato's Socratic method, and to the establishment of the methodological foundations of modern science by Plato, Theaetetus, Eudoxus, Archimedes, Eratosthenes, Cusa, et al. The argument goes as follows.

By means of Plato's Socratic method, one might adduce the underlying set of definitions, axioms, and postulates associated with the geometry of Euclid. These elements would have been sought out, by Socratic method, as the presumptions which must implicitly exist, as preconditions of belief in support of demonstrable propositions in a geometry based upon construction. The common set of such adduced pre-

14. Hecht, Saumont, Tennenbaum, op. cit.

sumptions is represented by the relevant definitions, axioms, and postulates. That common set is named an "hypothesis." Any proposition which is experimentally constructable, and which is not inconsistent with any of the constituent set of elements of the relevant hypothesis, is denoted as a "theorem" of that system. All the potentially statable propositions which might satisfy those requirements, constitute, in aggregation, a deductive "theorem-lattice."

With that, the fun begins.

From the point in the process, that such an hypothesis is established for belief, each relevant type of event is examined implicitly in a two-fold way. First, according to presumptions of belief which govern the way in which we identify an apparent occurrence as "believably existent," or not. Second, we compare the proposition, that the occurrence is "believably existent," with the relevant hypothesis, such as the hypothesis underlying a deductive formal geometry. In the case, that both the hypothesis and the occurrence are equally believable, but that no proposition associated with the occurrence could qualify as a theorem of the reigning hypothesis, our minds are confronted with a devastating sort of paradox, an ontological paradox of the same type associated with Plato's ***Parmenides.*** This is the type of paradox which is otherwise known in Classical art-forms as a metaphor.

This notion is at the center of the method of physical science,[15] and is also the characteristic of the method of composition known as "Classical" in the domains of poetry, music, tragedy, and plastic art-forms. The method involved, is at the center of those notions of a non-Euclidean physical-space-time recalled by Hawking's errors for our reconsideration here. Therefore, a brief restatement, for emphasis and clarity, is now interpolated.

We are situating the generation of scientific ideas in those cases in which a true paradox of the indicated form appears. In Classical art-forms, the same cognitive type of paradox assumes the guise of *metaphor*. In the latter instances, the use of metaphor is imposed upon the author, or composer, by the fact, that a reality exists for which existing language (e.g., such as a mathematics) has made no explicit provision. This difficulty may be circumvented, by juxtaposing two respectively established, but mutually irreconcilable kinds of representations, thus presenting a metaphor. The required resolution of the paradox, so explicitly described, forces the cognitive powers of the mind to resolve that riddle. The successful solution is supplied by the cognitive powers of the mind, adding a previously non-existent idea to the array of explicit references available to users of that language. The metaphor thereafter becomes a recognizable name for that new idea added to the language's repertoire.

In both experimental physical science, and in Classical art, the underlying mental processes involved are identical. The principles for Classical education established by Friedrich Schiller, are thus to be seen as representing something essential to the fostering of physical-scientific competence. Without a mastery of the Classical art-forms, to such effect that the student is forced to recognize the character of the underlying processes common to Classical art and scientific discovery, the future scientist will suffer a crippling kind of cognitive illiteracy respecting the existence of a principle of scientific discovery. Riemann's 1854 dissertation typifies such a pervasive principle underlying all scientific progress. A student's mastery of Classical art develops those aspects of mental processes indispensable for conceptualizing scientific matters which lie outside, and above, the domain of any existing formalized mathematical physics. Thus, the lack of a dominant position for Classical art-forms in the curricula of primary, secondary, and higher education, must result in a corresponding degree of relative science-illiteracy among the graduates. This is to be seen most clearly in such cases as that of Professor Hawking.

Consider the case, that experimental tests show that the challenged occurrence is indeed real, and that its validation involves an axiom-like principle of nature, or of cognition, or both, which was lacking in the construction of the relevant hypothesis. Not only must we add the validated, axiom-like principle to our repertoire; we correct, and otherwise revise the pre-existing, relevant hypothesis, to accommodate this newly validated principle. This accommodation presents the surviving axioms of the relevant old hypothesis as if they were "n" dimensions of physical-space-time geometry. Now, we are adding dimension "n+1." As Riemann stresses in 1854, we are not permitted merely to dump the new principle into the proverbial mathematical pot; we must take into account the new kinds of interactions to be considered by shifting from the hypothesis of "n dimensions," to the relevant new hypothesis of "n+1 dimensions." The new quality of interactions is expressed for measurement, in terms of physical-space-time "curvature." All of the leading work of Gauss, W. Weber, and Riemann (among others) expresses this mathematical comprehension of the process of experimental-physical progress.

This change in the way we must think geometrically, eliminates all further toleration for such aprioristic conceits, such as the notions that space and time are infinitely extensible, in perfectly linear continuity, backwards, forward, and up-and-down. How far any dimension (extensible application of distinct, validated experimental principle) is extendable, and with what restrictions, must be determined experimentally. Of this, we should have been forewarned no later than the Eighteenth Century, by the proof of isochronicity in gravitational field, and in refraction of light propagated at some rate of retarded potential.

Time itself, free of its aprioristic shackles, like space, is

15. The standpoint in physical science represented in this present writing, is the present author's work in the science of physical economy. As the reader will soon encounter this here, the science of physical economy has a unique authority respecting the issues under review here.

removed from the domain of Cartesian and algebraic intuition; its nature becomes a subject of experimental physics. The measurement of those deviations from a presumed value, which shows us the presence of a new principle to be considered in respect to lapses of time, provides us, by the methods of Gauss and Riemann, with what appears to the naive mathematician as "imaginary time," or, to the less simple-minded, the demonstration of the presence of an additional principle (a potential new dimension). Wilhelm Weber's anticipation of the fallacy of popular use of "Coulomb forces," by his seemingly prophetic discovery of a "reversal" of the apparent relative role of "strong" and "weak" forces within a range of a certain microphysical smallness, is among the most elegant examples of the qualitatively new meanings which must be added to the notions of "space" and "time" within the range of the extremely small.

Hawking's most obvious difficulty in telling time, is his implicitly obsessive attachment to the fraudulent presumption employed by professed Newtonians such as Leonhard Euler and his followers (Joseph Lagrange, Marquis LaPlace, Augustin Cauchy, Lord Kelvin, Rudolf Clausius, Hermann Grassmann, Maxwell, Lord Rayleigh, Bertrand Russell, et al.), in employing the arbitrary, "ivory tower" presumption of perfect continuity (e.g., "linearity in the most extremely small") to construct those bald tautologies, falsely adopted as purported "proof" of that perfect continuity.[16] Contrary to the Cartesians, Newtonians, et al., the issue of continuity in the very small, is not a question of mathematics, but of experimental physics. In such matters, mathematics must, like Philip Duke of Edinburgh to Queen Elizabeth II, play the subordinate role, of consort, not monarch, in science.

The predicament of those who must acknowledge revolutionary changes erupting within experimental physics, but who, typified by Hawking or Maxwell, fanatically resist all "geometries but our own," is that the paradoxes which their "ivory tower" fantasies have created, leer back at them, like Frankenstein's monster, from both the extremely small and extremely large. That ghostly spectacle has disposed many such modern positivists to suspect, that the name of the universe's most powerful deity, is Chaos, after all. Hence, a corresponding strain of brutishly pagan religiosity in the arguments of Maxwell's, Hawking's, and like minds.

Analysis Situs

The instant one grasps the implications of Riemann's referenced, 1854 dissertation, it is clear that the essential quality of our universe as a process, appears to science only in the primitive form of a succession of hypotheses. All of the principal problems of science, thus belong to a form typified by the ontological paradox central to Plato's ***Parmenides*** dialogue. What is the *One* which efficiently subsumes those *Many* hypotheses? Thus, we are obliged to shift our sense of what is primary, away from the fixed object, to the principle of *change,* the latter as the primary reality underlying the conditional existence of fixed objects.

As the cases of Cusa, and such professed students of Cusa's discoveries, as Luca Pacioli, Leonardo da Vinci, and Johannes Kepler, attest to this historical fact, modern science, based upon an experimental-physical principle of measurement (Cusa),[17] is based upon a line of development, running from Plato and his Academy of Athens, through Cusa, Leibniz, Gauss, Riemann, et al. In other words, upon those who developed and comprehended the primacy of a Platonic notion of change, this in the same sense that Riemann's referenced dissertation expresses such a primacy.

This notion of change, is the basis for the actuality which a confused Hawking mistakenly apprehends as "imaginary time." Since the hypothesis underlying the terms (e.g., theorems) of a sequence, as applied to any member of a sequence, is simultaneously efficient in governing all earlier and future members of that sequence, the notion of "isochronicity" is to be seen, from a Platonic standpoint, as adumbrated by a general notion of "simultaneity of 'infinity'."[18] The latter is a well-documented, traditional notion of western European philosophy, theology, and science, since Plato.[19] The same notion underlies Leibniz's conception of *Analysis Situs,* the notion which sent Hawking over the brink in his ruminations on "C, P, and T."[20]

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16. The most famous, and relatively most influential of the hoaxes perpetrated in defense of the aprioristic notion of perfectly continuous extension in space and time, is that of Leonhard Euler's 1748 ***Introduction to Infinitesimal Analysis,*** as stated, in a somewhat simplified way, in his 1671 ***Letters to a German Princess*** [cf. Lyndon H. LaRouche, Jr., ***The Science of Christian Economy*** (Washington, D.C.: Schiller Institute, 1991); Appendix XI, "Euler's Fallacies on the Subjects of Infinite Divisibility and Leibniz's Monads," pp. 407-425]. Essentially, Euler employs an axiomatic assumption, that extension in space is perfectly continuous, to construct a supposed proof of the theorem, that any ostensibly linear extension is infinitely divisible. Although Isaac Newton and Rev. Clark argued, in their attacks upon Leibniz, for this same effort to degrade the calculus, whose development had been specified by Kepler, to a basis in so-called "infinite series," it was Euler's influence to this effect which dominated the Nineteenth and Twentieth Centuries' Newtonian factions of Lagrange, et al., in an anti-Leibniz, anti-Gauss, anti-Riemann, rabid devotion to the practice of axiomatically assumed "linearization in the very small." Euler's tautological fraud, is to have derived a theorem respecting a claim which was already embedded "hereditarily" (axiomatically) in the method selected for constructing the alleged proof.

17. e.g., ***De docta ignorantia.***

18. "Infinity" is used here in the sense of universality: the volume of Riemannian physical space-time represented by regarding time as a "spatial" dimension.

19. See reference given in Note 4.

20. Thus, Hawking's blunders are to be seen as predominantly ideological in character. Those principles of science which Leibniz placed under the caption of *Analysis Situs,* must be recognized, in the first instance, as referencing principles central to the successful practice of predecessors such as Pacioli, da Vinci, William Gilbert, and Kepler, principles which had been suppressed by means of the hegemonic political influence of the followers of Ockhamite Paolo Sarpi in Sixteenth-Century Europe. Just as Sarpi's agents

One must see the problem of defining an underlying ordering-principle, for a succession of hypothesis, as a corollary of Plato's ***Parmenides*** paradox. For example, does the *entropy,* or, the *anti-entropy* of the universe increase as we increase the mathematical cardinality of physical-space-time geometry, from a geometry of "n dimensions," to one of "n+1 dimensions"? No mathematics defined as the empiricists and positivists demand, could formulate such a question.

For example, when these forms are encountered as characteristics of real processes, "right-handedness" and "left-handedness" are not simply interchangeable. Nor is the transformation from one state to the other a matter of statistical indifference. Nor does a human being rise to the age of approximately twenty-five years, to begin the descent to a biological state of infancy. In the real world, outside ivory tower speculations, "backward" and "forward," are never the simple reversal of one another. The same differences, which Hawking's "ivory tower" viewpoint implicitly outlaws, are precisely the ironies, the paradoxes, from which discoveries of principle are derived.

The most important of such problems in *Analysis Situs,* today, are those associated with disputes respecting the relative primacies of *entropy* and *anti-entropy*. That brings us to the third of the four clusters of issues posed by Hawking's chapter. We contrast the views of Hawking with the writer's own.

But, who winds the clock?

Hawking presents four types of time, four senses of direction of time. The first, which we have already referenced here, is the notion of simple, linear, similarity of backward and forward. The second, which he labels as the first of three, he identifies as "the thermodynamic arrow of time, the direction of time in which disorder or entropy increases." The third, "the psychological arrow of time. This is the direction in which we feel time passes, the direction in which we remember the past, but not the future." Finally, he lists "the cosmological arrow of time. This is the direction of time in which the universe is expanding rather than contracting." Silly and arbitrary as those notions of time may be, they are Hawking's expressed sentiment. Overall, Hawking's mind portrays itself, as borrowing from stray contemporary fads of opinion in his academic's environment, as the caddis-fly larva gathers odd bits of rubbish, rather indiscriminately, in preparation of its pupation.

Back during the middle decades of the Nineteenth Century, Britain's Lord Kelvin mustered one of his German lackeys, Rudolf Clausius, into the task of inserting a curious bit of pagan religious belief into the empiricist science-catechism, the so-called "Second Law of Thermodynamics." Clausius' ally, Hermann Grassmann, contributed significantly to constructing the mathematical fine points of the dogma.[21] This was done in defiance of the evidence of the universe's tendency toward evolution into higher states of organization, to say nothing of the anti-entropic characteristic of the human species itself. The mathematical argument employed relied, in a crucial way, upon Grassmann's specific approach to codifying Euler's tautological fallacy of "linearization of physical space-time in the extremely small." The reckless extrapolation of the notion of a "Coulomb force" to the extremely small, is a paralogism of the same type.

This poses a problem which obliges us to return to the standpoint of a generalized *Analysis Situs,* to the examination of the historically determined characteristics of Hawking's defective method. On this account, the immediate origin of this arbitrary construction of the so-called "Second Law of Thermodynamics," by Kelvin, et al., is what we have already identified as that Euler-Lagrange hoax known as "linearization in the extremely small," the which is the common distinction of the collection of Nineteenth-Century Newtonians such as Laplace, Cauchy, Grassmann, Kelvin, Clausius, Helmholtz, Maxwell, Rayleigh, Mach, Russell, et al.

However, to understand that phenomenon, one must locate Euler, Lagrange, et al., within the Europe-wide, Eighteenth-Century cult of Isaac Newton, as created and organized by the Paris-based spy-master of Venice, Abbot Antonio Conti, the creator, together with fellow-agents Guido Grandi, Francesco Algarotti, and Giammaria Ortes, of Newton's controller, Dr. Samuel Clarke, and of Physiocrat Dr. François Quesnay, Voltaire, the Paris-centered "Enlightenment," and Frederick II's harem of Leibniz-hating, Newtonian fanatics within the Berlin Academy of science: Euler, Maupertuis, Lambert, Lagrange, et al. Spy-master Conti and his network of salons are nested within the framework of the founding of the Seventeenth-Century French and Anglo-Dutch "Enlight-

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Francis Bacon and Thomas Hobbes sought to outlaw, fraudulently, arbitrarily, metaphor, hypothesis, and the subjunctive, the Rosicrucian mystics (such as Fludd) and other Sarpians, conducted a bloody inquisition against the principles central to the most durably successful achievements of, most emphatically, Kepler. Thus, on this account, "Enlightenment science," positivism most notably, presents us with a spectacle like that of a man who has amputated his own legs, to prove the impossibility of walking. Hawking's rant on the subjects of "C, P, and T," argues for indifference to that existent reality whose possibility he refuses to acknowledge.

21. These reports are not intended to suggest that the work of Clausius and Grassmann did not include actual accomplishments. The problem here, is to be understood as expressing the impact of a pervasive system of political corruption, which taints the work, and morals, among even otherwise accomplished scientific workers. The corruption usually begins in childhood and adolescence, in such seemingly innocent forms as submission to demands for conformity with the doctrines imposed by some relevant authority. In later years, all too often, the survival of a scientist's career may be made conditional upon his playing the role of an intellectual thug. The case of the thuggery directed against Max Planck, from the admirers of Ernst Mach in Vienna, Berlin, and elsewhere, is but typical of this moral problem pervading much of the "generally accepted classroom" authorities down to the present day. Clausius was an able scientific worker, who sullied himself as the price paid for the patronage of Lord Kelvin et al. The politically motivated corruption within science today, is far worse than it was in Kelvin's time.

enment" by the leader of Venice's dominant, *Case Nuove,* faction, Paolo Sarpi. Thus, Conti's Eighteenth-Century "Newtonian" salons premise their beliefs upon the axiomatic assumptions introduced to England by Sarpi's personal lackey, Galileo Galilei, and Sarpi's agents Francis Bacon and Thomas Hobbes.[22]

When "Newtonianism" and its offshoots are situated within the context defined by Sarpi, as they must be, it should become clear to us, that there is virtually no subject-area taught in any university undergraduate, or secondary-school textbook today, which is not derived, axiomatically, from the same doctrine underlying the entirety of Thomas Hobbes' ***Leviathan.*** This includes, most emphatically, all social studies, including virtually all branches of psychology, extends to the teaching of philology, linguistics, drama, poetry, and modern prose-style, all today's generally accepted classroom teaching of political-economy, and includes the pseudo-science, "political science," co-founded by Saint-Simon and the Madame de Staël. Less suspected, is the fact that the mechanistic doctrines of physics and generally accepted classroom mathematics, are also premised axiomatically upon exactly the same, perverse axiomatic assumptions underlying the entirety of Hobbes' ***Leviathan.***

There is a deeper, earlier, ancient Greek, aspect to these axiomatics. The root of the modern Enlightenment is traced, formally, from the Paduan "mortalist" Pietro Pomponazzi, the founder of that modern teaching of Plato's adversary Aristotle and Aristoteleanism, which Venice employed in its efforts to crush out of existence the mid-Fifteenth-Century, Platonic "Golden Renaissance," which had gained temporary victory in the 1439-1440, Florence sessions of the great, ecumenical Council of Florence. Although Sarpi broke with that version of Aristotle practiced by his defeated factional opponents of the Roberto Bellarmino's *Case Vecchie,* Sarpi's self-avowedly "Protestant" Enlightenment must be viewed as a "slightly heretical" branch of the same Aristoteleanism which Pomponazzi had taught to later Cardinal Gasparo Contarini. Sarpi led a revival of the faction of medieval positivist William of Ockham.[23] Like Ockham, and modern logical positivism's professed neo-Ockhamites, the followers of Sarpi and Conti adhered to a stripped-down version of Aristoteleanism.[24] These empiricists and positivists, as typified by Russell and Hawking, adhere, with a fanatical quality of intellectual violence, to Aristotle's standpoint of the "observer."

This is crucial for understanding Hawking's insistence upon taking Russell's standpoint, of clocks seen by observers. This is the fishbowl in which Hawking's thoughts swim. This is crucial for understanding all empiricist argument, including each and all of those four notions of time we have adduced from the relevant Chapter.

The present writer premises science, not upon the standpoint of the so-called "detached observer," but, rather, the "actor." This principle is central to the difference separating the economic science of Leibniz and this present author, from all the sundry neo-Aristotelean, or worse concoctions of today's university economics classroom. Hawking's borrowing from the "it seems to me" rhetoric of barroom sophistry, for his four stated notions respecting time, is to be viewed in this light.

As this is elaborated, repeatedly, in previously published locations, the foundation for certainty respecting the principles of scientific knowledge, is the proof that man's practiced use of successive discoveries of principle, respecting both nature and human cognition itself, has resulted in the coordinated increase of mankind's potential population, and also improvements of demographic characteristics of households. In short, man's successive increases in his species' power over nature, achieved through revolutionizing of society's behavior in this way. This process of increased per-capita power within the universe, corresponds to a Riemann sequence of change, from a practiced physical-space-time geometry of "n dimensions," to a superior one of "n+1 dimensions."

The latter sequence is driven, emotionally (i.e., *agapically*) by those processes of individual cognition which develop validatable new principles ("dimensions") as resolutions of those kinds of ontological paradoxes which we have associated with Classical forms of metaphor.

The conclusion to be derived from examining this evidence, is that when mankind employs its individuals' cognitive powers in that manner, the universe responds obediently to the exertion of increased dominion by the human species.[25] Thus, that aspect of cognition expresses a congruence with the fundamental lawful ordering of the universe. For reasons given above, this most "robust" of all correlations in human experience, obliges us to reexamine more closely those creative processes, within the sovereign precincts of the individ-

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22. On the Venetian roots of modern empiricism, see Lyndon H. LaRouche, Jr. in the following locations: "How Bertrand Russell Became an Evil Man," ***Fidelio,*** Fall 1994; "How Hobbes' Mathematics Misshaped Modern History," ***Fidelio,*** Spring 1996.

23. The common feature of Venice's Sixteenth-Century *Case Vecchie* and *Case Nuove* factions, is that both were equally impassioned in their desire to eradicate the influence of the Council of Florence, and the related (A.D. 1460-1483) founding, in Louis XI's France, of the modern form of sovereign nation-state. The essential difference, is that the *Case Vecchie* were committed to preserving the imperial form of a feudalism dominated by hereditary landed aristocracy; the *Case Nuove* were committed to playing northern and Habsburg-dominated Europe against each other, in a divide-and-conquer strategy which would bring the kind of financier-oligarchical maritime power, which Venice had represented, to imperial domination through Venice's Anglo-Dutch clone-states.

24. Look at Cartesianism in the retrospective view provided by Riemann's habilitation dissertation. Cartesian geometry, and the mathematics derived from it, is to Euclid as Ockhamite Sarpi is to Pomponazzi's Paduan Aristotle. Indeed, had the Biblical Jonah been a Sarpi, a Descartes, an Ernst Mach, a Bertrand Russell, or a Hawking, he would have swallowed the whale.

25. ***Genesis*** 1:26-28

ual mind, from which the gaining of such increased dominion flows.

Firstly, the Riemannian series corresponding to this principled increase of dominion represents the ontological paradox, the *Many,* for which these individual powers of creative cognition typify the solution, the desired *One*. In turn, the individual paradox which prompts each of the corresponding, successive discoveries of experimentally validated principle, is well known, in the manner we have indicated here. The correspondence of such paradoxes, as scientific propositions, to the role of metaphor in Classical art-forms, is also demonstrated. A close examination of the Riemann sequence, from this vantage-point, settles a crucial question.

The Riemann series, n to n+1, itself defines a meta-mathematical notion with two notable expressions. Firstly, the series defines an ordered increase of mathematical cardinality. Secondly, since each added dimensionality corresponds to a Gauss-Riemann discontinuity in the relevant, preceding function of reference, this mathematical cardinality is also expressed as the notion of an implicitly enumerable density of discontinuities for any arbitrarily selected interval of action. These notions of cardinality have a general relationship to the Gauss-Riemann notion of curvature in physical-space-time geometries.

These mathematical notions are coordinate with the increase of mankind's dominion in the universe, and, for reason given, with the ordering principle of lawfulness made known to us through man's progress in dominion. It is appropriate to identify these empirical relations by the term *anti-entropy*. The contrast of such a notion of "anti-entropy," to the notion of "entropy" supplied by Clausius, et al., is clear. The universe is characteristically "anti-entropic," rather than the "entropic" universe arbitrarily presumed by the "ivory tower" viewer such as Kelvin or Hawking.

So much for our Hawking's deluded occupation with his notions of "time's arrow," his conjectured distinctions among so-called "thermodynamic," "psychological," and "cosmological" time.

Economics: the science of action

Put to one side commonplace, erotic fantasies respecting money, prices, and possession. Focus upon the real economy, which is principally those physical changes in nature, by means of which the potential relative population-density (including correlated demographic improvements) is maintained and increased. Take into account, the essential part of the subjective aspect of physical economy, such as education, health-care, and science services, and the role of the institution of the modern, sovereign nation-state, itself, which are, taken as one, the preconditions for fostering scientific and technological progress. Note that, in this sense, those subjective aspects are functionally determining within physical economy. Help Professor Hawking locate a valid science of "time" within the bounds of such inquiry.

To this end, focus upon the transfer of the impulse of technological change, treated as a Gaussian characteristic, as a measure of the relative curvature of the economic process taken as a whole.

To define the relevant relations, examine a national economy as an indivisible entirety. Conduct this examination in solely physical-economic terms, without reference to money or prices. Compare the physical-economic output of that economy as a whole, and in terms of per-capita of its entire labor-force, and in terms of its entire functional area. Compare the required inputs, measured in market-basket terms, with the total produced output, in the same terms. What, then, is the meaning of the terms, "national profit" and "national Value Added"?

Express this problem in the following way. Equate the variable magnitude corresponding to the maintenance of the productivity of the economy as a whole (per capita of total labor-force), to "energy of the system." Equate that portion of output which exceeds the required "energy of the system" for the "next cycle," as "free energy." Stipulate, that the restriction, that the ratio of "free energy" to "energy of the system" must not decrease during successive cycles, correlates with "anti-entropy" of the economic process considered as a whole.

This "anti-entropy," if it is achieved, correlates with increasing cardinality of a Riemannian series of successive technological states. The role of the "strategic machine-tool-design" principle in modern industrial economy, illustrates the functional connections, between technological progress and increase of physical-economic productivity-rates, to be investigated in study of an actual economy.[26] It is solely that functional connection, between realized technological progress and increases of physical-economic productivity-rates, which allows the sustainable maintenance of "free energy" ratios of entire economies over medium- to long-term intervals.

For the rather obviously related reasons, the most significant thing to measure in an economy, is not the flow of product as such; rather, it is the rate of transfer of technological progress which is characteristic.

Thus, rather than measuring the clock-time for the movement of physical goods and related service along the network-pathways of the economy as a whole, we must measure these movements in terms of the associated rates of technology transfer accomplished by aid of the movements of physical goods and related services. This technology-transfer assumes the form of a necessary, characteristic rate of change associated with the movements of physical goods and related services. This added "dimension" of the economic process, corresponds to a Gauss-Riemann curvature of the relevant physical-economic space-time.

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26. Lyndon H. LaRouche, Jr., "Return to the Machine-Tool Principle," ***Executive Intelligence Review,*** Feb. 7, 1997.

This notion of relative curvature (or, "characteristic") may be applied in three respectively distinct ways: a) locally, b) in terms of the demographic-labor process of the economy as whole, and c) in respect to the area represented by the relevant economy. In all cases, it is not the lapsed time of the action which is determining, but, rather, the product of the rate of technology-transfer and product moved, which is decisive.

This returns our attention to a crucial bit of silliness in Hawking's argument. He writes: "Then, there is the psychological area of time. This is the direction in which we feel time passes, the direction in which we remember the past but not the future." On the contrary, the most distinguishing feature of human memory, is that we do remember the future, and that in a manner which, although not a simple reversal of looking toward the past, is just as efficient in determining human behavior as memory of the past. This was the central topic addressed in several among the present writer's treatments of the ruling principle of "time reversal" in the composing, performance, and hearing of Classical musical, motivic thorough-composition, and in economic processes.[27]

In competent industrial management, for example, the span of comprehension of the ongoing process, which is required of the relevant executives and their staffs, encompasses some number of years into the past's making of the productive process of the present moment, and also the shaping of the actions taken in the present moment, on the basis of memory of the resulting state of the economic process some number of years along the distant economic horizon. Indeed, all competent decisions of an important variety which are made in a society, including, for example, Mozart's, Beethoven's, and Brahms' method of composing music, and Wilhelm Furtwängler's method of conducting it, are based upon a principle of composition, according to which the present is chosen to bring about a predetermined future condition, a future condition which acts upon the process of decision by means of the faculty of memory.

This knowledge is older than the celebrated Ramon Llull; it is at least as old as Plato's lifetime. Contrary to Hawking, it not only exists; it is the most important faculty of memory.

One concluding observation on this point.

In competent education, as Friedrich Schiller and Wilhelm von Humboldt understood this, the essential requirement is that the pupils relive the experience of reenacting discoveries of principle, rather than merely learning them in a textbook fashion. That is accomplished by, first, reconstructing the relevant paradox, in the form of metaphor. This challenge to the individual pupil's sovereign powers of cognition, results, in successful instances, of course, in prompting the student's mind, not only to recognize the validation of a discovered solution, as a principle; the student is obliged to resynthesize his, or her general hypothesis bearing upon that entire area of knowledge.

This discovery of new hypothesis, is the direct means by which the future is known to us in an efficient way, as distinct from the fallacious methods of merely wishful, or charismatic conjecture. This is the essence of Plato's Socratic method, which, in turn, is a refined, conscious apprehension of the potential powers lodged within the developable, sovereign cognitive processes of the individual person. Since hypothesis applies simultaneously to past, present, and future states of the sequence hypothesis underlies, to know that hypothesis, is to know that future, and, thus, to be able to recall it from memory. To the degree the hypothesis is valid, the apprehension of the future is usually at least as accurate as our memory of the past.

Hawking, aided by Carl Sagan, wrote a book for popular readers. That road leading in search of popularity, was smoothly paved with prosaic banality. The unfortunate part of that popular appeal, is that this required virtually no bowdlerization of the author's professional views on the same topics. Even worse, some popular readers deceive themselves to imagine that they are receiving important truths by literary pathways paved with the mediocrity of popularizing ideologues. Serious matters deserve serious thought.

27. See note 2. In indicated issues of ***Executive Intelligence Review,*** see also, Lyndon H. LaRouche, Jr., "That Which Underlies Motivic Thorough-Composition," Sept. 1, 1995, and "Norbert Brainin on Motivführung," Sept. 22, 1995.

For further reading

The following books, which deal with the issues discussed in Mr. LaRouche's article, can be ordered from Ben Franklin Booksellers, 107 South King St., Leesburg, Va. 20175. Call 1-800-453-4108 (toll-free) or 703-777-3661.

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