The Geometry Intrinsic to Motion, Space and Time

Part I . A Comprehensive Principle

§ 1. The geometry of spacetime has to support objectivity. That is inescapable.

All of natural science must share a common grounding in the reality of nature. Also the mathematics we have discovered and use to describe the reality of nature can only arise out of, and so can only refer to, the same natural reality. Natural science and mathematics have a common foundation, they spring from a common source. Since this reference of the complex to the simple has been realized, the quest to understand and describe our universe has become a quest for an inferred principle that comprehends all of evolution and therefore can organize the apparent diversity of nature and affect the entire course of evolution. Because of this the quest to understand nature has become the quest for the initial condition of the universe, that is, for the initial appearance of objective reality which we think of as *spacetime*. All the mysteries of the evolution of the universe are bound up with the unknown, foundational nature of spacetime.

However, accessing an inferred foundational principle of the cosmos presents a difficult problem for the reason that such access implies unlimited understanding. This rather evident problem is not often acknowledged. But if understanding is limited then what is understood may depend upon what is not understood and the ground has not been reached. So we need to ask if comprehensive understanding is available. This is not a trivial problem. It results in the famous group of unanswered questions all of which regard the ground state of the universe: 1) How did the universe have an initial state of minimal entropy? 2) What causes spacetime to expand and the expansion to accelerate? 3) What maintains spacetime expansion in its balance between runaway and collapse? 4) Why is the expectation value for the vacuum energy density vastly higher than its observed value? 5) What caused initial thermal variations to form in spacetime? 6) Why are causally unconnected regions of spacetime thermally similar? 7) Why is the curvature of spacetime, i.e. gravitational force, so much weaker than the weak force? 8) What spacetime mechanism enables non-local correspondence (entanglement)? And 9) why is the evolution of spacetime apparently irreversible?

The existence of an answer to each of these questions depends on there being a comprehensive principle, the understanding of which implies that no potentially critical aspect of nature remains to be understood. Thus the possibility of unlimited understanding appears to be the central issue.

We are therefore going to examine the *very* earliest universe in some detail. That is, we shall examine the *emergence* of motion, space, time and a certain geometry

which is intrinsic to the emergence of motion, space and time *from* a condition of 'quiescence'. We will find that examination of the quiescence is not possible. All this may seem ambitious but it is less so than may be thought.

Our examination is to proceed by a decomposition of observation to its simplest occurrence; that is to objectivity *per se*. We are allowed to do this for this simple reason: existence cannot be denied. In noting this simple fact about existence we are noting only the simplest objectivity which is without condition and is undescribed. Objectivity *per se* is inescapable.

§ 2. But objectivity *fails*, and this renders objectivity complex.

So the key to understanding spacetime devolves to be the study of *objectivity per se*. Consider first that understanding that fails to include the observer is incomplete and that this is the very incompleteness that prevents us from being sure that we have reached the ground of nature. Therefore the observer has to be understood. But that is difficult for the reason that the role of the observer is inescapably reflexive. This inescapable reflexivity, in which the observer is always involved, is what prevents unlimited understanding being available, and since this is the central issue we need to explore it carefully.

At first, observation may seem to separate the observer from what is observed. At first, anything that is observed can be denied being the observer and so the observer seems to observe his environment while not being it. In this way a twofold structure is formed in which the observer appears to remain differentiated from the observed. Thus the observer seems still to be *available to be considered*. If the observer of existence *could* be considered that would sustain a twofold existence. But what will consider the observer? The problem is that the observer has not yet been objectified and cannot be objectified. Thus, at least for the observer, *objectivity fails* and we begin to see that when objectivity is investigated a very subtle, *intrinsic structure of objectivity* is revealed.

The first consequence of the failure of objectivity of the observer is that where objectivity fails it is not possible to attribute, that is to *bound*; to say that that which observes is this but not that, is here but not there, or is now but was not then. And without the possibility to bound the observer, observation cannot separate observer from observed and twofoldness of existence is not sustained. At this point we have encountered a great paradox: Objectivity *per se* is non-dual but is charcaterized by failure of objectivity.

This is a single condition. It cannot be divided into objectivity on the one hand and its failure on the other hand. Further, failure of objectivity is not only of the observer, it is general. Any attempt either to objectify or to deny existence strives to objectify the observer as a residuum. But that is not possible. Lying at the heart of

nature this is the great paradox of existence: Existence cannot be denied but neither can it be objectified. This is the situation within which nature contrives to display itself to itself. It is not contradictory. That the general failure of objectivity must always be accomodated in nature constrains spacetime geometry. This constraint is powerful, an absolute. Nautre has no choice but to accomodate failure of objectivity which has a unique architecture, which alone is able to evolve.

Failure of objectivity may seem to be formless but is the very beginning of form. Here is how general failure of objectivity operates to define spacetime geometry and to constrain evolution to its course. First, objectivity cannot fail unless it is present and simple objectivity, *existence*, cannot be denied. But we have seen that failure of objectivity is general and, since any bound objectifies that which is bounded, general failure of objectivity implies general absence of bound. And absent bound, spacetime cannot be local and cannot have discontinuity. Therefore geometry that is without discontinuity is required for objectivity to occur, it is the condition required for nature and without this condition there is no existence. This generality prohibits a uniquely anthropic attribution of objectivity. In this way the general failure of objectivity begins to reveal that *it is form* that is independent, peculiar and definite. This geometry, which is peculiar to the failure of objectivity, has no antecedent but is not a free parameter. Its intrinsic geometrical constraint cannot evolve and is consistently valid at any scale. Its inherent form is both inevitable and independent and this is the key to spacetime.

So an examination which may have seemed as though it would be ambitious is found to be tractable. The big bang of course was not an event that happened and then stopped. The big bang was the emergence of an ongoing process. It is important to remember that this ongoing process can only be observed from within by *part of* the process. That which would examine the process is the process itself. For this reason the intrinsic geometry of the emerging universe is open to examination by unexpectedly simple means.

It seems that at this time the condition that was present at the big bang has been hugely attenuated. But that is only partially true. It is true insofar as the probing of progressively finer scales neglects that observation is inherently reflexive. While reflexivity is neglected, observation will appear to be mediated and thus limited by a medium. Probing the initial condition of spacetime is thought to require that energy be placed into an arbitrarily restricted region. This seems to make experimental examination, i.e. *observation*, of the initial condition of spacetime a practical impossibility. From our present position, we seem to observe a well-aged universe from a time remote from the earliest time, and from a scale that is vastly larger than the earliest scale with no real hope of examining the earliest condition. Looking outward we encounter the fog of recombination and looking inward there are those practical limits. But the geometry of spacetime which must support the failure of

objectivity cannot evolve, is present at scale and there is no need to simulate the past in order to investigate it.

Over the millennia during which investigation of nature has been pursued, one central discovery has slowly emerged. This discovery is that the outwardly complex activity of nature has intrinsic order. Observation reveals to us a vast universe that is incomprehensibly improbable, that exists in a terribly delicate state of balance, all its evolution having depended on its exquisitely fine internal order. This state of enduring balance and revealed order suggests the consistent presence of an ordering influence, a fundamental principle, which to guide all of evolution must comprehend all of evolution.

Complex structure evolves from simpler structure. At present this simplest aspect of nature is unrecognized. But existence is form. Nature is geometrical at all scales and the geometry is dynamical. To direct *all* of evolution an influence can *only* operate as the underlying geometrical nature of activity. It is sometimes thought that the precise form of this active geometry is hidden in minuteness and therefore is inaccessible, but that argument does not consider objectivity and its failure, the consequences of which are not realized in current views of the geometry of spacetime.

§ 3. Some earlier considerations of the geometry of spacetime and its relationship to mathematics

Our two great theories are irreconcilable and neither theory is comprehensive. Using them requires mathematical ‘renormalization’ in the one case and leads to unphysical ‘singularities’ in the other. These problems arise because the geometry of the infinitely small, on which the spatial geometry in which the two theories operate depends, is misconceived.

The notion that the geometrical properties of continuous space, how it obtains its metric, arise from and depend upon dynamical characteristics of the space itself, which therefore are precedent to the geometrical description of continuous space, is not entirely new. In his well known habilitation lecture of 1854 Bernhard Riemann investigated the hypotheses which lie at the ground of geometry and, finding them inadequate, proceeded to refine the former grounding beginning his considerations with ‘general notions of magnitude’. But even the new grounding he developed he seems to have known was not quite fundamental, as he finally wrote of the ground of the metric behavior of a continuous space needing to come ‘from elsewhere’, that is, *from those things* that *are* the nature of space itself rather than from postulation. An understanding of spatial geometry based on the character of space was required. Riemann wrote:

Die Frage u¨ber die Gu¨ltigkeit der Voraussetzungen der Geometrie im Unendlichkleinen ha¨ngt zusammen mit der Frage nach dem innern Grunde der Massverha¨ltnisse des Raumes. Bei dieser Frage, welche wohl noch zur Lehre vom Raume gerechnet werden darf, kommt die obige Bemerkung zur Anwendung, dass bei einer discreten Mannigfaltigkeit das Princip der Massverha¨ltnisse schon in dem Begriffe dieser Mannigfaltigkeit enthalten ist, bei einer stetigen aber anders woher hinzukommen muss. Es muss also entweder das dem Raume zu Grunde liegende Wirkliche eine discrete Mannigfaltigkeit bilden, oder der Grund der Massverha¨ltnisse ausserhalb, in darauf wirkenden bindenen Kra¨ften, gesucht werden.

Which I translate as:

The question of the validity of the postulates of geometry in the infinitely small is bound together with the question regarding the inner ground of the measure-behavior of space. In this question, which still fairly is of the theory of space, comes the application of the above remark, that for a discrete manifoldness the principle of measure-behavior is already present in the notion of the manifoldness, while for a continuum this must come from elsewhere. Thus either the reality which underlies space must constitute a discrete manifoldness, or the ground of measure-behavior must be sought beyond in thereupon operatively constraining forces.

Riemann left these ideas to the world and later they were picked up by Einstein. Riemann intuitively knew that spatial continuum cannot be a freely permissive, measureable background for phenomena (i.e. *nothing*) but must be dynamical *itself*. The *dynamic 'operatively constraining forces', which act through spatial continuum defining the ground of its measure behavior, and thus its reality*, have since been partially described by Poincare, Einstein and Minkowski. However, the deepest aspect of dynamical continuous-manifoldness space remains undescribed.

A century after Riemann, in 1960, Eugene Wigner pondered what he referred to as "the unreasonable effectiveness of mathematics in the natural sciences". Now, over fifty years after this famous line was written, cosmology and physics still seek to know how this 'unreasonable' alliance may relate to a conjectured comprehensive principle. These issues of 'space' and of 'mathematics' and how they combine as 'physics' actually regard the geometry of objectivity.

§ 4. Elementary observation

Ideally, investigation of the underlying geometry of spacetime would begin with an observation that depends critically upon, and so reveals, the infinitesimal nature

of that geometry. To serve as grounding such an observation must be beyond doubt. There is only one such observation that is sufficiently secure and of sufficient refinement. It is entirely general and, as required to comprehend evolution, it is the simplest, the most elementary, of all observations. It is the ever-present observation of existence. If it is not ventured to understand this simplest instance objectivity then twofold existence may be inferred from experience that neglects the observer.

§ 5. Observation of spacetime geometry is unmediated

Elementary experience of existence is neither undertaken nor avoidable. The failure of its objectivity implies that elementary observation is not directed unto an object; that it is not afferent, has no observational pathway and is unmediated. With no mediating agency, it cannot be refined. It is existence observing existence.

If this argument is doubted as being merely manipulation of concepts one must consider that if all the words are eliminated the fact of experience cannot be eliminated or objectified, leaving unmediated experience.

It may be thought that this unmediated experience is diffuse and non-specific and that very little beyond the obvious can be got from it. But objectivity and its failure are coupled. Therefore *primary* observation is not observation of things, either large or small, and cannot have an associated scale. Being scale-independent, it is valid at any scale and is bound up only with the scale-independent geometry in which it is possible. As observation becomes increasingly simple and thus increasingly refined the factor limiting refinement is not the necessity to place mediating energy within an arbitrarily restricted region. Rather refinement is finally limited by the failure of objectivity, which is general and has no scale. Thus elementary observation is giving an unmediated, scale-independent view of the geometry of nature. This is the most refined observation that is possible. At this point in my arguments that may seem to be too strong a statement to make but we are to find that our primary observation of existence is the *ne plus ultra* of observation.

Failure of objectivity in elementary observation is inescapable and unvarying, which everyone can verify. Failure of objectivity cannot be denied or bounded and therefore constitutes appropriate grounding on which to build.

§ 6. Failure of definition

It may already have been noticed that failure of objectivity exposes the artificiality of distinguishing between *existence* and *consciousness*. In spite of the linguistic codification of their distinction objectivity is equally consciousness experiencing existence or existence experiencing consciousness. The words may be composed either way but the experience remains unchanged. Any confusion is in attempting to

distinguish observer from observed; that is, consciousness from existence. That this is impossible is inherent in the continuous geometry of observation.

Consciousness and existence are ill defined and in elementary observation they cannot be distinguished. The composite, *existence-consciousness*, cannot be bounded or removed, implying that existence and consciousness cannot be found apart and that existence is not the ground of, and did not precede, consciousness.

Nature, characterized by objectivity and its failure, cannot be objectified and ultimately cannot bear attribute. For natural science and mathematics this presents a difficult situation. I-self-existence-consciousness (ISEC) cannot deny existence but examination reveals that ISEC cannot be fully described.

§ 7. The effective limit of enquiry is the earliest entry point

This completes the introductory establishment of the fundamentals and limits of observation. We have found an epistemic barrier. We have unmediated observation of simple objectivity but its exact description is denied. One then asks, how closely can description of the objective world approach the epistemic barrier posed by non-objectivity?

Because the failure of objectivity constrains world geometry we can eliminate hypothetical conditions that fall outside the constraints. The geometry of spacetime then remains to ground the world and its descriptive mathematics.

Part II – The Geometrical Arguments

§ 8. No bound of objective existence, no non-existence, no discontinuity

Existence cannot be denied but cannot be objectified. Any bound or discontinuity objectifies. An absence of existence or a bound to existence cannot be used in argumentation. Existence cannot be denied, bounded or discontinuous.

§ 9. No elements, rather non-local volume

An element (i.e. an *identifiable* existence within the remainder of existence) must be distinguished from what it is not. This would require a bound within existence, a discontinuity where existence is not. But non-existent discontinuity cannot exist and no element can be distinguished. Therefore, absolute locality cannot be identified and the manifolds of absolute locality, line and surface, which in the same way strive to bound existence, cannot be identified. Existence, which cannot be denied, cannot be bounded, discontinuous or local.

§ 10. A note on corporeality

Things are corporeal and are thought of as having identified objective reality and bounds, but objective existence cannot be bounded and cannot be corporeal.

§ 11. Unbounded continuum; no asymmetry

These few observational constraints establish *unbounded, non-local continuum*. These conditions have no asymmetry.

§ 12. An *objective imperative* defines *motion-spacetime*

But the *sine qua non* of *unbounded non-local continuum* is that it is objective. There is an *unbroken relationship* of objectivity between observer and observed which can never be absent. This may be expressed as the *continuous relativity* of observer-observed which is an absolute *objective imperative* of existence. This imperative to be continuously objective, which is intrinsic to existence, is what gives meaning to the three fragmentary and individually meaningless concepts *space*, *motion* and *time*, none of which acquires meaning until all of them combine as the seemingly complex, but truly fundamental entity *motion-spacetime* (MST). MST is provisionally defined as: *continuous relativity of unbounded, non-local continuum*.

It will be noticed that dynamical unbounded non-local continuum of continuous symmetry, the base platform of objective reality, is smooth and does not provide a reference for objectivity, and that this initial definition is incomplete. But the way in which relativity (i.e. *reference*) can be generated has been meaningfully constrained: Reference must be generated within this smooth continuum (MST). Describing the generation of reference within continuum (which seems to be reference-free) will occupy us through Section 18.

Since none of the three fragmentary concepts (space, motion and time) has a peculiar behavior and so none of them can exist separately they must all be present in the simplest observation; *motion-spacetime*, which is the sole entity of nature. All motion *is* MST; motion is not *in* MST. All 'physical' concepts, energy, temperature, density, mass and so forth reduce to MST, that is, to dynamical geometry.

§ 13. Isotropic opposition and centrality

The observation of simple objectivity cannot be localized. Thus simple objectivity cannot be nonuniform (e.g. more here and less there). Without a preferred direction simple objectivity is isotropic. Elementary observation is then of *unmediated isotropic relativity* (i.e. isotropic *dynamical opposition*). The observing faculty cannot

be objectified or bounded and can have no interior. Therefore MST can have no absolute scale and cannot be reduced or enlarged in an absolute sense. But here is a paradox: Being unbounded the observer cannot have an interior and yet isotropic opposition, a consequence of non-local objectivity, places observation centrally with regard to opposition. To picture this consider the general celestial observation. There is always an observer. If the observer is irreducible and corporeal existence is removed what remains is the isotropic expansion of 'spacetime'.

This appearance of centrality which is intrinsic to the objective imperative is the fundamental manifestation of the general celestial observation. However the initial appearance is that observation is from a prohibited center. This intermediate step in the larger paradox must be resolved and to do this it will help us to consider some initial mathematical implications.

Part III – Initial Mathematical Implications

§ 14. Consistency of mathematics

To be above doubt mathematics must be consistent. Therefore a strong consistency requirement is borne by the body of mathematics. But internal consistency of a sufficiently rich formal axiomatic system has proved to be impossible to verify. Thus it would be desireable to avoid formal axiomatics, i.e. postulation. Is it possible to eliminate postulation from mathematics? If that could be done our descriptions then would defer their initial hesitancy longer than is possible when postulation is involved, and thus they could approach the epistemic barrier we have found as closely as is possible. Strong consistency requires that mathematics accommodates failure of objectivity. Mathematical concepts such as *unity* and *zero* bear the strong consistency requirement.

§ 15. Geometrical foundation of mathematics

Strong consistency requires that meanings for the concepts zero and unity must always be available. No-bound of existence and the disallowance of 'non-existence', particularly as a separator, are intrinsic to the geometry defined by the failure of objectivity. It is not possibile to violate failure of objectivity which is a grounding mathematical principle derived from the intrinsic geometry of existence. This inviolable observational grounding of geometry implies that valid mathematics is achieved without postulate.

§ 16. A consistent meaning for *zero* in MST

As a locus of observation a central observation point would be a quiescent defined location within MST which is never quiescent and has no absolute location. Thus our examination of continuum does not find *any* such point, element or origin, our present referents for number. Nor do we find 'nothing' existing as 'origin', our present referent for *zero*. Since we cannot use either *element* or 'non-existence' in argumentation, consistent referents for *unity* (i.e. *number*) and *zero* must be found.

The central reference (the observer) from which opposition is seen cannot be a singularity. There is a fair representation of this problem in algebraic geometry. If, in an otherwise continuous function, we find a singularity which, in order to understand the function as a whole, must be eliminated we blow up the singularity making it into a *zero-section*. This problem is similar to the problem we face in describing the observer of isotropic opposition – which cannot be objectified.

The problem of understanding a singular point, for instance an origin, that is included in a function is described by Cauchy's formula expressing the value of a holomorphic function at the origin in terms of an integral around a contour surrounding the origin

$$\frac{1}{2\pi i}\oint \frac{f(z)}{z}dz = f(0) \quad . \tag{16.1}$$

This tells us the behavior of a holomorphic function at the origin is determined by what the function is doing at a set of points surrounding the origin. The notion of holomorphic behavior defined *at* an origin point has transformed in this formula so that holomorphic behavior at an origin is now defined by the behavior of a set of points along a surrounding contour. This is not a point but an 'extended' notion that skirts absolute location.

Cauchy's formula is offered as a heuristic. An important difference in the two concepts is that the Cauchy integral is observed from outside while the centrality always observes isotropic opposition placing observation centrally with regard to objectivity.

Further, the Cauchy formula as written applies to the complex plane. We need to think of it as though it were generalized to the holomorphic concepts of MST. Then the meaning of the integral is that the nature of zero-section in MST cannot be understood in local terms. 'Behavior at the observer' cannot be directly accessed and can be described only non-locally. MST is continuum, not two things (origin and surround).

Cauchy also shows the origin may be any point as the contour integral formula can be origin shifted as

$$\frac{1}{2\pi i}\oint \frac{f(z)}{(z-p)}dz = f(p) \quad . \tag{16.2}$$

Here location is seen almost as though it were non-objective and accessible to understanding only in terms of objective phenomena and this becomes a sort of epistemic barrier.

Consistent mathematical concepts are required to refer even to the simplest form of MST. In particular *zero* meaning *nothing* or *non-existence* is nowhere present in MST and cannot be used. Something like *zero-section* however is unavoidable as the non-objective observer. Zero-section (a blown up singularity) does not imply nothing or absolute location, rather it implies that direct access (unlimited understanding) is not available (i.e. objectivity fails).

Functionally zero-section is quite different from nothing/non-existence so we have an evolved concept of *zero* for our dealings with fundamentals. This concept requires its own symbol so

is suggested which combines the traditional 0 symbol with the tilde which is used to indicate approach and to mean *not* (i.e. not zero). The sinusoidal form of the tilde also suggests motion that is periodic. From time to time the nonobjectifiable central reference of opposition of MST, the observer, will be referred to as zero-section and for convenience I will substitute Θ for its symbol.

Part IV Reference, Scale And Metric In Non-local Continuum

§ 17. The observer is irreducible. MST expands uniformly

The objective imperative and the isotropic opposition it implies place observation centrally with regard to continuous unmediated relativity. This gives a preliminary description of MST. This observation of MST has no interior and thus is *irreducible*. Because observation of opposition is isotropic, unmediated and irreducible, dynamical reference cannot *approach* observation and objectivity can only appear as continuous *recession*, away from observation. Thus motion-spacetime can only be observed as continuous isotropic 'expansion' (in an absolute sense recession has no scale). This unmediated observation is of the infinitesimal geometry of spacetime.

The objective imperative is intrinsic to existence and is generally translational. It functions as the source of MST, *away from which* isotropic objectivity uniformly and endlessly recedes. Recession from centrality is consistent with the general celestial observation. However, objectivity is not corporeal, cannot be bounded and, without

absolute scale, is not being created (we cannot say that there is more MST). The geometrical objective imperative is then the primal force, the positive cosmological constant Λ.

Isotropic relativity, having neither interior nor asymmetry has the SO3 symmetry of unbounded sphericity. We will need to refer to this set of properties from time to time and as a convenient terminology is needed the neologism *telosphere* is introduced. All subsequent observations are evolutions of the telosphere which is an end-sphere in terms of following phenomena into irreducible simplicity the limit of which is the epistemic barrier posed by non-objectivity. The primal observation is isotropic opposition, the irreducible telosphere, observed as though from centrality by the nonobjectifiable observer. By shifting focus to look farther outward the general celestial observation of a homogeneous, isotropic, expanding universe (at large scale) is obtained, the observer remaining impossible to objectify.

In big bang cosmology observation was present as the telosphere at the big bang which can be a node but cannot be a beginning, an MST bound. At the present limit of astronomical observation homogenity is increasing and extrapolation into greater distance indicates that homogenity continues to increase as the big bang is approached. The position of the observer can only be central in this view as the observer is not particular but general. This generalizes the Copernican viewpoint that the position of the observer is not privileged. It is interesting that as the celestial observation is expanded and appraaches the big bang the observer finds himself in the telosphere.

§ 18. The metric relations of MST: Variation of the continuous symmetry of non-local continuum constrains expansion.

As so far described, the telosphere is *smooth* and smooth expansion of unbounded continuum lacks any reference and reference is required for objectivity. This is the heart of the paradox. The telosphere is an introductory device. It does not exhibit metric, has no speed and cannot be observed. Observed expansion exhibits finite speed, metric. Therefore the objective imperative *must* generate isotropic expansion in such a way that it is *constrained to metric rate*. Only then can it be observed.

Isotropic expansion is purely geometrical. As mentioned above, an influence able to direct all of evolution can only operate through the underlying geometrical nature of activity. Induction of metric (and thus observable speed) can only be effected by altering, thus decreasing, the continuous symmetry of isotropic expansion. The objective imperative, being unbounded, to maintain metric speed, must then continuously vary MST symmetry. Thus the primal force is more complex than Λ.

§ 19. Irreducible harmonic periodicity and the least energy principle

The objective imperative, which may be thought of as the prime mover of nature, is a non-local property of MST that has the effect of a ubiquitous *pressure* initially inducing isotropic recession. But smooth recession and continuous symmetry do not provide a basis for metric. The MST continuum, at this stage of its description, is a group of geometrical properties. The only one of this group that is available for variation is continuous symmetry. Thus in order to induce *metric* the objective imperative can only operate by inducing continuous variation of the symmetry of isotropic recession. This variation of symmetry can happen in only one way. It will be sinusoidal and perfectly regular enabling metric (finite) speed with a particular set of very special properties.

Here are the constraining factors and how they work to induce the special properties of MST metric. When symmetry is being reduced, the trajectory, the geodesic, of MST departs from perfectly spherical. Geodesic lengthening *of any amount* means return to continuous symmetry is available as a path of continuous variation. Pressure from the objective imperative prohibits continued lengthening of telosphere geodesics when a less energetic MST interval is available forcing a return through continuous symmetry. This initiates a sinusoidal cycle of symmetry variation as MST collapses continuously into the trajectory *that maintains metrical symmetry variation in the least energetic MST interval*. The pressure-effect of the objective imperative compels *minimal deviation* from continuous symmetry and *immediate return* through continuous symmetry. This is the simplest instance of the least energy principle. It is intrinsic to the objective imperative and can never be violated. This initiates harmonic resonance whose metric is derived from the inherently sinusoidal period that is the fundamental cycle of the objective imperative; the base harmonic of nature. Observation of this sinusoidal cycle is unmediated. It can only be observed as scaleless or irreducible and can only be perfectly regular. The cycle is imperative and cannot be interrupted and being irreducible it cannot be divided. This *metric recession* of MST geometry is observed as MST interval (rapidity).

This is the emergence of existence, *objectivity*, from the failure of objectivity. The elementary observation becomes *isotropic recession of metric continuously varying symmetry*. The coincidence of this isotropic recession *with* symmetry variation is possible only in non-local continuum, in which location has inherent indefiniteness.

§ 20. The base harmonic is *c*

By means of this invariable cycle metric, speed, is established in isotropic expansion without establishing an absolute scale. Within an irreducible base period a cycle of expansive harmonic resonance is observed in endless repitition. Each cycle of is

formed in an irreducible interval. This is observed as the base MST interval, which defines the highest possible speed. Appearing as isotropic expansion of MST, this defines the maximum propagation rate of MST curvature. This is *c* the propagation speed of causality. This metric speed is determined by geometrical imperatives intrinsic to the objective imperative which initially require isotropic recession Λ, then metric, giving *c*. By acting to deform MST curvature, these same geometrical imperatives produce the antipodal complement of Λ. What were thought of as 'forces', expansion Λ and its metric constraint G, are the complementary geometrical effects of the objective imperative. This is the grounding of General Relativity.

In this way we find we would be considering 'initial conditions' for the big bang, however objectivity cannot be bounded and origin is disallowed. A big bang can be a minimally simple node, a telosphere, but not an absolute origin, a bound, and the universe, *existence*, can have no absolute age, only episodic age with no absolute scale. This recovers conformal cyclic cosmology.

Part V. The common ontology of MST and mathematics

§ 21. Periodicity of continuum supports enumeration.

Unitarity cannot be elemental, but the sinusoidal periodicity of the base cycle is indivisible and its endless, irreducible iteration is the only scaffold for enumeration that is consistently available. Consistent enumeration, the natural numbers, must refer to the base harmonic cycle which they must enumerate. The regular, endless, irreducible and indivisible base harmonic of MST is then the basis of measuring; the fundamental unit. Unitarity exists within dynamical continuum, not as an element.

Unity in the telosphere has twin interpretations. The first can be rendered as entirety, the wholeness of the telosphere. Its twin concept is the unitarity of the iteration of the indivisible base cycle of action. Both interpretations of unitarity are consistently present and, defined in terms of objectivity, arise as consequences of the objective imperative. Harmonic resonance of MST is a discontinuity-free pattern. No gap appears between irreducible cycles as they are iterated and counted as a natural number and its successor. Inflection of the sinusoidal continuum is non-local. These conditions have implications for analysis and for other areas of the present mathematical architecture and also for Quantum Field Theory and General Relativity.

Our present concepts of point, element, unity, and zero are inconsistent. The difficulty in the present attempts to establish the real numbers without incurring inconsistency is that all of these attempts are trying to establish separation and continuum at the same time.

§ 22. The consistent view of primeness in MST.

The base harmonic of MST is the fundamental operating principle of nature: motion-spacetime is discontinuity-free, periodic and integral. The natural numbers, as they count iterations of the base cycle of action, find the cycle cannot be divided but can be arranged in groupings of integral cycles. These possible groupings of the iterated base harmonic then are understood as the canonical forms of the natural numbers. *Primeness*, represents the base period of MST, its iteration and the possible groupings of the cycle, the allowable ways in which the cycle can form groupings in order to evolve. In this way MST geometry underlies the prime numbers, the Fundamental Theorem of Arithmetic, the operator values e and π (which emerge from primeness), the unit circle, sphericity, hyperbolicity and the complex numbers. Both sphericity π and hyperbolicity e are characteristic of both MST and primeness. By means of this basic identity of geometry with dynamical MST it is seen that the ontology of mathematics arises directly from existence.

Beginning with elementary objectivity this reveals that the geometrical basis of continuum and prime number theory is the foundation of mathematics. Underlying everything this principle of integral grouping of a base cycle has always governed evolution.

The common ontology of mathematics and MST is what makes encoding work and the problems we have with encoding stem from ontological approximations we are making. A specific MST region encodes a specific mathematical structure and the telosphere encodes a specific mathematical architecture. We now begin to develop the interrelation of the geometry of the telosphere, the number system and the basic dynamical properties of MST.

Part VI. General properties of MST

§ 23. 'Time' in MST

In the present concept of spacetime, neither time nor space has a behavior of its own. Meaningful quantities are achieved only in spacetime. Still a truly meaningful understanding of the 'time component' of spacetime is elusive. This is because motion is viewed as elemental or discontinuous. Time cannot be understood in a discontinuous framework. Here is the problem:

To observe time it appears to be required that one state of existence pass, giving rise to another. Failing two states time is not observed. For example if we consider making a time measurement by the most accurate clock conceivable then what would be noted in this clock would seem to have to be a failure of congruence of 'two states' of existence that appeared in sequence. We might see an atom change

from one state to another state and the failure of congruence of the two states is noted. There is however no clear understanding of how one distinguishes the 'first state' from the 'second'. To understand the actual situation, consider that no clock can be more refined than the telosphere. In the telosphere what is time?

Absolute time, the only time in which we have any interest at all, requires fixing a local instantaneous now. Thus 'time', if we use traditional zero when establishing a 'now', brings with it both absolute locality and quiescence. This implies absence of continuous relativity, objectivity and existence. An instantaneous now would be non-existent. An observation or specification that seeks to determine an absolute location of MST is necessarily objective and observes MST. Nonobjectifable zero-section, 'the observer', is never observed. All observation and all specification is of MST and is inherently non-local and indefinite. This refines the indefiniteness noted by Heisenberg to

$$\Delta_O = \nu_f \tag{23.1}$$

where Δ_O is indefiniteness of observation and ν_f is frequency of the fundamental harmonic. In this way time can be understood only as MST, and transience, the impression of the passage of a 'now' from future through present into past is an artifact of irreducible, unstoppable geometrical displacement in which there is no concept of instantaneous now and metric MST is all that is observed. Neither time nor space exists separately. Existence is only active geometry in which the name 'time' is the *rapidity* of relativity theory in which now has become not only relative to the observer but always has the indefiniteness of (23.1).

§ 24. A note on entropy

Entropy is disorder and the telosphere is well-ordered. The properties of the telosphere establish a unique form, given in only one way. The telosphere thus embodies minimal entropy which is given as

$$S_t = K \log 1 = \Theta \tag{24.1}$$

where Θ is zero-section.

A non-expansive mode of the translationally symmetrical telosphere is not possible. Process cannot be reversed. Isotropic recession cannot reverse to become afferent with respect to observation. This implies irreversibly increasing entropy, the entropic arrow of time, and is the basis of thermodynamics.

§ 25. The energy content of the telosphere

In the quantum regime there is an inverse relation between wavelength and energy, given by the energy of the quantized photon

$$E = \frac{hc}{\lambda} \tag{25.1}$$

where E is the energy of the photon h is Planck's constant *c* is light speed and λ is wavelength.

But what does this equation say, what in fact is energy? The 'capacity to do work' is the propensity to move which is only the objective imperative which underlies all action. 'Energy' is the imperative for continuous relativity, nature's fundamental pressure, which appears as MST. It is a property of existence, of the telosphere, which has no absolute scale. Thus there is no available measure of the absolute quantity of energy which is therefore never created or destroyed. This is the source of the conservation of energy. The metrical rate of the sinusoidal base harmonic of the MST continuum measures this pressure, the earliest form of metric energy. Thus the equation for the energy of the telosphere, from which the quantized energy equation derives its form, must be of the form

$$E_T = \frac{c}{\lambda} \tag{25.2}$$

Where λ is the irreducible 'wavelength' of the fundamental harmonic and c is the propagation rate of MST curvature, a constant derived from the four parameters of MST (as shown by Minkowski, § 29) and functionally equivalent to e. (25.2) can be restated in its inverse as

$$E_t = \frac{\nu_f}{c} \tag{25.3}$$

This states that indefinitely high (the highest possible) observed frequency of the base harmonic of the objective imperative is the source of the universe's energy. The energy content of the universe is indefinitely high but it is not 'infinitely' high.

Part VII. How the objective imperative forms the world from the base harmonic

§ 26. Primeness, the (Euler-) Riemann zeta function, e, and π [1], [2], [5]

Both π and e, bearing the strong consistency requirement, are properties of MST. The operator π arises in telosphere continuous (spherical) symmetry. The base e arises as a geometrical effect of the restraint of expansion imposed by the objective imperative. To unfold the roles e and π play in base-cycle harmonics we first need to look into the (Euler-) Riemann zeta function, a permutation of the harmonic series

$$\zeta(s) = 1 + \frac{1}{2^s} + \frac{1}{3^s} + \frac{1}{4^s} + \frac{1}{5^s} + \ldots \qquad (26.1)$$

The (Euler-)Riemann zeta function and its immediately derivative equations encode primeness. This encoding is first shown in the Euler product formula (EPF)

$$\sum_n n^{-s} = \prod_p \left(1 - p^{-s}\right)^{-1} \quad , s > 1, \qquad (26.2)$$

the left side of which is the real-valued zeta function.

Among the most significant formulas in mathematics, the EPF is an equality relation that is logarithmic. The sum over the indefinite sequence of natural numbers is found to equal the product over the indefinite sequence of the prime numbers when each sequence is properly arranged. This indicates that e has a role in the formation of motion-continuum. The EPF also shows (by another method than Euclid's) that the primes extend indefinitely.

Euler's formula was taken by Riemann as his starting point in his 1859 *Uber die Anzahl der Primzahlen unter einer gegebenen Grosse* in which Riemann examined ζ(s) as an analytic function of a complex variable. Let us review a few properties of the zeta function that give it fundamental significance.

Beginning with the EPF Riemann developed ζ(s) into its functional equation

$$\Pi\left(\frac{s}{2} - 1\right)\pi^{\frac{-s}{2}}\zeta(s) = \Pi\left(\frac{1-s}{2} - 1\right)\pi^{\frac{-(1-s)}{2}}\zeta(1-s) \quad . \qquad (26.3)$$

This extends the domain of ζ(s) beyond the half-plane Re s > 1 to the whole complex plane with a simple pole at 1. The functional equation maps the extended complex plane; that is, the complex plane (with a simple pole at 1) with the concept of infinity adjoined. The zeta function encodes primeness (26.2) and, as extended, maps the complex field (26.3). Strong consistency means the extended complex plane is motion-spacetime. So ζ(s) in some way maps the simplest MST, the base harmonic.

Since ζ(s) encodes primeness one may take the view that the zeta function imposes structure on the (metric) telosphere as though the zeta function were imposing the FTA on MST (on the telosphere), in fact as though ζ(s) were *primeness*

itself. Indeed the relation of the structured MST continuum (the telosphere) and the structured zeta function (primeness) is mutual encoding. They imply one another. Neither is precedent to the other. We may say

$$\zeta(s) \Leftrightarrow T \tag{26.4}$$

It may then be said that primeness is (largely) characterized by four equations: the zeta function (26.1), the Euler product formula (26.2), the functional equation (26.3), and the J function (so called by H.M. Edwards)

$$J(x) = Li(x) - \sum_{\rho} Li\left(x^{\rho}\right) - \log 2 + \int_{x}^{\infty} \frac{dt}{t\left(t^2-1\right)\log t} \tag{26.5}$$

Taken together, these four equations form a self-consistent group that implies a structure and that structure implies both primeness and the telosphere. The four equations acquire their form from being encoded in MST. The telosphere (spherical-hyperbolic MST geometry) encodes the mathematics of primeness.

primeness ⇔ telosphere

Examination of this 'group' exposes essential details of this mutual encoding.

§ 27. How mutual encoding is realized in the 'structural group' [1], [2], [5]

Equation (26.1): The zeta function encodes primeness. The basic relations of primeness are presented in the FTA, in the canonical forms of the natural numbers which have to refer to groupings of the iterating base harmonic. Primeness is a geometrical property, a metric property of the base harmonic, and is generated in large part by e and π.

Below, a general view of how the ζ(s) 'structural group' refers to telosphere geometry is outlined.

Equations (26.1) and (26.2): The EPF rearranges ζ(s) into an equivalent formulation. Initially, Euler's interest in the harmonic series was kindled by the Basel problem, finding a closed form for the reciprocal squares, and the perplexing appearance of π in his solution $\frac{\pi^2}{6}$ of that problem. Also the real-value zeta function (with any even integer exponent) encodes π.

The reduction of the number system to canonical form in Euler's derivation of the EPF reveals the well known, but still stunning, logarithmic relation of primeness

to the natural numbers. Our curiosity is greatly aroused. This logarithmic relation means that ζ(s) encodes e and primeness (along with π), number theory, and the foundations of mathematics. Euler developed the EPF by writing the primes in their canonical forms, the divisibility groupings of the base harmonic.

For two millennia previous to Euler's discovery of the product formula in 1737, the sieve of Eratosthenes and Euclid's observations of both the existence of an unlimited number of primes and the FTA had been sufficient evidence to realize that primeness is encoded somehow – else how could we know these things? But the encoding was unobvious. That primeness is encoded in the zeta function became quite obvious with the discovery of the EPF but, for the next hundred years, development proceeded slowly.

So, though the two formulations are equal, the Euler re-statement of ζ(s) reveals a relationship that is profoundly meaningful but is obscure when the zeta function is considered alone. We can add to this insight.

The complicated image that is formed by the structural group begins with these observations:

- ζ(s) in some way encodes π (the Basel problem).
- The EPF encodes primeness.
- ζ(s) encodes primeness.
- Because ζ(s) encodes primeness it encodes the continuum (enumeration).
- The encoding of primeness is logarithmic and so is a function of e.
- The zeta function encodes e and π.
- If e and π are encoded hyperbolicity and sphericity are also encoded.
- The zeta function associates 1 with indefinite extent.

Equations (26.1), (26.2), and (26.3): Riemann's derivation of the functional equation is quite direct and involves the conceptually important contour integral,

$$\int \frac{(-x)^{s-1}\,dx}{e^{x}-1} \tag{27.1}$$

which Riemann describes as ". . . from +∞ to +∞ taken in a positive sense around a domain which includes the value 0 but no other point of discontinuity of the integrand in its interior . . .." [5]

Discontinuity is disallowed so this integral on a contour surrounding the origin must be viewed as the Cauchy integral on a contour surrounding an origin is viewed. To be used in fundamental contexts the integral must be interpreted as describing zero-section of MST. Thus we interpret Riemann's use of this contour integral as presenting motion-continuum and zero-section in the zeta function, the EPF, and the functional equation.

The 'global' functional equation (26.3) is thought of as having been derived by

employing these two inescapable concepts, MST and zero-section, which of course are not explicitly present in either Euler or Riemann's work but are implicit in both. Equation (26.3) remains valid for all s and shows that ζ(s) is single valued and finite over the entire complex plane with a simple pole at 1.

ζ(s) (extended) is a map of the continuum associating every complex value with a particular location of some geometry with a simple pole at 1. The domain extension of ζ(s) drags along the domain of the EPF. Here is how ζ(s) generates the telosphere.

Equations (26.1), (26.2), (26.3), and (26.5): The J function, the main result of Riemann's 1859 paper, encodes of the counting process of the number of prime numbers up to a given quantity. The encoding of primeness is present in ζ(s) but is too obscure to be noticed. In the EPF however the encoding is seen and can be used to some extent (e.g. as a second method of showing the number of primes has no limit).

In the J function the encoding has an explicit, useable form. More importantly for the present purpose, evaluation of its four terms displays the operators e and π encoding primeness geometrically. Again, encoding works because mathematics and MST have a common ontology. Here, in outline, is the encoding of primeness.

First, π is present in real s considerations of the zeta function where closed forms of even integral exponents are all factors of π. Somewhere in the background of zeta π is present as an operator but how π is functioning is not yet explicitly clear. It just seems to appear. Pi is sphericity and consistency requires the spherical reference to be the telosphere.

Next, in Riemann's 1859 paper the role of π as an operator which determines primeness and the continuum is seen in the use of the complex exponent s. Complex numbers encode π and e in their logarithmic form. Complex numbers mean that π and e are operating together.

The J function, even though it is an analytical function, must produce a natural number. The first, third, and fourth terms of (26.5) are quite simple. Each produces a number.

The simplest of the four terms is the third. It is the natural logarithm of 2. The log function is the inverse of e^x so e is the operator in the logs and the log integral function. The third term number is determined by the base e operating on 2 (the first prime number and a concept number). Note also that e is *defined* as the area under the rectangular hyperbola. Primeness (MST) is the interplay of sphericity and hyperbolicity, π and e, with the groupings of the fundamental harmonic.

The fourth term is an integral, an area, that again is determined by e as the reciprocal of the log of t the height on the critical line. Both e and π are acting as operators producing telosphere geometry.

The first term is the principal term. It comes from the Prime Number Theorem and gives the PNT approximation of the count of primes under a given quantity again as an area that is determined by e. The other three terms are corrections to this estimate.

§ 28. The error term [1], [2], [5]

The second term is more complex and interesting than the first, third and fourth because in this term e and π function together explicitly as operators in a complex interrelation. This can be examined as J is evaluated and e and π operate in the following way.

Almost as though to explicate these operator functions, the error term of the J function

$$\sum_{\rho} Li\left(x^{\rho}\right), \tag{28.1}$$

as it is evaluated, presents the operation of π and e.

The quantity x of (28.1) is the number, in ascending along the critical line of some root ρ of ζ(s). The critical line takes on many different shapes as zeta and the structural group equations are evaluated. The critical line can be shown in other forms than Re ½ on the complex plane. Evaluation begins by raising this number x to the power of all roots ρ up to x. If the RH is valid, all these powers have the form ½ + ti so for any given root the modulus of $x^{\frac{1}{2}+ti}$ is $\sqrt{x}$ while the argument varies. The constant modulus and varying argument array these roots (which are the critical line) in a circle of radius $\sqrt{x}$ centered on the origin in the complex plane which we interpret as zero-section, the origin of enumeration, of primeness and as the observer of isotropic recession. This circle comes from the rules of complex numbers which derive from the unit circle. The fundamental unit circle is the telosphere (Fubini-Study metric).

What does this mean? The base harmonic is iterated. Its iterations are 'counted' as enumeration. Enumeration can be arranged in a series of groups or canonical forms called prime and non-prime numbers according to whether the accumulated iterations of the base harmonic can be sub-grouped or not. The reciprocal of this series is the harmonic series. In this way the base harmonic underlies π and e. This shows how π, sphericity, arises from the objective imperative and is inseparable from metric MST, from the integral divisibility, the groupings, of the base harmonic.

If the RH is valid and all roots ρ of ζ(s) have real part ½ then this geometry is a circle and not a warped non-circle. But the geometry is the telosphere which has

continuous symmetry. This seems to validate the RH, with the understanding that the intrinsic indefiniteness of MST means that the RH is valid but transcendental.

The next step is to apply the log integral function to these points on the circle of radius $\sqrt{x}$. This process introduces the effect of e on π through the Li function. The log integral function reforms the circle of these ρ's (the critical line centered on 'zero') into two conjugate, ever-tightening spirals around the conjugate foci +πi and -πi, with RH valid.

With RH valid this in-spiraling becomes ever-more-nearly circular as ti increases and the conjugate locations +πi and -πi are approached. In the limit of approach (with RH valid) these spirals become circles surrounding the zero-sections +πi and -πi, which they must do in approach to the telosphere.

As the error term is progressively evaluated primeness drives toward zero-section with πi (neglecting its conjugate) as the focus. The visible operators effecting this are e and π but in the background the 'pressure' is the objective imperative. Primeness, which is random, or pseudo-random, possesses these internal, hidden, geometrical symmetries, assuming RH (but the symmetries are required).

The next step is to sum all the Li points that form the section of the critical line we are evaluating into the in-spiraling that is centered on πi and -πi. This produces a generally harmonic progression of the points approaching zero. Riemann called these terms *periodischer Glieder* but their progression is not truly periodic but only oscillatory. Still there is what appears to be a bounded greater-and-lesser oscillation that approaches zero a generally harmonic way. This combination of randomness and boundedness is the influence of the pseudo-randomness of primeness and again appears to be what introduces irregularity into the evolution of the telsophere.

Part VIII. MST geometry determines light speed

§ 29. Light speed is the geometry of e

Order within natural processes and the constancy of light speed are two of the most significant discoveries. The realization that light speed is constant implies things about natural process which have revolutionized our understanding of nature. Among the conditions of nature determined by that which determines light speed are: 1) distance contraction and time dilation, 2) the interdependence of energy with time, and of momentum with position, 3) the relativity of simultaneity, 4) the equivalence of mass and energy, 5) relativistic causality, 6) the union of space with time, 7) the hyperbolicity of spacetime geometry, 8) dynamically effective geodesic spacetime, and 9) non-locality. The condition that causes light speed to be constant at c, with its great cascade of consequences, is the objective imperative.

To recap briefly, the natural numbers are iterations of the base harmonic. The groupings of the base cycle are the canonical forms of the natural numbers, that is primeness. Primeness and MST are reflections of one another. The operators e and π are the form of objective imperative requiring isotropic recession, continuous variation of symmetry, and the hyperbolicity and sphericity of MST. The isotropy of objectivity constrains MST to pass through continuous symmetry, sphericity, giving π. The indefiniteness of radius is the reason π is transcendental. The collapse of MST continuous symmetry to geodesic, minimal asymmetry and its return to continuous symmetry is unmediated and irreducible. This continuous sinusoidal variation of symmetry, the base harmonic cycle, can only be observed as irreducible and thus has *only one* possible rate c and c is e. Light speed is c ≡ e. This is shown in this way:

The geometry of e is the rectangular hyperbola (Figure 1) given by

$$xy = 1 \tag{29.1}$$

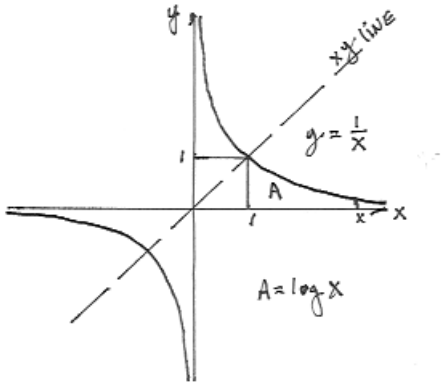

Figure 1

which has the property that the area A under the curve from the origin of the curve at x = 1 for all x ≥ 1 is given by

$$A = \log x. \tag{29.2}$$

When

$$x = e, A = 1. \tag{29.3}$$

The unit rectangular hyperbola is generated by beginning at 1 and drawing the curve determined by the function A = log x taken as the integral of infinitesimal areas A.

$$A = \log x = \int_1^x \frac{dx}{x} \tag{29.4}$$

The base e is defined by the geometry of the rectangular hyperbola.

$$A \Leftrightarrow e \Leftrightarrow H \tag{29.5}$$

where H is hyperbolicity. The collapse of continuous symmetry, in the least possible time at the highest possible speed is *also* defined by e, as the highest possible value of frequency of the MST harmonic, its irreducible period.

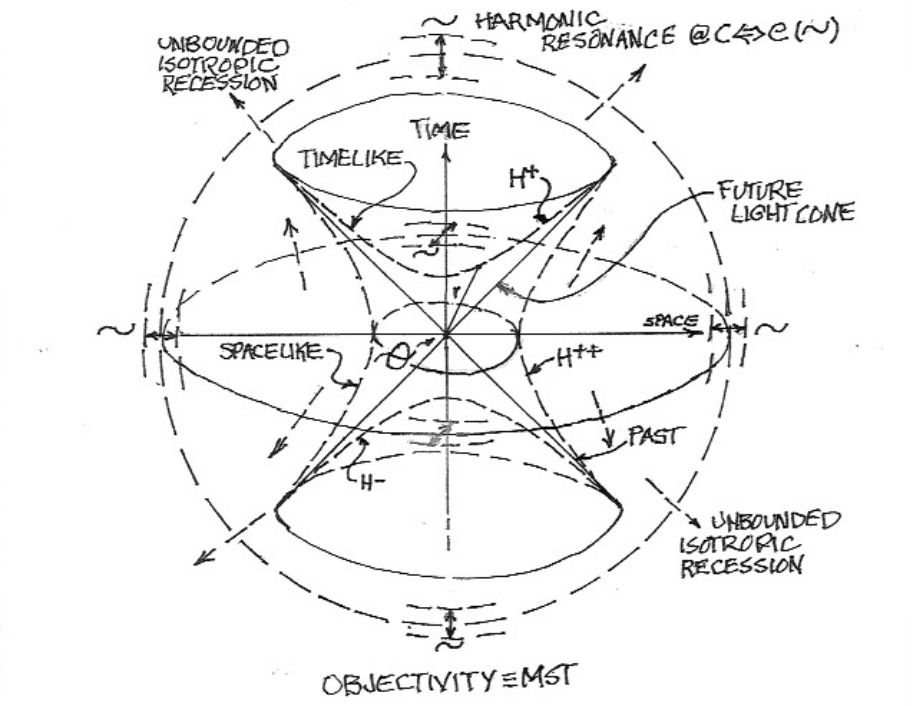

Figure 2

This was shown by Minkowski (Figure 2). The interior of Figure 2 is the light cone diagram with one spatial dimension suppressed. With two spatial dimensions and time MST is displayed as three hyperbolic manifolds with their asymptotes.

Every observation or measurement is an 'interval' of MST which requires a four-term Pythagorean theorem which combines the three dimensions of Euclidian space x, y, z with time t entering the formula as a fourth parameter. Time enters the formula with its sign opposite from the sign of the three spatial dimensions. These four parameters then develop the trajectories of all possible cases of MST (motion is of MST not in it).

The light cone diagrams have three possible variations: t positive, t negative, or t = 0.

If time is entered with a positive sign the infinitesimal interval ds^2 in the formula

$$ds^2 = dt^2 - dx^2 - dy^2 - dz^2 \quad (29.6)$$

is positive. in timelike displacements. This quantity can be interpreted as time. This signature gives the hyperbolic H+ and H- manifolds. If time is 'zero' (Θ) this gives the conical nappes of which the original instance is the base harmonic c.

A world line beginning at Θ and moving uniformly, traces the line r ending on H+. Higher speed moves the ending of the world line tracing H+. Collectively the endings of such world lines trace the hyperbolic manifold H+, from the Θ velocity location at 1, to the asymptotic limit of the H+ manifold, the 'light cone', which is traced by freely propagating MST curvature, such as the metric telosphere. Analog storage of 'information' as conformation of MST is represented as H ++. This is what causes entanglement. The exterior of Figure 2 is E3, with time suppressed, in which isotropic recession is suggested by arrows and the base harmonic is suggested by sine curves.

MST exists as the hyperbolic manifolds and the twin asymptotic light cones which fill all space. They are motion aspects of the sphericity of E3, the outer portion of Figure 2. Merged, they are M4. The two geometrical aspects, sphericity and hyperbolicity are, respectively, the form and motion aspects of MST. Hyperbolicity, the motion aspect, is identified with the base e. Its upper limit is the asymptote c.

Continuous variation of symmetry in the least possible time at the highest possible speed (the base harmonic) can only have speed c. This highest possible speed is determined by the geometry of the objective imperative as the base e. This is displayed in the Minkowski diagrams. We call this highest speed *light speed* but *c* is implicit in objectivity and prior to quantized radiation was present as the more fundamental form of radiation, the propagation rate of MST curvature.

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