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Mathematics

Dynamical Systems

1. Non-Linear Algebra as a Dynamical System

October, 94 -March, 95

114 pages in 3 parts. We define a finite groupoid as a collection of n elements with an arbitrary multiplication operation, that is to say a multiplication table. Let z = f(x, y) be a real function of two real variables. If the surface in 3-space represented by this equation has a finite number of values $A = a_1, a_2, \ldots, a_n$ **such that** $x, y \in A \rightarrow z \in A$**, then one can interpret the table of these values** $\{a_i, a_j, f(a_i, a_j)\}\ i, j = 1, 2, \ldots n$ **as the** ***generalization of the notion of the fixed point in 1-dimensional linear dynamics*** **.**

In these papers a complete description and analysis of *all* 2-element and 3 -element fixed point groupoids (also called binary composition algebras) on quadratic surfaces is presented. For the 2-element groupoids a calculation is made on the partial derivatives at the combination points (a_i **,** a_j **) , i,j = 1,2 to ascertain if they are if they are hyperbolic, attractive, repellent, or borderline.**

2. Benoit Mandelbrot's 5-Ring Fractal Conference

Conference at U. Cincinnati, September 1987. Sponsored by IBM and the NSF, this 5-day conference was designed as a basic introduction the concepts of Fractals and Chaos for computer scientists and persons working in related fields. In addition to

covering the conference, the author wanders about Cincinnati and the University campus, applying what he is learning to the sounds, sights and events around him.

3. Patterned Sequences and Functions

Let S be an infinite sequence of distinct numbers or indeterminate letters, notated $S = a_0, a_1, a_2, \ldots, a_n, \ldots$. We will say that S is patterned if any finite block $B = a_k, a_{k+1}, a_{k+2}, \ldots, a_{k+m}$ is reproduced elsewhere in the sequence in a block C. It is easily shown that C may be chosen so that B and C are disjoint.

After a general discussion of the properties of such sequences, the focus of attention turns to sequences of decimals to some base n (n-cimals), sequences of rationals, and Diophantine analysis. Of particular interest are iterate sets, collections of n-cimals obtained by successive left shift on the entries of an n-cimal. Patterned n-cimals play an important role at the boundary of iterate sets.

Patterned functions are defined in analogy to patterned sequences. Several theorems are proven that relate them to the theory of functional approximation.

4. Iterate Sets , Convergently Patterned Functions

The iterate set of a function Φ is the family of functions

$\Phi = \{ f_t(x) \} = \{f(x+t) \}$ Two metric topologies are defined in the space of bounded, locally Lesbesgue integrable functions on R^+. One of them is a refinement of the other. Convergently patterned functions are limit points. more specifically boundary points, of these iterate sets. Problems associated with convergence and

compactness are related to general considerations of the theory of functional approximation.

5. Self-Referencing Sequences

A self-referencing sequence of numbers or elements is one whose repetitive structure is such that it can be segmented into blocks which reproduce the structure of the original sequence. Such sequences are completely characterized in this paper, and interesting theorems proven about them.

6. Back-Reconstructible Algorithms

A function Φ on the positive real line, (readily generalized) has been constructed from pieces of another function P , known as the associated function, on the basis of an algorithm R , which selects pieces of its graph and splices them together.

The exact form of the associated function is unknown. The configuration of Φ ιs known only after a certain point on the line, which is also unknown. The algorithm R , however, is completely specified.

Under what conditions on R and Φ , is it possible to completely back-reconstruct Φ to the origin? Algorithms which permit this possibility are designated partially or totally back reconstructible, depending on the amount of information they provide.

Foundations

1. Two Papers in Transfinite Arithmetic :

The constructions in these papers derive from the following consideration: the technical term *countable* used in describing a certain kind of infinite set should mean , literally, a set that *can be counted*

. There are important differences between the process of counting a finite collection versus an infinite one that deserve more careful consideration.

Let us say that someone puts a finite number N of marbles inside a black box. Later I reach in it and pull them out, one by one, through a slot. In this case the order in which they are removed doesn't matter. Anyone who pulls all of them out will end up with the same number, N.

But if *you* put an infinite number of marbles in the box following some counting scheme, then *tell me* that their number is countably infinite, and *I* fish them out , one at a time, there is no guarantee that *any previous chosen countable ordinal* of my will exhaust the total number in the box.

There has to be a postulate to the effect that *any* count taken of a set *known to be countable must* terminate in some countable ordinal λ , even if λ cannot be known in advance, and this doesn't seem to be a postulate that can stand up to serious philosophical analysis: If no-one can state what the ordinal λ is , how can it be asserted that there must be one?

The order in which the marbles are put into the box is called the *presentation* . Presumably, the contents of the box are *presented* to the person putting the marbles into it, but *unpresented* to the person to whom the box is handed over.

It is argued in these papers that *an unpresented set of indistinguishable objects cannot be counted* . In some sense it is "uncountable" . To say that a set is countable means that someone has counted it. This pre-counting is essentially the presentation.

A. Weakly Infinite Cardinals, 1981:

In an attempt to give some meaning to the exponent σ, in the expression $2^{\sigma} = k_0$, I produce several constructions on a Hilbert space of an unordered, yet countable, number of dimensions. At the same time, a ***two-valued cardinal*** **for sets of indeterminates is employed, the left term of which gives the total number of elements in a set, while the right term gives the total number of** ***distinguishable*** **elements of that same set.**

By means of these constructions I establish a series of ***weakly infinite cardinals*** **$\{\sigma_j\}$, such that**

$$2^{\sigma_j} = \sigma_{j-1}, \ j > 0 \ ;$$
$$2^{\sigma_0} = K_0 \ .$$

A ***relativity postulate*** **for Hilbert spaces is enunciated :** *" All infinite -dimensional subspaces of a countable dimensional Hilbert space are geometrically indistinguishable from the space itself".* **The rest of the paper goes into what is meant by the term** *"geometrically indistinguishable."*

2 . Generalized Ordinals, 1991 :

(i) Since a 'countable set' must be ***presented*** **in a certain way in order to be 'counted' by a countable ordinal, there is no way to say that an unpresented set is countable or transfinite, but only that it is infinite. A presented set is one that has been pre-counted in some fashion that indicates that it is countable, as well as the process for counting it. The "effective uncountability" of a countable but unpresented set is called the** ***Box Paradox*** **.**

An argument is made to show that, without this clear distinction of presented and unpresented sets, Zermelo's method of setting up the ordinal process on the reals to generated the

ordinal e, of transfinite Aleph-1 , can also to a set of order type q , of the rationals.

3. Transfinite Sums, (1980) :

An investigation into ways of rendering expressions such as

$$S = \sum_{j=0}^{\varpi^n} a_j$$

meaningful, where ω^n is the lowest ordinal corresponding to the n^{th} order transfinite cardinal. An example is the classical identity :

$$\prod_{n=1}^{k} \cos(x/2^n) = 1/2^k \sum_{j=0}^{2^{k-1}} \cos(\alpha_j^k x), where$$

$$\alpha_j^k = 1/2 \pm 1/4 \pm 1/8 ..... \pm 1/2^k$$

the index j going over all switchings of the "plus" and " minus" signs.

The intermediate sum can be interpreted, in the limit, as a *transfinite sum* , since it will have Aleph-1 addends. It also has the form of a Riemann sum , so that it goes over naturally into an integral. This paper therefore investigates properties of certain kinds of infinite series that may be interpreted as Riemann sums. The construction is intriguing, but I could find little useful application for it.

4. Counter-Intuitive Science

Modern science abounds with assertions that appear to fly in the face of simple commonsense. This comes as something of a surprise, because hard science claims to be derived from simple perceptions and irreducible self-evident notions. Even the most abstruse scientific theory is built on ideas so elementary that no sane person would bother to dispute them. An examination of the counter-intuitive statements characteristic of modern science

indicates a decision is made as to what set A of self-evident notions will be treated as *more self-evident* than another set B , which, having been designated as *less self-evident* are replaced by a counter-intuitive statements derived from A.

The set of examples chosen for this paper are drawn from modern logic, relativity and quantum theory . In each case our curiosity prompts us to reverse the direction of the standard syllogism: that is to say, if two sets of assumptions, A and B, are taken to be self-evident , and if , by giving its verdict to A , modern science has demonstrated that B is no longer tenable, we examine the consequences of giving *greater* validity to assumption B, then looking at the set of "counter-intuitive "conclusions that replace A.

This leads to an alternative science, one might call it the *dual image* of contemporary science. It is speculated that, at least in certain cases, the pairing of *Image/Dual-Image* may be a more effective vision of reality than a narrow adherence to either side of the debate.

5.Review of Ray Monk's Biography of Bertrand Russell

Numerous biographies have reinforced the public's interest in the basic facts of the life of Bertrand Russell. After evoking the notion of a "relevance dilemma" in professional philosophy, the author, using Ray Monk as a guide, discusses the scope and merit of Russell's efforts in the following domains:

A. Logic

B. Popular Writing

C. Political Activism

D. Sexual Liberation

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Topology

1. Topological Insights

A. On Homeomorphisms and Order Types

B. On infinitesimal Neighborhoods

C. On the Topology of the Euclidean Line

A. Order types on the real line are more general than homeomorphisms, because the "order type" of R is completely specified by its Dedekind cut structure, that is to say, the bounding properties of its limit points, a homeomorphism of R onto itself must take into account its connectedness. For example, one can easily construct subsets C of R which has the same order type as R itself but which are not homeomorphic to R.

The topology of C can therefore be imposed on R by virtue of the identity of order type. This section of this paper classifies all such topologies

B. Draw a simple, non-self-intersecting closed loop K in the plane, and let q be a boundary point of K. Let $\boxed{O = I \cup \{q\}}$, where I is the open interior of K. We modify the standard topology of the plane , R^2 , by adjoining O as an open set. All intersections and unions of open sets Q of R^2 with O are also open. However, sequences of points in the plane that normally converge to q in the standard topology, will no longer converge to q in the new topology. In effect, the various intersections of O with the neighborhoods of q form an *infinitesimal neighborhood* : K can be replaced by its intersection with any arbitrarily tiny neighborhood of q, to give the same topology.

C. It is customary to treat the open interval I = (0,1) as homeomorphic to the entire real line, R. There is a way however,

to characterize the distinction between the "extendability" of I and the "inextendability" of R, by invoking a stronger definition of homeomorphism based on neighborhoods rather than open sets: two topological spaces on R, $M_1 = (R, T_1)$ and $M_2 = (R, T_2)$ will be deemed strictly homeomorphic, if there is a 1-l map carrying *neighborhoods* of M_1 into *neighborhoods* of M2 , and vice versa.

This construction allows one to give objective topological meaning to the concept of an infinitely extended set.

2.A Metric Topology on the Space of Permutations

A topology is placed on the space S_ω of all permutations of the positive integers $Z^+ = 1,2,3$............ S_ω is a group: if

$$\begin{array}{l} \sigma,\rho \in S_\varpi \\ \sigma = (s_1, s_2, s_3, \ldots, s_n, \ldots), \\ \rho = (r_1, r_2, r_3, \ldots, r_n, \ldots) \end{array}$$

one defines the product by $\sigma\rho = (r_{s_1}, r_{s_2}, r_{s_3}, \ldots)$. The identity for this group is $\varepsilon = (1,2,3,4,\ldots\ldots)$. The topology is defined via a map of S_ω into an infinite-dimensional Hilbert Space :

$$\begin{array}{l} \psi : S_\omega \to H \\ \psi(\sigma) = \psi((s_1, s_2, \ldots\ldots)) \equiv (2^{-s_1/2}, 2^{-s_2/2}, \ldots\ldots) \end{array}$$

This paper discusses the unusual properties of this topology.

Geometry

1.Theoretical Foundations of Foundation Theory, 1988:

The axioms of Hausdorff Topology and Projective Geometry are set up in a way that reveals them to be mutually exclusive. Foundations are defined to be coverings of sets governed by a combination of axioms taken from each of them .

Combining some of these axioms with the negations of others, with their duals and the negations of their duals generates a large class of geometrical structures . Foundations appear to be natural geometric objects.

2. Projective Constructs and Concepts in Relativity and Quantum Theory, 1992 :

Although a paper in mathematical physics, its concerns are primarily those of projective geometrical. Its' contents are summarized in the Mathematical Physics section.

3. Generalized Centroids, 1981:

Generalizing the centroid notion to a larger class of topological sets in the plane. Refining the concept of spatial dimension by a hierarchy of sub-dimensions . These are similar to Fractal dimensions, yet sufficiently different to warrant their investigation. An interesting aspect of this paper consists of a generalization of integration over a broader class of topological domains.

4. Theorems on Plane Convex Sets, 1986 :

The fixed point theorems of Differential Topology are used to generalize classical results about conic sections to general convex figures.

Combinatorics

1. Cubical Matrices, 1978:

This paper looks at the identity relations on 3-dimensional arrays composed via tri-linear scalar products. There are several ways to do this. For example, one may treat the square arrays defined by lateral, vertical and horizontal sections, as determinants, which are then multiplied together;

or one may construct a genuine tri-linear product on the basis of the three orthogonal lines passing through every point. This ambiguity is actually a defect for it makes it very difficult to define inverses. These objects have interesting symmetry relations.

2. Associative Harmony, 1962 :

Mathematical structures in serial composition. Combinatorial properties of all-interval tetrachords. Progressions of trichords sharing a common interval. Combinatorics of trichord associative harmony. 4-point counterpoint with all-interval tetrachords.

Number Theory

1. Dissonant Functions, Primal Sequences, 1983:

This paper treats the greatest common divisor function, or g.c.d., applied to rational polynomials in one variable, like an inner product: Suppose that f(x) and g(x) are polynomials in one variable over the integers, with rational coefficients. Then f and g are *dissonant* if g.c.d. (f,g) = 1 at all integer x . A *primal sequence* is a sequence of polynomials, all pairwise dissonant. Several nice theorems are proven. For example, it is shown that one may have a primal sequence of linear forms { f_j (x) = a_j (x)+b_j } , of any finite length, but that they are no infinite primal sequences of linear forms.

In the case of dissonant functions, f and g, the function h(x) = gcd (f,g) = 1. Otherwise, h is always periodic for any two integral polynomials with no common algebraic or integer factor. The theory of primal sequences of dissonant quadratic polynomials quickly runs into difficulties.

2. Additive Algebraic Structures,1982:

Let A and B be sets of real (or complex) numbers . Define A (+) B = C as the set formed by adding together each element of A with each element of B. The paper discusses maximal and minimal solutions of equations of the form A (+) X = B, for certain interesting sets A, B, on the real line and in the complex plane. That is to say, given A and B, how small or how large can X be without the sum of A and X exceeding or falling short of B? Also discussed are equations of the form $A(\bullet)X = B\,;A(+)X = B(+)X;A(\bullet)X = B(\bullet)X$, etc. Minimax solutions of X(+)Y=A , and the equation (k)X = X(+)X(+)....(+)X = A are also discussed .

In the final part of the paper, simple algebraic structures with a binary relation derived from additive number theory are classified.

3. Generalizing the Greatest Integer Function, 1983 :

During the production of this paper on an I.B.M. mathematics typewriter in a room adjacent to the office of the secretaries in the U.C. Berkeley math department (with their permission), I was rudely kicked out by the chief administrative secretary , Nora Lee. Quote: *" Your status is very low in this department."* She then went to the office of the staff director , Anne Anscombe, told her some kind of story, and got me thrown out. A few years later Anne Anscombe fled the Berkeley campus, never to return . It turns out that she was embezzling thousands of dollars from the university by charging for orders of computer equipment that existed only on paper. Nora Lee quit soon

afterwards , not understanding how little relationship there is between mathematics departments and the real world.

Generalizing the g.i.f. **: one starts with an arbitrary sequence of reals { M_j } j = 0 , ±1, ±2, ±3, ... , M_j going from - ∞ to + ∞ , with**

$M_j < M_{j+1}$, all j . If x is any real number and it is the case that $M_j \le x < M_{j+1}$, one can define two functions analogous to the greatest integer function, [x] :

$$(a)[x]_M = M_j$$
$$(b)\{x\}_M = j$$

Several theorems relevant to the theory of approximations and to functional analysis are proven.

Algebra

1. Non-Linear Algebra:

114 pages in 3 parts. We define a finite groupoid as a collection of n elements with an arbitrary multiplication operation, that is to say a multiplication table. Let z = f(x, y) be a real function of two real variables. If the surface in 3-space represented by this equation has a finite number of values $A = a_1, a_2, \ldots, a_n$ such that $x, y \in A \rightarrow z \in A$, then one can interpret the table of these values $\{a_i, a_j, f(a_i, a_j)\}\ i, j = 1, 2, \ldots n$ as the ***generalization of the notion of the fixed point in 1-dimensional linear dynamics*** **.**

In these papers a complete description and analysis of *all* 2-element and 3 -element fixed point groupoids (also called binary composition algebras) on quadratic surfaces is presented. For the 2-element groupoids a calculation is made on the partial derivatives at the combination points (a_i , a_j) , i,j = 1,2 to ascertain if they are if they are hyperbolic, attractive, repellent, or borderline.

2. Theorems on anti-groups, 1978:

Properties of maximal anti-groups of finite groups . Theorems about the decomposition of finite groups into maximal anti-groups, their inverses, and their products.

3. When is a groupoid a semi-group? 1984:

(a) An algorithm is constructed for determining , from operations on the multiplication table of a finite groupoid A, if A is a semi-group.

(b) Some combinatorial results on the tables of groupoids and semi-groups are presented . For example , if A is a groupoid with elements a, b, c, and these elements (in any order) occur in the table in the amounts 2+3+4 = 9, then A cannot be a semi-group.

ANALYSIS

1 . Three Papers on Patterned Sequences

Patterned sequences arise naturally as limit points of collections of shifted iterates of sequences, decimals, n-cimals, functions, etc. They belong more generally to the study of automorphic functions, sequences, etc. If S is a patterned sequence, then every finite sub-block of S may be found in S at least twice, and therefore an infinite number of times. If a is any real number between 0 and 1, and b is any integer, we may express a to the base b as a "b-cimal" $a= 0.\ e_1e_2\ e_3...e_n$ ...., where e_j is an integer in the set (0,1,2,....., b-1) The iterate set associated with a is a collection A of real numbers, $A= \{ a_k \}$, where $a_k= 0.e_k\ e_{k+1}$......., $k = 0,1,2,3,$.........

The first paper in this series asks questions about C and its topological closure . One always finds patterned b-cimals in the closure. If a is a patterned b-cimal, then C is automatically closed and indeed a perfect set. When is the closure of C discrete? Countable? Uncountable? These questions are all answered in the first paper.

The second paper discusses very general properties of patterned sequences, notably the phenomenon of braiding : A patterned sequence,
(function) is braided if one can identify two or more distinct patterning structures on its graph. Braiding algorithms are presented.

The third paper looks at properties of iterate sets of sums of real numbers a + b , and a + r , a · r , when r is a rational number.

2. Patterned Functions , and Limit Functions of Iterate Function Sets, 1983 :

These papers explore the idea of the patterned form in functions of 1-variable. I have also invested 2-variable and complex variable patterned functions, but have not written up the results. A function f(x) is patterned if ,for any interval L = [M ≤ x≤ N] , one can find an h > 0 such that
f(x+h) - f(x) = 0 , x ε L . These functions, the simplest automorphic functions beyond periodic functions are interesting for several reasons;

(1) In the paper on algebraic causation (described in the section on Mathematical Physics) they are used in the construction of scenarios of "point source causation" such as the Big Bang. They also occur as limit functions of iterate sets of

functions defined by $f_t(x) = f(x+t)$, and therefore have applications in Hamiltonian Dynamics.

These functions also have the property that no finite neighborhood of such a functional shape, such as a arc or landscape can give sufficient information to exactly pin down one's location, a property shared also of course, with periodic functions.

3. Back-Reconstructible Algorithms,1986:

Given a shape which has been generated from the pieces of another shape, (such as a functional arc) , by the application of an algorithm, under what conditions is it possible to reconstruct both the generating shape and/ or the algorithm? Sufficient conditions are stated .

MATHEMATICAL PHYSICS

Causation Theory

I. Causal Algebras, 1986 :

This paper was presented at the 11th General Relativity and Gravitation Conference in Stockholm, Sweden in August, 1986. It is a large paper and develops several themes:

(1) There is no single uniform definition of Causality which covers all the sciences: Physics, Biology, Geology, History, Cosmology, Journalism : all utilize different causal schemas in their actual practice. For example, biologists admit teleological notions. Historians are allowed to use their own humanity as a measuring instrument for the interpretation of the humanity of departed

persons; thus the scientist introduces himself into the criteria for objectivity, etc.

(2) All definitions of Causality can be cast into the form of an algebraic structure, generally some kind of function algebra, with rules of composition that reflect the laws of nature, and specifications that are used in making predictions.

(3) Analytic function algebras are those most often used in physics because they mirror Kantian causation: ***all events past and future in a closed system are determined by the activity in some infinitesimal neighbor of any point in time.*** **Examples of alternative function algebras modeling such causation are treated .**

(4) Other causal models are examined and their algebraic structure described: substrate dependence (biology), point-source causation (cosmology); back-braided causation (quantum theory), atemporal descriptive causation (journalism)

(5) The modeling of point-source and back-braided causation leads to the introduction of the patterned sequences and functions described in the section on mathematics papers.

2.On Modeling Causal Singularities, January 2002

We discuss various ways by which analytic functions, and collections of analytic functions can model discontinuous and quantized behavior.

(1) Processes. A relatively converging infinite series combined with a process on the indices, can model situations in which change in hidden in the way the various contributing forces are accumulated, never revealing itself save at certain key

dramatic moments of breakdown. The behavior of the system is not predictable from the function, but can be predicted from the process acting on the algorithm (in this case the infinite series), by which it is calculated. Example:

$$y = \sum_{j=1}^{\infty} \frac{(-1)^{n_j}(\sin t)^{2n_j}}{n_j} = \ln(1+\sin^2 t)$$

This has jumps at the points t = (n+1/2)π . If the series is systematically rearranged through permutations on the indices of the summands, it can jump to any pre-assigned value, or oscillate within any pre-determined segment of values $\underline{a} < y \leq b$.

(2) Boundary conditions. The local information derivable from the configuration of all the state variables of a billiard ball in mid-trajectory reveal only so much of its future as can be given before its next collision with the walls of the table. However, knowledge of the shape of the table combined with that of the configuration of the billiard ball, re-introduce a determinist model for all future states

(3) Varieties of singular points obtained through the intersections of collections of analytic functions in several variables. The paradigm for this is the collision. Such discontinuous behavior does not violate causality or modeling by analytic functions.

3. The Theory Of Barriers: Finitism & Intuitionism in Physics, 1996

No-one has ever observed the presence, temporal or permanent, of infinite magnitudes. The expression itself is furthermore ambiguous, since two meanings of the word 'infinity' are involved: *actually infinite* entities , such as number, spatial extension or past time, and entities merely *capable of manifesting* *themselves in any finite quantity, however large* , or the potentially infinite. Infinite entities usually involve the violation of some conservation law. For example, an infinite velocity would imply that, at least for an instant , material objects could be in two places at the same time. An infinite energy source violates all the laws of Thermodynamics. Whenever a magnitude is infinite, there is always a possibility that the part may be equal to the whole.

We suggest that physicists ought to look for:

(a) An upper bound to acceleration.

(b) A durational quantum for spontaneous decay, explosion or transformation.

(c) An upper bound to matter density. Radiation density.

(d) An upper bound on gravitational and electromagnetic potentials within massive or charged particles .

(e) A discrete quantum of velocity for objects moving away from rest.

(f) A discrete time quantum.

(g) A mass quantum, closely allied with an upper bound on frequency or a lower bound on wave-length.

(h) A length quantum, causing objects to "jump' from location to location in inertial motion.

Conjecture: In any situation in which the actually infinite is proscribed by some law of nature, one will find the potentially infinite proscribed by a barrier. This epistemological position is dubbed *Physical Finitism* . The actual or potential *infinitesimal* has no more physical viability than the actual or potential *infinite* , all of these being essentially metaphysical categories. We are unequivocal in believing that a time quantum is present in

Nature. The evidence for it, as we try to show , comes from a great many directions.

4. Counter-Intuitive Science

Modern science abounds with assertions that appear to fly in the face of simple commonsense. This comes as something of a surprise, because hard science claims to be derived from simple perceptions and irreducible self-evident notions. Even the most abstruse scientific theory is built on ideas so elementary that no sane person would bother to dispute them.

An examination of the counter-intuitive statements characteristic of modern science indicates a decision is made as to what set A of self-evident notions will be treated as *more self-evident* than another set B , which, having been designated as *less self-evident* are replaced by a counter-intuitive statements derived from A.

The set of examples chosen for this paper are drawn from modern logic, relativity and quantum theory . In each case our curiosity prompts us to reverse the direction of the standard syllogism: that is to say, if two sets of assumptions, A and B, are taken to be self-evident , and if , by giving its verdict to A , modern science has demonstrated that B is no longer tenable, we examine the consequences of giving *greater* validity to assumption B, then looking at the set of "counter-intuitive "conclusions that replace A.

This leads to an alternative science, one might call it the *dual image* of contemporary science. It is speculated that, at least in certain cases, the pairing of *Image/Dual-Image* may be a more effective vision of reality than a narrow adherence to either side of the debate.

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Quantum Theory & Relativity

1. Introduction to the Ideas of Quantum Theory for the General Public, 1967;1986;1997:

The first version of this book was assembled from the notes for an informal course given at the University of Pennsylvania during the period of the establishment of "free universities" in the late 1960's. It was also given at the Free University of New York, a fascinating experiment in alternative and political higher education that fell apart when it was taken over by Maoist 'cultural revolution' types. Experience with their methods prepared me for dealing with their co-religionists over in Paris during the "Events of May,68 " .

The theme that runs through the 4 chapters of this book is the viewpoint in modern physics which seeks to define the limitations of knowledge, the known, the knowable and the unknowable. The unknowable is the new, third category for epistemology : the uncertainty of quantum physics, the space-like acausality of relativity, the incompleteness of Gödel's Theorem, the unconscious mind .

The book sells well on college campuses, and on street corners adjacent to them. Its chapters are entitled,

I. The Existent and the Knowable;

II. Science and Nature at the Interface: Planck and Heisenberg;

III: Dualism vs. Completeness: Einstein and Bohr .

2.Euclidean Time & Relativity, 1967, 1987

This article also comes out of ideas developed in the course presented at the University of Pennsylvania. It was shown to the philosopher of science , Costa de Beauregard to support my admission to the *Institute Poincaré* in 1969 for one year of studies of mathematical physics:

A ruler is a transportable system, a clock is a dynamical system . Characterizing Time on the basis of how it is measured, as is done in relativity, one must distinguish between constructible and non-constructible clocks in one's space time. This in turn is reflected in restrictions on the kinds of dynamical systems that can exist. The existence of clocks that will measure a certain kind of time dimension requires a fairly elaborate set of axioms.

This paper examines such axiom systems for various kinds of temporal topology: homogenous, quantized, linear , cyclic , mixtures of cyclic and linear time, and so on. Applications to both relativistic and non-relativistic space-times are discussed .

3. Topological Paradoxes of Time Measurement , 2002:

The construction and results of this paper are derived from "Euclidean Time and Relativity " . See above.

Distance in space is measured with rulers. Duration in time is measured with clocks. Clocks are dynamical systems, that is to say, machines. Their functioning therefore depends on the particular mechanical laws which govern the universe in which they are employed.

Definition: **A linear universe is one in which there is some way by which the measurement of duration by clocks can be transformed into a measurement of distance by rulers. A relativistic universe, in which the postulate of relativity (constancy of the speed of light) pertains is obviously an example of a linear universe.**

A non-linear space-time is therefore one in which there is no mechanical or dynamical system, that can be used to parametrize time in terms of the spatial dimension.

Basic Theorem:

Let U be a non-linear space-time, $Time \otimes Space$**, where the spatial component is a 1, 2 or 3D Euclidean Manifold . Assume that:**

(1) Given a ruler of length R, it is always possible to fashion a ruler of length R'<R

(2) Given a clock measuring duration T, it is always possible to fashion a clock measuring some duration T'<T

(3) No time reversal. Time is always measured in the forward direction, which is a given.

(4) No such restriction applies to space. Rulers can be freely transported in all directions, freely rotated, etc.

ASSERTION :

(1) Under the above set of assumptions, it is not possible, from the existence of a clock C_0 **, which measures a durations of length T, to construct, (save by trial and error), a clock measuring a duration of length 1/2 T . More generally, it is not possible to construct a clock measuring an interval of time aT, where a is any constant 0<a<1 .**

(2) In contrast to this it is possible , in either a 1-dimensional, 2-dimensional or 3-dimensional Euclidean space , using a ruler, to determine, from a given length L , the midpoint 1/2 L .

3. Projective Concepts & Constructs in Relativity and Quantum Theory, 1988-92 :

This paper was presented at the Bolyai-Lobatchevski Conference on Non-Euclidean Geometry at Nyerigyhaza, Hungary in the summer of 1999. An abridged version of it was later published in Heavy Ion Physics

A *projective construct* is an object that can be described using the vocabulary of projective geometry and not in contradiction with its axioms.

***Examples* : A convex closed curve is a projective construct: *Lines* intersect them in only two *points* . A self-intersecting *line* is not a projective construct: self-intersecting lines are forbidden by the axioms. Certain projective constructs can now be re-labeled as "lines" and "points" to serve as the irreducible primitives of geometries that will automatically have models in the projective plane. This method is used to construct 9 non-Euclidean geometries, most of which have natural applications in physics. Dualism is also automatically built into a projective construct: the dual construct is obtained by interchanging the dual pairs : "line" and "point" ; "angle" and "segment" , etc. In particular I discuss the properties of a dual relativity in which, since 'angle' is interchanged with 'segment', there is an absolute upper limit to proper time,**

$$s = \int_a^b \sqrt{(cdt)^2 - dx^2 - dy^2 - dz^2}$$

The Projective Postulate for Mathematical Physics :

" Every observable of our universe which can be described as a projective construct implies the existence of a dual observable . "

Heuristic arguments are given to suggest that the Hubble expansion field is the dual observable to the relativistic light ray, and that the absorption of quanta can be interpreted as dual to spontaneous pair-particle creation.

In the last section of this paper I describe quantum theory in terms of a projective "uncertainty space" , in which matter and momentum are dual vector quantities and uncertainty is a scalar with some of the properties of matter. This is in sympathy with the thought of Leibniz, who defines matter as substance inherently impervious to knowing.

4. Intrinsic Uncertainty of Time Derivatives in Quantum Mechanics, 1992:

The procedure used in the differential calculus, by which the tangent of a curve at a point is derived from rotating its secant about that point as a pivot, breaks down in Quantum Mechanics : the Uncertainty Principle guarantees the impossibility of doing this in practice.

One is led to the conclusion that all "time derivatives" in the quantum domain are ***self-complementary*** **, that is to say ,** ***intrinsically uncertain*** **. The Uncertainty Principle can be used to compute a most likely" value for time derivatives. The same**

methods are used to compute intrinsic uncertainties for accelerations, thus for forces.

On the basis of these observations it is argued that two forms of momentum, time-dependent and time-independent, are needed in the formulation of Quantum Theory, analogous to time dependent and time independent forms for the energy.

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PSYCHOLOGY

1. Life and Life-Energy, 1959:

Psychic energy. Trauma and shock. Origins of the Unconscious Mind. The cycle of re-adjustment: Four stages of the Rebirth Mechanism. Identity, Non-Being, Being and Becoming. Perception, Will and Creativity.

2. Love and Cosmology, 1979 :

The interior cosmology of romantic love. The basic archetypes, their projection onto all those who, directly or indirectly, impinge on the unfolding of the drama of love. The private fate-secret that is at the root of intimacy, and defines fidelity in the wider sense. The construction and rending of the primal mythology , the simultaneous activity of processes in opposition .

3. The Corpse In The Bedroom : Topics in "Hamlet" , 1987 :

Hamlet's grief shown to derive largely from mourning for his mother's spiritual death. His futile attempts at preservation of his own sense of moral superiority . Polonius as caricature of a certain kind of gross depravity. Ophelia's insanity, her role as

matrix and transmitter of cosmic forces of destruction. Her suicide and burial. The theatrical relevance of the seemingly misplaced soliloquy "To be or not to be..."

Act III as religious Calvary, as rite of passage: court, theater, chapel and parental bedroom. Incest and the semiotics of sterility and barrenness.

4. Shrinking Expectations, 1967:

In 1967 I prepared two courses on Epistemology , given at the Free University of New York and at University of Pennsylvania. The notes from the physics course formed the basis for two physics articles : ***Introduction to The Ideas of the Quantum Theory (See above)*** **and** ***Euclidean Time and Relativity*** **, (*****See above)*** **.**

The second course, from which this small book was developed , was on the history and epistemology of psychology. An overview of 300 years of European psychology, psychiatry and alienism. History of the notion of an unconscious mind from the Renaissance to the present day. Growth of the mental hospital. History of medical hypnosis. Philosophical discussions of hypnosis, the unconscious mind, adjustment, etc.

5. Hysteria and Enlightenment , 1992 :

A 200 page historical novel based on the controversial cure of the hysterical blindness of the 17-year old piano prodigy, Marie-Therese von Paradis, by Franz Anton Mesmer in the 1770's. Distinction between sight and vision. The medical revolution of the 18th century. The ambivalence of the physician as scientist and charismatic healer. The Enlightenment critically examined.

6. Logical &Psychological Question Theory 1994 :

Well-formed questions in logical question theory. "Psychological Question Theory " defined .Categories of personhood and the structure of anxiety. The possibility of using the theory of well-formed questions as a foundation for a theory and science of the emotions.

7. Malevolent Malpractice, 1998

A no-holds barred attack on the psychotherapeutic pseudoscience of the lat 100 years. Freudian Psychology. Agressive Chemical Therapies. Electoshock Therapy. Psychosurgery. Behavior Modification. Neuroleptic Drugs. The neurotransmitter theory of emotional affect.

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Conference Coverage

*****Einstein Centennial Symposium, March 1979**

*****International Congress of Math-Physicists, August 1983**

*****General Relativity and Gravitation, Stockholm, Sweden , August 1986**

*****Mandelbrot on Fractals and Chaos, Cincinnati, Ohio, September 1987**

*****Conference to celebrate A. Wiles' proof of Fermat's Last Theorem , Boston University, August 1995**

*****Symposium in honor of Subramanyam Chandrasekhar, December 1996**

*****American Mathematical Society Conference , January, 2000**

Book Reviews

(1) Sylvia Nasar's Biography of John Forbes Nash, **A Beautiful Mind** ; Simon &Schuster, 1998

Reviewed in Ferment XII #4 -#7 Fall, 1998 . On the Internet at <http://www.fermentmagazine.org/essays/fnash1.html>

(2) Ray Monk 's 2-volume biography of Bertrand Russell:

Volume I: **Bertrand Russell:** The Spirit of Solitude 1872-1921 ; The Free Press , 1996

Volume II : **Bertrand Russell:** *The Ghost of Madness 1921 - 1970* Jonathan Cape , 2000

Reviewed in Ferment XV#3, March 2002. On the Internet at <http://www.fermentmagazine.org/essays/russell1.html>

(3) Irwin Schrödinger: **The Interpretation of Quantum Theory** Oxbow Press ,1998 Reviewed in FermentIX#9, January 1999 . On the Internet at

http://www.fermentmagazine.org/FermentIX//FIX9.doc

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Science Writing

In Memoriam Einstein :

A complete report on the celebration, at the Institute for Advanced Study, of the 100th Anniversary of Einstein's birth. March 21-23rd 1979,

René Thom:
the Aristotelian Vision of Science:

Conversations with the inventor of Catastrophe Theory, August, 86

Mandelbrot's 5-Ring Fractal Circus:

Benoit Mandelbrot, Chaos, and the view from Cincinnati, Ohio; September,1987

The Quest for Alexandre Grothendieck :

In May ,1988, the author set out to find the famous recluse mathematician, Alexandre Grothendieck. In an old stone cottage in a village in the south of France, Grothendieck shared his views on contemporary trends in mathematics, ecology, and the power politics of science. In 1994 he vanished again. A new search revealed his whereabouts without invading his privacy, in September, 1995.

Alexander Yesenin-Volpin,
logician-dissident:

Life and thought of the controversial Intuitionist logician, a figure of enormous stature in the Russian civil rights movement of the 60's

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Hysteria & Enlightenment:
Franz Anton Mesmer and Marie-Therese von Paradis

This combination of novel with documentary evokes, through fiction, historical research and speculation , the music, science, medicine and politics of the Enlightenment in Vienna , 1750- 1780. The focus is on the cure of the hysterical blindness of the 17-year old piano prodigy, Marie-Therese von Paradis, by Franz Anton Mesmer, the man who brought hypnosis to the attention of European medicine. This tragic and beautiful story has been told many times. From its' fertile soil the author reaps a rich harvest of insights into: the structure of perception; the distinction between sight and vision; the learning process; the relationship of music to mental illness ; the medical revolution of the 18th century; the excitement and turmoil of the Industrial Revolution; the physician's dual persona as scientist and charismatic healer; psychiatric practice, then and now ; and related issues.

An Introduction to the Ideas of Quantum Theory
1967;1986;1999

Topics range from Planck's discovery of the quantum of action in the 1900's to the verification of the existence of non-local phenomena in the 1990's .This introduction, intended for the general educated public, differs from most popular accounts of Quantum Theory in several respects :

(1) Although the mathematics is kept to a minimum, the discussion is geared to the educated public. Standard accounts tend to be written far above, or far below this level.

(2) A high standard of prose is maintain throughout.

(3) The theory's subtlety has not been sacrificed.

(4) This book also may be used in classrooms, as a supplement to standard mathematical texts. Its' bibliography provides an excellent resource for further study.

Can Anyone Be a Two-Cultures Man?

A satirical dialogue between Ignatius Y. Snew and an impecunious college dropout in Mushposh, South Carolina, about the relevance of the Two Cultures Dilemma

Pons Asinorum

5 humorous narrative of a mathematical character. The book is based on the premise that one does not have to understand very much mathematics to make fun of it.

Circular Tangrams

A modification of the millennial Chinese Tangram puzzle, using pieces which combine straight with circular edges. Cardboard pieces and 14 puzzles. Diagrams are included which show how to a ruler and compass to reconstruct a set of Circular Tangram pieces.

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