Concerning an Algorithmic Approach to Euclidian Geometry and Everettian Quantum Theory

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Physical Sciences - Article

Keywords: Euclidian geometry, quantum physics, Everettian Quantum Theory

Posted Date: July 13th, 2021

DOI: <https://doi.org/10.21203/rs.3.rs-694215/v1>

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Abstract

We introduce an algorithmic approach to Euclidian geometry⁶ which provides an experimental framework involving Euclidean constructions and deconstructions thus enabling a foundation^{2,12} for testing Everett's interpretation of quantum theory^{4,5}. We contend that the cosmos be modelled as the advance in space-time until some event occurs leading to the termination of some phenomenon, in the sense of the algorithmic halting problem¹⁴. Our approach involves iterative geometrical constructions using Euclid's proposition 3 which are equivalent to a Turing machine. Our conjecture is that the postulates of Euclidean geometry, for which we require particular extensions to postulates 2 and 3¹⁰, are physical principles, and also that our algorithmic approach is identical to quantum theory^{4,5}. We suggest that our conjecture concerning quantum theory and the second law of thermodynamics is that they are mutually dependent, this too being a principle. We suggest a unifying theory for gravitation and sub-atomic particles^{2,7,11,12}. We propose a new experiment: the investigation of anomalies in astronomical observations with as example the phenomenon of black holes disappearing when galaxies collide with or without gravitational wave emission⁸.

1. An algorithmic approach to Euclidian geometry

We start with the definition of parallel straight lines⁶ (BOOK I. DEFINITIONS, p153):

“23. **Parallel** straight lines are straight lines which, being in the same plane and being produced indefinitely in both directions, do not meet another in either direction.”

We now reproduce here Euclid's five postulates⁶ (BOOK I. POSTULATES, p154):

“Let the following be postulated:

1. To draw a straight line from any point to any point.
2. To produce a finite straight line continuously in a straight line.
3. To describe a circle with any centre and any distance.
4. That all right angles are equal to one another.
5. That, if a straight line falling on two straight lines make the interior angles on the same side less than two right angles, the straight lines, if produced indefinitely, meet on that side on which are the angles less than the two right angles.”

Concerning the note on Postulate 5⁶ (BOOK I. NOTE ON POSTULATE 5, pp202-220), also known as the Parallel Postulate, this postulate in particular has resulted in much discussion, to wit (as by December 1925) 19 pages of notes of which 17 pages concern “Noteworthy attempts to prove the Postulate”. Our conjecture here is threefold:

- i. that to treat Euclid's geometry as an algorithmic system, the decision as to whether or not to perform some construction is an algorithmic decision;
- ii. that the use of Euclid's geometry, thus rendered algorithmic, behaves as a Turing Machine¹⁵;
- iii. that there exists no proof, that is algorithm, of postulate 5, as there exists no corresponding finite construction, and that this is a physical principle.

We contend that the cosmos be modelled as the advance in space-time until some exception occurs leading to the termination of some phenomenon. By termination we mean ‘halting’ in the sense of the algorithmic halting problem¹⁴. Such phenomena are events, which can have action over a period of time up to a termination state algorithmically defined, such as, for

example, the initiation of a black hole, the disappearance of a black hole, sub-atomic energy level mutations; that is, birth and death in general.

To this end, in respect of i to iii above, we further refine our conjecture as follows. To treat Euclidian geometry as an algorithmic system requires particular extensions to postulates 2 and 3 together, where our conjecture is that a finite line continues indeterminately to describe a circle of undetermined radius. We observe that our extensions correspond to the difference between a Turing Machine and a finite state automaton (Hopcraft and Ullmann¹⁰ p81). We claim that our conjecture here is a principle.

In sum, prompted by the following (Deutsch⁴):

“Church (1936) and Turing (1936) conjectured that these limitations on what can be computed are not imposed by the state-of-the-art in designing computing machines, nor by our ingenuity in constructing models for computation, but are universal. This is called the ‘Church-Turing hypothesis’; according to Turing,

Every ‘function which would naturally be regarded as computable’ can be computed by the universal Turing machine. (1.1)

The conventional, non-physical view of (1.1) interprets it as the quasi-mathematical conjecture that all possible formalizations of the intuitive mathematical notion of ‘algorithm’ or ‘computation’ are equivalent to each other. But we shall see that it can also be regarded as asserting a new physical principle, which I shall call the Church-Turing principle to distinguish it from other implications and connotations of the conjecture (1.1).”,

our conjecture is that the postulates of Euclidean geometry with our extensions are in fact principles. Thus, in respect of our conjecture, Deutsch’s principle is a corollary, and this being so, we propose the corollary that our Euclidean constructions and Turing machine computations are equivalent.

We now give as an example application of our algorithmic approach to Euclidian Geometry: the generation of Fibonacci numbers.

Let F_i and F_{i+1} be successive Fibonacci numbers, where $F_0 = 0$ and $F_1 = 1$.

We have $F_{i+2} = F_{i+1} + F_i$.

We apply Euclid’s Proposition 3⁶ (pp246-247) which for convenience we reproduce here:

“Given two unequal straight lines, to cut off from the greater a straight line equal to the less.”

Let AB , C be the two given unequal straight lines, and let AB be the greater of them. Thus it is required to cut off from AB the greater a straight line equal to C the less. At the point A let AD be placed equal to the straight line C ; [1, 2] and with centre A and distance AD let the circle DEF be described [Post. 3]

Now, since the point A is the centre of the circle DEF ,
 AE is equal to AD . [Def. 15]

But C is equal to AD .

Therefore each of the straight lines AE , C is equal to AD ;
so that AE is equal to C .

[C.N. 1]

Therefore, given the two straight lines AB , C , from AB the greater AE has been
cut off equal to C the less.

(Being) what it was required to do."

Where:

- Post.3 *idem*,
- Def. 15 "A **circle** is a plane figure contained by one line such that all the straight lines falling upon it from one point among those lying within the figure are equal to one another ;"
- C.N. 1 "1. Things which are equal to the same thing are also equal to one another."

Given $F_{i+2} = F_{i+1} + F_i$, we have $AB = C + EB$, and vice versa.

That is, we can calculate F_{i+2} by geometrical means, given F_{i+1} and F_i , and this so in an iterative manner down to F_0 . In the case of F_0 , this being zero in value, the length of straight line C is itself zero, that is the straight line C is a point, noting "1. A **point** is that which has no part."

We are now in a position to produce the algorithmic geometrical construction for an arbitrary Fibonnaci number, which we now do for illustration up to F_4 .

We have, for F_0 , where straight line C is a point for which $F_0 = 0$ ("has no part" *idem*), and which we illustrate with $\bullet$, as well as the derived circle construction DEF :

C
 $\bullet$

D E
 $\bullet$
 A B
 F

We have for $F_1 = 1$, and $F_2 = F_1 + F_0 = 1 + 0 = 1$, where unity takes the scale $\blacklozenge \longrightarrow \blacklozenge$,

We have for F_3 , $F_3 = 1+1 = 2$,

We have for F_4 , $F_4 = 2+1 = 3$,

We now make two remarks:

- i. Firstly, to calculate F_4 geometrically it has been necessary to *construct* the calculation for each of F_0 , F_1 , F_2 and F_3 , and in this order, each depending for its calculation on the preceding construction.
- ii. Secondly, for F_0 we start with a point. Following directly from our conjecture that the postulates of Euclidean geometry are principles, the Euclidian point, which “has no part” *idem*, is indeed an object corresponding for example to variously at the astronomical level to singleton or nadir phenomena such as the ‘big bang’, ‘the end of the cosmos’ or their back-to-back combination in the ‘bounce theory’; and at the sub-atomic level to phenomena such as electron-positron annihilation, and electron orbit changing with photon emission or absorption together with ancillary phenomena such as tunnelling and entanglement.

We now adorn our diagrams concerning the construction of a pair of parallel circles of undetermined radius intersecting at a right-angle which encompass our conjecture. We contend furthermore that the surface⁶ (BOOK 1 Definitions p153) intervening between the circles is a Mobius strip.

Simplifying:

Examining any of the intersection constructions more closely:

variously the vertical line represents either algorithmic events, *in fine* halting or the sequence of such events which might be interpreted as the passage of time, the direction or ‘arrow’ here not being indicated, or vice versa in respective of the horizontal line. We wish to stress here that the sequence of events contains events which are ordered with respect to one another, but that we do not interpret that the sequence itself has some particular order. Thus, there is no difficulty in our conjecture for deconstruction where, in the case of our example of the Fibonacci numbers, we use Euclid’s Proposition 3 for effecting subtraction rather than addition as in the afore described constructions. In terms of algorithmic execution, we are now free as to whether these progress ‘forwards’ as is conventionally the case, or ‘backwards’, and this related too to function inversion as in the example of cipher encryption/decryption.

2. Turing machine equivalence

We commence this section with the essential of the halting problem. Our conjecture is that Euclid’s postulate 5 is equivalent to the proposition that there exists no algorithm to determine if an arbitrary procedure is an algorithm, which, by definition, must halt¹⁴. Thus, our conjecture that Euclid’s postulate 5 is a principle applies likewise to the halting problem.

As a preliminary to developing at a practical level an equivalent Turing machine for our Fibonacci numbers example, we now give a set-theoretic formulation using the Z formal specification language^{1,13}; We have the following schema, where above the horizontal line we have type specifications where user types use *italic capital letters*, and below predicates. Predicates are implicitly connected by conjunctions. The predefined type **N** represents the natural numbers. The type specifications are in accordance with the Church-Turing principle⁴ *idem*.

$F_i, F_{i+1}, F_{i+2} : \mathbf{N}$ $F : \mathbf{N} \times \mathbf{N} \times \mathbf{N}$
$(F_i, F_{i+1}, F_{i+2}) \in F$ $F_0 = 0$ $F_1 = 1$ $F_{i+2} = F_{i+1} + F_i$

This specification specifies the Fibonacci numbers but does not describe their calculation, that is, their construction. Following the sequence of geometrical constructions above we propose both the construction and also the deconstruction of the Fibonacci numbers. We observe that a use of the deconstruction of the Fibonacci numbers is where we wish to calculate if a given natural number is a Fibonacci number. We have, for one step of each:

- Construction: F_i and F_{i+1} and we wish to calculate F_{i+2}
- Deconstruction: F_{i+1} and F_{i+2} and we wish to calculate F_i

Using the Prolog programming language³, we can express the calculations of construction and deconstruction involving respectively addition and subtraction with the following clauses, where variables in Prolog start with capital letters, and where single line comments start with a %:

```
% Construct from FNless1 to FN
f(FN, FNless1, FNless2) :- var(FN), FN is FNless1 + FNless2.

% Deconstruct from FN to FNless1
f(FN, FNless1, FNless2) :- var(FNless1), FNless1 is FN - FNless2.
```

We now implement in Prolog a Turing machine to simulate our Euclidean construction and deconstruction algorithms, where bracketed comments appear between `/*` and `*/`, and commented variables preceded by `+` and `-` indicate respectively data input and data output:

```
/*
turing_machine(+Goal, -Out) :-
    where Out is a variable in Goal as in e.g.
        Goal = turing_machine(Goal, Out).
*/
turing_machine(Goal, _Out) :-
    Goal.
```

For example, we can calculate construct from F_3 to F_4 and deconstruct from F_4 to F_3 respectively:

```
?- Goal = f(F4, 2, 1), turing_machine(Goal, F4).
Goal = f(3, 2, 1),
F4 = 3
?- Goal = f(3, F3, 1), turing_machine(Goal, F3).
Goal = f(3, 2, 1),
F3 = 2.
```

3. Quantum theory

In Deutsch⁴ we read:

“The intuitive explanation of these properties places an intolerable strain on all interpretations of quantum theory other than Everett’s.”

In the abstract to Deutsch⁵ we read:

“Claims that the standard methodology of scientific testing is inapplicable to Everettian quantum theory, and hence that the theory is untenable, are due to misconceptions about probability and about the logic of experimental testing”.

We contend that our algorithmic approach to Euclidean geometry is not only applicable to quantum theory, but is identical to Everett’s interpretation of quantum theory. We postulate further that the event-time continuum in the cosmos where an event corresponds to an algorithmic execution completion is equivalent to a Turing machine arriving at the halt state. From this we deduce that the traversal of the cosmos can be modelled as a Turing machine traversing its tape. Thus, quantum theory amounts to precisely whether or not the Turing machine which traverses a given quantum in the cosmos halts or does not halt. We claim further

that our algorithmic approach to Euclidean geometry is a suitable framework for the standard methodology for the scientific testing of quantum theory⁵.

In respect of the cohabitation of our conjecture concerning quantum theory and the second law of thermodynamics, due to the conservation of mass and energy, these former are mutually dependent, and that furthermore, we conjecture that this independence is a principle. In particular, at the Euclidean point *idem* at the beginning of a construction, or at the end of a deconstruction, the entropy is undetermined with a corresponding quantum bit state value of 0.5 between 0 and 1. Furthermore, this too we conjecture to be a principle.

4. A unifying theory for gravitation and sub-atomic particles

We suggest a unifying theory for gravitation and sub-atomic particles, the former involving modelling of variously black holes and sub-atomic particle tunnel entrances as Klein bottles, and inverted Klein bottles as cornu copiae for, as well as sub-atomic particle tunnel exits, new astronomic material-energy creation by means of anyons^{2,12} as well as their destruction, and in doing this we variously accommodate Hoyle's steady state thesis¹¹, the 'big-bang' and the 'big-bounce' theories of the origins of the cosmos and indeed a continuum between these, as well as the inflationary universe⁹, and also Wheeler's one electron universe thesis⁷, or, due to Everettian quantum theory, the coexistence of two or more of these models. As well as this, Hoyle's steady state thesis englobing one or more of these dynamic models, presents, to our knowledge, as a unifying theory a new theoretical domain of study. Furthermore, on the basis of the construction of increasing dimensions exhibited by the point, the straight line⁶ (BOOK 1 Definitions p153), the surface, the Mobius strip and the Klein bottle, our conjecture is that the number of dimensions is undetermined and that this is a principle, and in consequence we accommodate string theory. We contend also that our theory accommodates loop quantum cosmology in which granules correspond to the physical realisation of points, and furthermore our theory accommodates a combination of string theory and loop quantum cosmology. What matters is that these are all based on Euclidian geometry.

5. A new experiment

This concerns the investigation of anomalies in astronomical observations; for example, that of black holes disappearing when galaxies collide with or without gravitational wave emission⁸. Under certain conditions such as when the galaxies that collide are in the same plane, this might be interpreted as when the galaxies:

- Co-rotate, in which case black holes that collide do so additively by coalition with the generation of gravitational waves;
- Contra-rotate, in which case black holes that collide do so subtractive by condensation with the generation of anyons *idem*.

This can be visualised as the equivalent to two rotating co-planar maelstroms which either augment or cancel each other out, and in the latter case the resultant mass-energy appears 'somewhere', this latter to be determined but it could be perhaps in the form of 'Hoyle' cornu copiae anyons *idem*. We observe that corotation corresponds to addition, and contra-rotation to subtraction (c.f. Euclid's Proposition 3 *idem*).

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