Application of Chaos and Fractals in Fundamental Physics and Set Theoretical Resolution of the Two-slit Experiment and the Wave Collapse*

M.S. El Naschie[1,2]

1. Department of Physics, University of Alexandria, Egypt.
2. P.O. Box 272, Cobham, Surrey KT11 2FQ, UK
Email: Chaossf@aol.com

Abstract

A fractal point is both a point and an entire Cantor set on magnification. The present paper proposes a new model for quantum mechanics and resolves some problems of quantum measurement. In this model a particle is represented by a transfinite zero set given by two dimensions zero and the golden mean. The quantum wave on the other hand is modeled by the surface or the neighborhood of the zero set particle. This means a quantum wave is an empty set with the two dimensions minus one and the gold mean squared. Measurement in effect is the reason of causing the empty set to become non-empty. Consequently the quantum wave disappears for the split of a second but another wave takes over unless we have a continuous measurement.

Keywords: E-infinity-transfinite set theory. Quantum wave collapse. Measurement problem. Noncommutative geometry-quantum Cantor sets – K-theory, the golden mean in quantum mechanics.

We present a convincing resolution of the wave collapse and the two-slit experiment based on random fractal sets and the extended Menger-Urysohn transfinite theory of dimensions. We use two component dimensions starting from A. Connes dimensional function of noncommutative geometry [1-3]

$$D = a + b\phi, \quad a,b \in Z, \quad \phi = (\sqrt{5} - 1)/2 .$$

We demonstrate the equivalence of Connes function to that of E-infinity bijection formula [3-5]

$$d_c^{(n)} = (1/d_c^{(0)})^{n-1}$$

where n is a real integer and $d_c^{(0)} = \phi = (\sqrt{5} - 1)/2$.

The golden ratio $\phi = (\sqrt{5} - 1)/2 = 0.618033989$ which was experimentally confirmed a few months last year in the Helmholtz Centre in Germany and University of Oxford, England as basic to quantum mechanics arises naturally from the requirement of a random fractal horizon of a noncommutative geometry akin to that of Penrose fractal tiling and the related compactified Klein modular curve. This curve with 336 + 3 = 339 hierarchal degrees of freedom or isometries is also

* This is an invited lecture presented in the 3rd International Symposium on Nonlinear Dynamics, Sept. 25-28, 2010, Shanghai , China, in celebration of Prof. M.S. El Naschie's 65th birthday. The Symposium was dedicated to Prof. M.S. El Naschie for his contributions to incorporate nonlinear dynamics, chaos and fractals in quantum physics and to Prof. C.D. Yang for his original contribution of using complex spacetime in quantum mechanics.

equivalent to the holographic boundary of E-infinity spacetime [3,5].

One of the most important results of the present work is the identification of the empty set with wave-like quantum probability and the vacuum while quantum-like particles are described as a zero set. Consequently the two dimensions relevant to the particle are

$$\text{dim particle} = P(d_{MU}, d_H) = P(0, \phi)$$

where d_{MU} is the Menger-Urysohn dimension and d_H is the corresponding Cantorian or Hausdorff dimension. For the quantum wave on the other hand we have

$$\text{dim wave} = W(d_{MU}, d_H) = W(-1, \phi^2).$$

Since we have identified the wave which is devoid of energy matter and momentum with the empty set, it follows then as an almost trivial result that any attempt to observe the two-slit experiment while in progress will render the empty set non-empty and instantly lead to what we perceive as a wave collapse, leaving the zero set of the particle as the only observable. Using the preceding conclusion it is then a relatively straight forward and technical analysis which leads us to the form of semi manifold which supports the preceding requirement. It turns out that this semi manifold is a fractal quotient manifold of the Gaussian type with a Hausdorff dimension given by

$$D_H = \frac{(\phi)+(\phi^2)}{(\phi)(\phi^2)} = 4 + \phi^3 = 4 + \cfrac{1}{4 + \cfrac{1}{4 + \dots}} = 4.236067977,$$

and a Menger-Urysohn dimension

$$D_M = \frac{0+(-1)}{(0)(-1)} = \infty$$

as well as an average topological dimension equal to

$$< D > = \frac{(1/2)+(1/2)}{(1/2)(1/2)} = 4.$$

In other words this manifold is nothing else but the core of E-infinity Cantorian spacetime which may be envisaged as an infinite hierarchy of concentric four dimensional cubes.

The present lecture is divided into two parts. We first give a general review of all previous work on the application of chaos and fractals in high energy physics [3]. The second part is subsequently devoted to the resolution of the paradox presented by the two-slit experiment and the associated wave collapse [5].

The main idea behind the new mainly mathematical resolution of the wave collapse is the following. Using an elementary cobordism argument we see that any empty set must have a negative topological dimension as well as a positive Hausdorff dimension. The border of a one dimensional line is the zero dimensional quasi point. Thus the point is the surface of the line. This is an expression of the topological fact that a point is defined by its neighbourhood. Similarly the empty set is the neighbourhood of the zero set. That means the empty set is the surface of the zero set. This is just a mathematical way of saying that the quantum wave function is the surface of the quantum particle. Measurement causes an empty set to become non-empty. However if a second measurement did not take place, the particle propagates as a wave again because the empty space has infinitely many empty sets in it to give as a surface to the particle. In general particle and wave are as inseparable as the surface of a cube and a cube. It is as simple or as incredible as that.

References

[1] A. Connes. *Noncommutative Geometry*, Academic Press, New York (1994).
[2] M.S. El Naschie, von Neumann geometry and E-infinity quantum spacetime, *Chaos, Solitons & Fractals*, **9**(12)(1998), 2023-2030.
[3] M.S. El Naschie: A review of E-infinity theory and the mass spectrum of high energy particle physics. Chaos, *Solitons & Fractals,* **19**(2004), 209-236.
[4] M.S. El Naschie, On certain "empty" Cantor sets and their dimensions, *Chaos, Solitons & Fractals,* **4**(2)(1994), 293-296.
[5] M.S. El Naschie, The theory of Cantorian spacetime and high energy particle physics (an informal review), *Chaos, Solitons & Fractals*, **41**(2009), 2635-2646.