The Algebra of Movement

Glenn Takanishi
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Abstract

This article studies a language to describe our dynamic physical world as explained by David Bohm. Both Satosi Watanabe and Ilya Progigine also contributed enormously to laying the foundations for constructing a theory of dynamic movement as a way to develop a new way to look at order. In some sense, what they tried to reveal was not a mystery, but rather "hidden" in plain sight.

1 Introduction

This exploration into the foundations of physical reality requires a language to describe what might seen like an exotic adventure. But it's not. What is exotic is the discipline which evolved over that past century call quantum mechanics. Our physical world has always been there as it always is.

In 1980, David Bohm [1] wrote "Wholeness and Implicate Order" in which he laid out a beautiful pattern for weaving a theory which tried to reduce the mysteriousness of quantum mechanics. In the appendix to chapter 6, A-5 Algebra and the Holomovement, David Bohm tried to formalize, using algebra, as a way to describe the movement of energy, and thus that which subsumes quantum theory.

Ilya Prigogine's work [4] on the transformation operator M, and Satosi Watanabe's work on his propensity operator [7] has made me question fundamental concepts, especially with the mathematical formalism, some of which seem contraditory. But in spite of this their work in this field has been inspirational to me.

2 Sequences and State Variables

A sequence can be a relationship of multiple state variables. Assuing these variables are a function of time we can represent the sequence as a finite series of the form:

$$A_j(t) = \sum_{i=0}^{n} \lambda^g A_i(t)$$

The lambda, λ^g, are the eigenvalues of the sequence. David Bohm writes [2] that although the variable A_j, is "in itself undefinable, it nevertheless signifies a certain sort of 'movement' to the total set of terms" which is the superpositions of variables. This language of movement is a summation of the effects of the sub-states of the whole system moving forward in time.

> *Similarly, in the algebraic mathematization of this general language, we consider as a totality an undefinable algebra in which the primary meaning of each term is that it signifies a 'whole movement' in all the terms of the algebra. Through this key similarity there arises the possibility of a coherent mathematization of the sort of general description that takes the totality to be the undefinable and immeasurable holomovement. [3]*

I've always made the simple minded assumption that the microscopic nature of discrete quanta is subject to a kind of interference with each other, and hence microscopic quanta generally obey the statistical laws of entropy. As Richard Feynman said quanta are neither particles nor waves. But I think David Bohm had it exactly right in the way he wrote about it above.

Finally, David Bohm says that in the "quantum context" that the 'law of the whole' involves tranformation or metamorphoses, M, which leads from this algebra of the combining of states to a sub-algebra which he says as $E' = \mathrm{MEM}^{-1}$. This sub-algebra of transformation appears to be like the mathematical operation to describe an observation.

As it happens, the Heisenberg uncertainly principle was formulated to describe sub-atomic particles, however, the uncertainly principle is applicable for waves in the "classical" macroscopic world. The context in which the transformation operator, M, above can be applied is good for the macroscopic as well as the microscopic world. And this kind of notion of generality is natural to statistical mechanics.

3 Movement and Transformation

The transformation operator, M, in Ilya Prigogine's theory [4] works in the microscopic world. He worked hard developing a microscopic entropy transformer so that he could show how M transformer's effects arises in the macroscopic world. He mentions [5] that his transformation operator M is the complimentary variable of the density of phase space (the density of microscopic states).

The uncertainity principle, for me, always said much about the relationship between time and energy. Now with Ilya Prigogine's insight, I can intuitively imagine a relationship between the rate of change of space or temporal movement, and the density or mass, in the form of microscopic states, of the medium. The density or the mass of the medium is in flux; rate of change in the flux cannot be constant to work. This might be is speculation, but I think it's right. Although not the justication, I'll state that Ilya Prigogine's transformation operator formulation is beautiful.

Satosi Watanabe tried to lay a bridge between the subatomic microscopic world and our classical macroscopic one in an extremely mathematical [6] way which was his natural inclination. But he based his theoretical foundation [7] for the "Algebra of Observation" on Kodi Husimi's work in experimental physics.

> However, as early as in 1936, Kodi Husimi showed the possibility of arriving at quantum logic starting from a very few experimental facts about atomic physics without relying on elaborate quantum mechanics.
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> My approach adopted in the present paper is still much less restrictive than Husimi's assumptions. As a matter of fact, I do not commit myself at all to atomic physics. I shall show that I can arrive at a (non-distributive) logic of a very general nature from a few very simple assumptions. [8]

Satosi Watanabe's algebraic function of observations which subsumes quantum observations is described as a finite series of state variables in which the the range of the sum of state variables mirrors a probability distribution from 0 to 1.

Let us make very rough sketch of a sequence of finite, dynamic state variables, $\alpha_{0,}$ α_1, $\ldots$, α_{n-1}. Treating these state variables as a set in a finite distributive lattice [9] with $f(\alpha_i, t) = \rho_i$, and $\sum_{i=0}^{n} \rho_i = 1$, we write an additive sequence of the form:

$$A(t) = \sum_{i=0} f(\alpha_{i,}t).$$

Satosi Watanabe says this formalism applies to quantum logic describing an observation of an atom as a non-Boolean computation [9]. But I have not strictly followed his method of computing quantum states above.

4 Summary

I feel that this article is an introduction to the study of dynamic sequences in an ergodic system. The variables or elements in these sequences represent physical objects in the natural world, either microscopic or macroscopic. The application of these sequences is limited to dynamically time ordered Markov processes, but still widely applicable to a large class of phenomena in the form of diffusion equations of which I think the Schrodinger equation is in a class of.

The origins of a formal theory of dynamic sequences of this type is just starting to be clear to me. I have lots of work ahead.

As a formal discipline, studying the “algebra of movement” has been an inspiration to me in the sense of understanding physical reality.

As yet, I have not understood all the possibilities of using this formalism, but I value the notion of using the dynamic function $f(\alpha, t)$ as a kind of predicate operator which naturally provides order when as used in a computer programming language.

And as an aside, the notion of a dynamic function of the kind which David Bohm, Ilya Progogine and Satosi Watanabe attempted to construct has dominanted my thinking in creating software models of logical procedures. I'm more convince as time passes, that the methodology of constructing complex models requires an exploration into how entropy and the long term temporal process covered by ergodicity and sequential order effects artifical model building.

5 References

[1] Wholeness and The Implicate Order, David Bohm, London; Boston: Routledge & Kegan Paul, 1980, www.routledgeclassics.com

[2] Ibid., page 207, paragraph 3.

[3] Ibid., page 208, paragraph 1.

[4] Being and Becoming, Ilya Prigogine, W. H. Freeman and Company, 1980.

[5] Ibid., page 174.

[6] Satosi Watanabe, Algebra of Observation, Supplement of the Progress of Theoretical Physics, Nos. 37 & 38, 1966.

[7] Satosi Watanabe, Theory of Propensity, in Language, Logic and Method, ed. Cohen and Wartofsky, 283-308, Reidel Publishing Company, 1983.

[8] Ibid., page 284, paragraph 2.

[9] Ibid., page 305 on Quantum Logic.