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Third Relativity

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It seems likely that quantum dynamical law does not have a separate objective existence, but is one aspect of the quantum process of nature, a matter-space-time-dynamics unity, and is not only variable, but may be the only variable. This is one result of a systematic application of the criteria for a group contraction given by Inönü and Wigner (1952). They point out that nonsemisimplicity is circumstantial evidence for a group contraction in which some coupling coefficient has been taken to a singular limit. In their example, the coupling coefficient is c and the group contraction $c \rightarrow \infty$ passes from special to Galilean relativity.

1. SPACE-TIME AS IDOL

By an idol of a theory we mean an element of the theory with a transformation law that couples it to elements that do not couple back to it. We borrow the term from Francis Bacon. An idol breaks simplicity and semisimplicity of the tranformation group.

A field/space-time point (say, a vector field at a space-time point) has the same kind of nonsemisimplicity as the space/time point of Galilean relativity, now under the coordinate transformations of general relativity. Present space-time is absolute as Galilean time was absolute, and is the base for the field fiber as time was the base for the space fiber. Absolute time was the idol of Galilean relativity. Absolute space-time is the idol of field theory in the same sense.

2. NETWORK AS SIMPLIFIED FIELD

The field/space-time nonsemisimplicity is absent from a finite-difference theory. It first arises in the limit $\Delta t \rightarrow 0$ of the calculus, when the chord is attached to one of its endpoints and forms a bundle. This indicates that there

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is a small fundamental time τ cutting this limit off and coupling field back to space-time, like the small fundamental inverse velocity $1/c$ coupling space back to time.

At the scale of τ, the nonsemisimple field/space-time supposedly resolves into a semisimple quantum field-space-time composite. We call this composite the quantum network, and the individual link of which it is composed the chronon. Quantum field theory is supposed to be a singular limit of quantum network dynamics as $\tau \to 0$.

3. DYNAMICS AS IDOL

No one natural dynamics for q space-time suggests itself as saliently as it does for general relativity and other gauge theories. This led us to question the existence of an absolute dynamics at the chronon level of resolution, as one way out of the dynamics impasse.

Ultimately the search for an absolute dynamics must be as futile as the search for absolute motion or absolute acceleration, and for much the same reason. There is an absolute reference frame neither for non-motion, nor for non-acceleration, nor for non-dynamics (stasis).

It is not merely that the dynamics changes from time to time and place to place, as Newton (1704) already suggested [Smolin (1992), (1997)].

Rather, the semisimplicity criterion of Inönü and Wigner (1952) suggests that the very split between kinematic variables and constant dynamics in present quantum theories is arbitrary and relative (Finkelstein and Rodriguez, 1984). Then only an atavistic vestige of the commonsense split between space and time inclines us to consider dynamics absolute, fixed by nature. Quantum theory already acknowledges that measuring any variable of a system is operationally inseparable from changing the dynamics of the system.

There is indeed theoretical indication that the one constant τ marks not only the transition from q to c spacetime, but also the boundary of a "third" relativity, that of dynamics.

While we argued for the variability and relativity of dynamics earlier, we made only slow progress in this new territory, mainly because there are many possibilities.

4. THE STATISTICS QUESTION

Our uncertainty begins with statistics. The c theory assumes Maxwell–Boltzmann statistics for space-time points by giving them unique mathematical labels x^{μ}. In our previous attempts at quantum networks we explored first fermionic and then bosonic chronon statistics, mainly out of excessive respect for precedents. But these are inappropriate for space-time elements, which are distinguishable. Furthermore, we had already found that a 2-valued statistics was necessary to account for spin 1/2 at the chronon level (Finkelstein and Gibbs, 1993; Finkelstein, 1996), and none of the usual statistics (F-D, B-E, M-B, or para-) are 2-valued.

We formerly understood a statistics as a representation of a permutation group of classically distinguishable entities. Since such entities likely do not exist, to be consistently quantum in concept we understand a statistics now as a functor constructing a q composite from a q individual. Both composite and individual are conveniently represented by Hilbert spaces, and then the functor is from the category of Hilbert spaces to itself. The functors for M-B, F-D, and B-E statistics are self-evident. The choice of statistics is now the most important mathematical input to q network dynamics, completely specifying its kinematics.

5. A STATISTICS PROPOSAL

What makes some headway possible now is that a unique chronon statistics presents itself, through a deeper spin–statistics connection than the usual one: Spin 1/2 at large time scales $t \gg \tau$, we now see, requires 2-valued statistics for chronons.

The simplest possible 2-valued statistics for chronon is the one based on Dirac's Clifford algebra C_N for a real N-dimensional Hilbert space (Dirac, 1974). It morphs a real Hilbert space H to the spinor space $\Sigma(H)$ underlying the Clifford algebra over H. This extends a projective statistics proposed for quasiparticles by Wilczek (1997, 1998, 1999), from permutations to arbitrary orthogonal transformations. We call it the Clifford-Wilczek (C-W) statistics. We call a composite with this statistics a *squad*.

6. IMPLICATIONS OF QUANTUM NETWORK DYNAMICS

In our earlier efforts we made classical models of space-time geometry out of sets, and analogous quantum models out of quantum sets (F-D composites). Now we make classical models of dynamics out of permutations, and analogous quantum models out of squads (C-W composites).

Now the q field-space-time-dynamics unity is not only variable, but is the sole quantum variable, whose operator algebra is the Clifford algebra $C(N_+, N_-)$ with $N_\pm$ depending on the extent of the system under study. An element of this algebra defines both a space-time region and its content in an appropriate singular limit $\tau \to 0$, $N \to \infty$.

For short, we call the q dynamics, regarded as the sole quantum variable, the *nomos*.

Now the spinorial chessboard (Budinich and Trautman, 1988) can be read as a table of possible C-W quantum theories. It shows how every squad breaks up into an M-B assembly (a sequence) of subsquads of 8 elements, with a remainder squad of fewer than 8 elements. This corresponds satisfactorily to the structure of the tangent bundle to space-time, which is likewise an M-B assembly of 8-dimensional elements.

The usual mathematically undefined Feynman integral over c paths of quantum field theory is now replaced by a well-defined trace over a finite-dimensional vector space $\Sigma(H)$ of the nomos. We "save the appearance" of constant dynamical law, much as one does that of constant space-time geometry, by the low coupling of matter to the dynamics. Perhaps this coupling is measured by the same Planck time $T_t \ll \tau$ that measured the coupling of matter to space-time.

Operational considerations based on present quantum field theory and gravitation put the breakdown of field theory concepts and the emergence of q network structure roughly 10–15 orders of magnitude closer to ordinary experience than the Planck time, suggesting that although τ has the same units as the Planck time, it is greater by many orders of magnitude. Finite-τ effects are probably already important at present experimental energies; it is our theory that is lagging.

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