SLAC – PUB – 4259
March 1987
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ON THE DISCRETE RECONCILIATION OF RELATIVITY AND QUANTUM MECHANICS*

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Continuum ("classical") physics rests on arbitrary units of mass, length and time; it is "scale invariant". Modern physics is quantized. Dalton and Prout recognized that mass is quantized, Faraday and Thompson showed that electric charge is quantized and Planck and Einstein discovered that action is quantized. Once these three facts are grasped, the goal of physics should be to replace MLT–physics by counting in terms of these quantized values (or equivalent units) and to replace continuum mathematical physics by computer science. We sketch here how this might be done.

The consequences of our "Discrete Physics"[1,2] are summarized in Table 1. These have been obtained by postulating[1] finiteness, discreteness, finite computability, absolute non-uniqueness and additivity. The fourth postulate is particularly important because it not only requires us to use "equal prior probability in the absence of specific cause" but also implies the concept of indistinguishability; for a related development of this idea, see Parker-Rhodes[3].

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*Work supported by the Department of Energy, contract DE–AC03–76SF00515.

Presented at the XXVI International Universitätswochen für Kernphysik
Schladming, Austria, February 17–27, 1987.

We start with a universal ordering operator isomorphic to the ordered integers and D independent generators of Bernoulli trials (coin flips) synchronized at $n = 0$. Following McGoveron[1], we specify our "metric marks" $i = 1, 2, 3...$ by the requirement that after n_i trials the accumulated number of heads be the same across all D "dimensions":

$$h_x^{n_i} = h_y^{n_i} = h_z^{n_i} = \ldots$$

Clearly the probability of this occurring is

$$u_n = \frac{1}{2^{nD}} \sum_{h=0}^{n} \binom{n}{h}^D \lesssim \frac{1}{\sqrt{D}} \left(\frac{2}{\pi n}\right)^{\frac{1}{2}(D-1)}$$

The construction gives us a coordinate dimensionality of D but no way to distinguish which axis is which. This "homogeneous and isotropic" synchronization of the metric across $D = 2$ or 3 dimensions can be repeated as often as we have time for, but the probability of being able to continue this for $D \geq 4$ vanishes.

Our next step is to fill in a cubic array in three dimensions by constructing all (up to some finite number) sequences of "drunkard's walks" of fixed "step length" L; the universal ordering operator specifies a fixed "time" t for each step. Clearly the velocity it takes to reach position $(2h - n)L$ in n steps is:

$$v = \frac{h - (n - h)}{h + (n - h)} \left(\frac{L}{t}\right)$$

and is bounded by some limiting velocity $c = L/t$. As we have shown elsewhere[1], this construction allows us to invoke the Einstein synchronization of distant coordinate systems and derive the Lorentz transformations in our discrete version of 3+1 "space time".

The construction just sketched can be generalized to define a metric based on any finite and discrete set of attributes referring to any finite collections. These collections can contain indistinguishables and hence have ordinality which is strictly less than their cardinality. We require this extension of the conception of "collection" from finite sets to finite "sorts"[3] in order to show directly that there are incompatible (non–commuting) observables, and that these coincide with those encountered in quantum mechanics. We also find that the limiting velocity depends on how much information we need to specify an attribute. Since electromagnetic information can require (directly or indirectly) a knowledge of all attributes, it will have to be transferred at the minimal of these limiting velocities. Thus we conclude that there must be supraluminal velocities which can be used for synchronization but not for signaling. We have therefore provided a conceptual framework in which the EPR–Bohm supraluminal correlations in violation of Bell's theorem are not mysterious; supraluminal signals are still impossible.

In order to pass from coordinate to momentum space, we note that our fixed step length L can be used to define an invariant mass by taking $L = h/mc$. We can then define $E^2 - p^2c^2 = m^2c^4$ and construct a 3+1 momentum energy space. Until we find a way to fix the unit of mass this "quantized" theory is still scale invariant—a fact which Bohr and Rosenfeld exploited in their derivation of QED from macroscopic "Gedankenexperimenta".

We now consider 3 distinct masses m_a, m_b, m_c each with its own 6–D phase space (which we have proved has to be embedded in a common 3+1 space when we specify asymptotic ("scattering") boundary conditions). We perform the embedding by allowing scattering events only when the discrete velocities $v_a = v_b = v_c$

coincide at some finite step of the generating operators. Defining mass ratios by (relativistic) 3–momentum conservation then gives us the classical relativistic kinematics of particulate scattering. Hence our insistence on finite and discrete constructions reconciles quantum mechanics with relativity in that both a limiting velocity and discrete events arise from the same construction.

The connection to laboratory events is provided by our basic epistemological postulate: wherever the discrete construction specifies an event, it could lead to the chain of happenings which fires a counter. Random walks between counters at the De Broglie phase wavelength hc/E (and the implied coherence wavelength h/p) allow us to identify h. Taking due account of the finite size and time resolutions of the counters then allows us[1] to derive the "propagator" of quantum scattering theory, including the complex in and out states:

$$P(E,E') = \lim_{\eta \to 0^+} 1/(E' - E \mp i\,\eta).$$

To obtain the scale invariants of the theory we construct the mass labeled bit strings (velocity states) by a simple algorithm (Program Universe) which constructs a hierarchy of quantum numbers that closes at the fourth level. (The combinatorial hierarchy is 3,7,127,$2^{127}-1$.) These quantum numbers are conserved in our quantum scattering theory and are associated with the standard model as follows 3:$\nu_e, \bar{\nu}_e$ Higgs? 7:$e, \bar{e}$ with spin; $\gamma_L, \gamma_R, \gamma_{\text{coulomb}}$; 127 $= u, d$ quarks and antiquarks (16 states) x8 for the color octet (less the null state). Cosmology is also well explained (cf. Table 1).

Table 1

DISCRETE PHYSICS (This Theory)

Constructed 3+1 space-time with supraluminal synchronization.
Limiting velocity c, step length $L = h/mc$, proton mass $m_p^2 = \frac{\hbar c}{(2^{127}+136)G}$.

DERIVED RESULTS (times $[1 + O(\frac{1}{137})]$)

$$\frac{e^2}{\hbar c} = \frac{1}{137}\,; \quad \frac{m_p}{m_e} \simeq \frac{137\pi}{\left(\frac{3}{14}\right)\left(1+\frac{2}{7}+\frac{4}{49}\right)\left(\frac{4}{5}\right)} = 1836.151497\ldots$$

quantum numbers of the first generation of quarks and leptons
relativistic quantum scattering theory.

CONJECTURED RESULTS

$m_q = \frac{1}{3}\, m_p$	$m_{\pi^o} = \frac{1}{7}\, m_p$	$2m_e = \frac{1}{137}\, m_{\pi^o}$
$q = u, d$ quark	lightest hadron	electron-pion ratio

COSMOLOGY

Flat space, event horizon, zero velocity frame, expanding universe,

$$N_{\text{baryon}} \approx \left(2^{127}+136\right)^2 \approx N_{\text{lepton(charged)}}$$

evolution of heritable stability in the presence of a "random" background.

REFERENCES

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3. A. F. Parker–Rhodes, "The Theory of Indistinguishables," Synthese–Library 150 Reidel, Dordrecht, 1981.