Quantum Origin of Classical Poisson Distribution Universality

Peter Cameron*
Mattituck, NY USA 11952

(Dated: August 27, 2018)

The 'In Theory' video series of Quanta magazine[1] has opened its second season with a "...series of dives deep into math and physics theories, kicking off with universality, a phenomenon that reveals underlying mathematical connections in the world... Scientists have discovered a mysterious pattern that somehow connects a bus system in Mexico and chicken eyes to quantum physics and number theory."[2]

The possibility exists that the universality is not so mysterious, though universal manifestation of quantum wavefunction fingerprints at the human scale would be most surprising. This brief note suggests that universality has its origin in the geometric Clifford algebra of quantum mechanics[3–5].

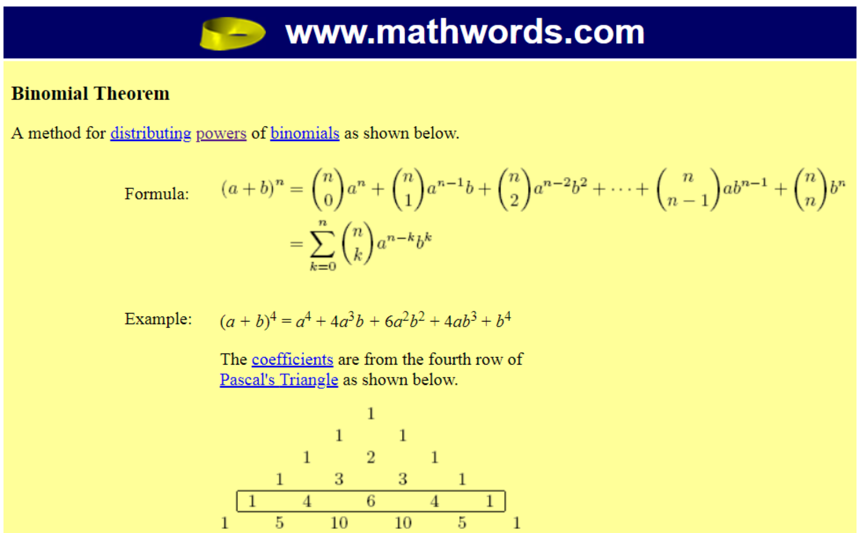

FIG. 1: Pascal's triangle and geometric wavefunction composition[6]

The Poisson distribution is a classical continuous approximation to the Binomial distribution, valid in the limit of large n. Unlike more familiar Gaussian and Maxwell-Boltzman probability distributions, it predicts a distribution of apparently random intervals in spacetime. In the quantum limit of small n of interest in the two-body problem of wavefunction interactions, the discrete Binomial distribution applies. Binomial coefficients for n=3 are (1,3,3,1), also the coefficients of the Pauli algebra of 3D space - 1 scalar, 3 vectors, 3 bivector pseudovectors, and 1 trivector pseudoscalar, with triples of vectors and bivectors required for orientational degrees of freedom of space.

Taking fundamental geometric objects of the eight component 3D Pauli algebra to be a vacuum wavefunction, interactions can be modeled by the geometric Clifford product, generating a 4D Dirac algebra of flat Minkowski spacetime - Spacetime Algebra[3–5]. The sixteen wavefunction coefficients (1,4,6,4,1) of n=4 spacetime are boxed in the above figure. Time emerges from the interactions, encoded in phases of the 4D pseudoscalar of the Dirac algebra. The amplitudes can be understood to comprise the particle physicist's S-matrix of observables.

The universality might be taken to be a consequence of the fact that the Binomial distribution, which the Poisson distribution approximates, is built into the wavefunction and wavefunction interactions. The universality appears to be emergent at the most fundamental level, at the level of the wavefunction and its interactions.

Octonions enter here. The eight component 3D Pauli wavefunction can be considered a representation of the octonion, with potentially useful implications for the octonion string theory approach recently reviewed in Quanta[7]. Absence of 3-body associativity is not an issue in 2-body wavefunction interactions, rendering the octonion algebra a Clifford algebra in the present context.

The apparent universal influence of wavefunction geometry and geometric interactions of wavefunctions on macroscale phenomena suggests exciting possibilities in exploring predictions of such a wavefunction model in small condensed matter experiments, perhaps with carbon nanowires and graphene.

* electronGaugeGroup@gmail.com

[1] https://www.quantamagazine.org/videos/playlist/in-theory/

[2] D. Kaplin, quoted in T. Lin "The Universal Pattern Popping Up in Math, Physics and Biology", Quanta, 23Aug2018. https://www.quantamagazine.org/the-universal-pattern-popping-up-in-math-physics-and-biology-20180823/

[3] D. Hestenes, *Space-Time Algebra*, Gordon and Breach, New York (1966)

[4] D. Hestenes, *Space-Time Algebra*, 2nd edition, Springer International (2015) https://www.amazon.com/Space-Time-Algebra-David-Hestenes/dp/3319184121/ref=sr_1_1?s=books&ie=UTF8&qid=1534702547&sr=1-1&keywords=david+hestenes

[5] D. Hestenes, "Oersted Medal Lecture 2002: Reforming the mathematical language of physics", Am. J. Phys. **71**, 104 (2003) http://geocalc.clas.asu.edu/pdf/OerstedMedalLecture.pdf

[6] http://www.mathwords.com/b/binomial_theorem.htm

[7] N. Wolchover, "The Peculiar Math That Could Underlie the Laws of Nature", Quanta electronic magazine, 20Jul2018. https://www.quantamagazine.org/the-octonion-math-that-could-underpin-physics-20180720/