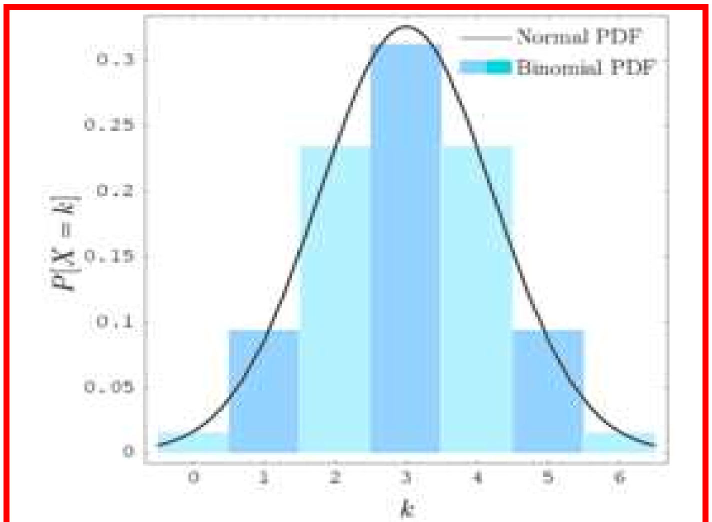
Joel H. Mayer, M.D.

IS REALITY DIGITAL OR ANALOG?

I. How can space time or other continuum - with continuous symmetries - emerge from a'digital' description?

Figure 1: A Binomial Distribution Blending to a Normal Distribution



http://schools-wikipedia.org

My position is that continuous symmetries arise out of digital behavior *'In The Limit'* as the number of digital elements grow more and more numerous. To see that this is so imagine a plate or tray upon which an experimentalist places one or more permutables (less formally coins). Next, follow the outcome when the coins are tossed up in the air off the tray and then allowed to come to rest on the surface of the tray- free of external hindrances. Quite obviously, repeating this exercise will lead to the formation of a number of symmetrical binomial distributions.

Now turn your attention to the fact that the number of elements in each distribution, graphically the number of columns, is given by the number of permutables or coins in the set (**n= 1, 2, 3, ...**). It follows that as we increase the number of permutables, the overall appearance of the binomial distribution becomes more and more easy to describe by the graceful curves due to Abraham De Moivre (1667 - 1754) and Carl Friedrich Gauss (1777 - 1855) as with the discrete columns original to Jacob Bernoulli (1654 - 1705).

The underlying mechanism is of a discreet, more properly a- 'quantal' nature. Yet the manifestation takes on the appearance of continuous behavior as we add permutables. In other words, more fine, as the number **n** in the formula:

$$P_p (n \mid N) = \binom{N}{n} p^n \; q^{N-n} = (N! / (n! * (N - n)!)) * p^n * (1 - p)^{N-n}$$

grows more and more large, the number of discrete columns increases directly. And, as the number of columns increase. The saw tooth appearance of the step pyramid grows less jagged and more near to the appearance of a smooth and continuous bell shaped curve of double curvature.

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II. What is the nature of space? How would a discrete universe expand without the discreteness becoming evident? Or, does it become evident?

The ancient Greek mathematicians taught us that space is that which has length, width, and breadth. Why would anyone hazard to change this bedrock definition?

When we expand a photograph ten to twenty times the original size the image becomes more and more grainy as the pixels fall away from one another. Molecules and atoms are sub-microscopic particles much smaller than pixels. They are invisble to the human eye. When the distance betwen these bodies increases, more formally, when there is a drop in density, there is no reason to think the process will fall within the bounds of human perception.

III. What are the implications of a minimal length, time, or energy, and how could we observe them now? Or, is this the wrong way to view fundamental discreteness?

At the exact moment when we are able to define minimal length, minimal time, and minimal energy, we have arrived at a complete understanding of our manifestation. My viewpoint, that the discreet takes on a continuous appearance ***'In The Limit'*** as the number of permutables becomes more and more numerous, was first stated by Galileo:

"Those materials which produce heat in us and make us feel warmth, which are known by the general name of "fire", would then be a multitude of minute particles having certain shapes and moving with certain velocities" ... "The operation of fire by means of its particles is merely that in moving it penetrates all bodies, causing their speedy or slow dissolution in proportion to the number and velocity of the fire corpuscles and the density or tenuity of the bodies." ...

"Since the presence of fire corpuscles alone does not suffice to excite heat, but their motion is needed also, it seems to me that one may reasonably say that motion is the cause of heat," ... "And perhaps when such attrition stops at or is confined to the smallest quanta, their motion is temporal and their action calorific only; but when their ultimate and highest resolution into truly indivisible atoms is arrived at, light is created."

Galileo Galilei (1564 - 1642) *' The Assayer'* (1623) in: DISCOVERIES AND OPINIONS OF GALILEO, Translated and with an Introduction and Notes by Stillman Drake (1957) pages: 277 - 278.

By my light, the father of quantum mechanics was not Max Planck, as is commonly believed, but rather Galileo Galilei. Please note that Signor Galileo used the word **'quanta'** hundreds of years before Max Planck.

IV. Is a universe that is infinite in various ways incompatible with a digital description?

"But the smallest portion of matter which we can subject to experiment consists of millions of molecules, not one of which ever becomes individually sensible to us. We cannot, therefore, ascertain the actual motion of any one of these molecules, so that we are obliged to abandon the strict historical method, and to adopt the statistical method of dealing with large groups of molecules." James Clerk Maxwell (1873) *'Molecules'*.

Physicists visit the imaginary land of the infinite for the same reason compulsive gamblers fly out to Las Vegas. If you doubt that day dreams about the infinite are just as counter productive as they are habit forming. Drop down to the bottom of this essay and read my critique of the paper James Clerk Maxwell published in 1860.

The real issue here has to do with mathematical illiteracy. To the benefit of no one, modern day authors have removed the formula due to Abraham De Moivre from the textbooks. The consequence of this rash and foolish gesture is that we can no longer see the bridge between ***'discontinuous behavior'***. As described by the binomial distribution due to Jacob Bernoulli. And ***'continuous behavior'*** as described by the bell shaped curve due to Carl Friedrich Gauss.

I believe that in the very small, the world is always digital. And that the best way to explain what we observe at the level of the fundamental particle is to use Bernoulli's formula to build a step pyramid / binomial distribution. Further, I wish to imagine that for as long as we describe continuous behavior by the formula due to Abraham De Moivre:

$$\text{DeMoivre(1733)} = Y = (2.0 \div \sqrt{2.0 * \pi * n})*(e^{-\left(\left(\left(x_{avg} - x\right)^2\right) \div (n \div 2.0)\right)})$$

The relationship between the digital and the analog is easily understood. Both expressions, that due to Bernoulli, and that original to De Moivre, define the number **n** (n = 1, 2 ,3, 4, ...) in exactly the same fashion. For those who are fluent in both formulas. The interplay between digital and analog, discreet and continuous, is perfectly clear.

Regretably, modern day textbook authors have deleted all mention of De Moivre's formulae and replaced it with the expression due to Gauss:

$$\text{Gauss(1809)} = Y = (1.0 \div (\sigma * \sqrt{2.0 * \pi}))*(e^{-\left(1.0 \div 2.0\left(\left(x_{avg} - x\right)^2\right) \div \left(\sigma^2\right)\right)})$$

With this oversight we lose, as Max Planck was fond of remarking, our *'bridge to understanding'*. While it is possible to arrive at a value for the number **n (**the number of permutables in the set) through Gauss' term for the standard deviation **σ** (sigma). The method is conspicuous by it's abscence from the literature.

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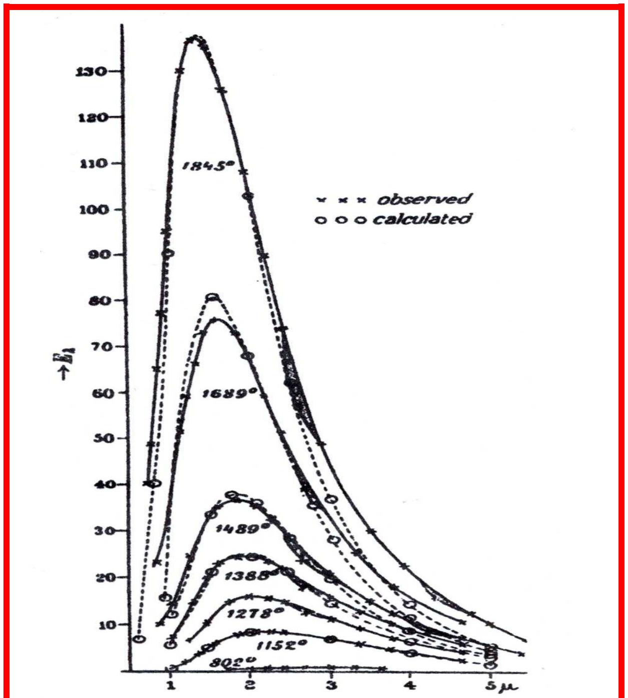
V. How is a digital description consistent with a 'flow' of time? How does causality work?

We apply discrete units to time such as: seconds, minutes, hours, days, months, seasons, and years. Because it is in our best interest to apply these conventions. If, for example, we did not view time in discreet units of seconds cardiologist's would not be able to define the cardiac arrhythmias. If, for a second example, we did not view time in discreet units of months, and seasons, farmers would not know when to plant their crops.

I believe that people who deny causality, or as I would phrase it, 'cause and effect relationships', harbor a hidden agenda. Pedants who pose questions of this sort have no interest in scientific truth or moral absolutes. They are working in an underhanded manner, as 'devil's advocates', to erase the distinction between moral and immoral behavior.

VI. Can the World be modeled as (or even be) a digital computation? Where does this picture lead us?

Figure 2: Black Body Radiation (Lummer and Pringsheim)



Moelwyn-Hughes, E A (1961) Physical Chemistry, page: 94

The sketch at the left is the first and perhaps the best example of discrete behavior presenting to the observer as a continuous manifestation. Each bell shaped curve represents the energy spewing off populations of metallic particles in a black body radiator or furnace. The best way to explain the bell shaped appearance of the isotherms is to opine that the metal particles in the gas take on energy in discrete units or 'quanta'. And that the energy is distributed amongst the populations of particles according to the law of the binomial. The problem here- De Moivre's formulae for the bell shaped curve has fallen off the horizon and Gauss' formulae makes no mention of the variable- **n**. This quantity symbolizing the number of permutables in the set (less formally coins on the tray).

A physicist 'unaware' of the formulae due to Abraham De Moivre. Will never be able to use the formulae due to Gauss to analyze Black Body Radiation in such a way as to explain the graphs as the behavior of a population, and in terms of the binomial distrbution. His compass card has too few points.

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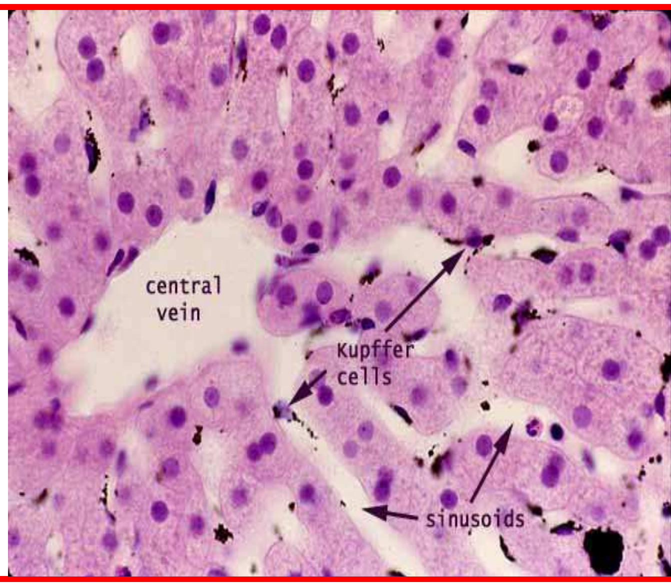
By my light, the fact that De Moivre's formulae is no longer mentioned in the modern text books explains just how it is that modern day forays into the nascent subject of bioenergetics are completely irrational. Living systems nearly always exhibit bell shaped behavior. But without a knowledge of the interplay between the formulaes due to Bernoulli, De Moivre, and Gauss, the real dynamics will never be brought to light.

VII. Are simple discrete models like cellular automata, etc., effective approaches to physics?

One of the most popular, and one of the best modern-day treatments of the subject of cellular automata rests in a book authored by Mr. Stephen Wolfram, entitled - **A New Kind Of Science**. (see: http://wolframscience.com/) There are, however, two glaring deficiencies in Mr. Wolfram's foray. The first- that he makes no mention of the universal tendency or inclination of cells to arrange themselves in lobules as a prelude to forming up into organs and glands.

Figure 3: Liver Cells Exhibiting Some Pleomorphism



http://www.siumed.edu

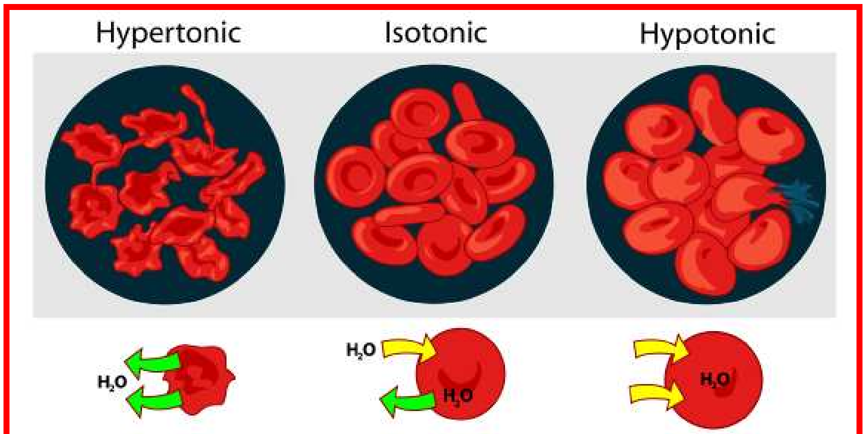
The second- that he makes no mention of the issue of energy consumption by the cells and the distribution of energy in units of quanta among the cells. (see: http://wolframscience.com/nksonline/section-8.6) In my work, **NEOPLASIA MATHEMATICS**, these deficiencies are completely remedied. Everyone agrees that the hepatocytes in a single lobule of liver tissue differ in size in a rough correspondence with the curve of the bell shaped distribution. The only question remaining, how best to explain this universal manifestation?

A modern-day biophysicist, unaware of the interplay betwen the formulaes due to Bernoulli, De Moivre, and Gauss but fully trained in anthropomorphisms. Will assert that the difference in size from one cell to the next gives a measure of the influence of a nearly infinite number of 'control factors' (sic).

By the light of the moderns, these all powerful control factors scream orders at the cells while perched on mountain top telomeres in the DNA molecule. Much in the same way as Moses, staff in one hand, stone tablets in the other, howled at the top of his lungs for his people to obey.

A more realistic explanation of the difference in cell size among hepatocytes. Would be to assume that the genes are quantized on the property of energy. And, that the energy distributes among the genes on the law of the binomial. The higher the energy levels taken on by the genes, the faster the net rate of protein production by the cell. The faster the rate of protein molecule production, the greater the intensity of the intracellular osmotic pressure.

Figure 4: Red Cell Size as a Function of Osmotic Pressure



http://en.wikipedia.org

The higher the osmotic pressure, the greater the number of water molecules drawn into the cell. The greater the number of protein and water molecules in the cell, the larger the cell. It is just that simple!

Please note that we arrive at a mechanical explanation with no need to invoke anthropomorphic 'control factors' because we are fluent with the formulaes due to Bernoulli, De Moivre, and Gauss.

"Certainly, I might add, each great physical idea means a further advance towards the emancipation from anthropomorphic ideas." Max Planck, 1915

VIII. Is there a deep, foundational reason why reality must be purely analog, or why it must be digital?

"One mans amplifies, the next one alters, and what came from the author's own mouth becomes so transformed in spreading that he will no longer recognize it as his own."

Giovanni Ciampoli (February, 1615) in a letter to Galileo

A question of this sort brings to light the dangers of quoting from a source without testing the relevant equations cast by the source. A physics professor, an electrical engineer, a social scientist, who assumes an equation he found in a paper or book is correctly solved on the authority of the author treads a dangerous path. A dangerous path, indeed!

Physicists, particularly particle physicists, often state formulaes in their papers and books which have no basis whatsoever in reality. As you can see from the narrative on the next two pages. James Clerk Maxwell published a formula in 1860 which is in error, in some instances, by as much as two hundred percent. Yet every physicist in the world will tell you his work springs directly from the sacred scrolls of Maxwell. Consider the following:

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Maxwell on the Distribution of Molecular Velocities (1860)

In the paper James Clerk Maxwell (1831 - 1879) published in 1860 (*'Illustrations of the Dynamical Theory of Gases'*, Philosophical Magazine, Series 4, Volume 19, page: 19) the author summarizes his efforts by saying:

"It appears from this proposition that the velocities are distributed among the particles according to the same law as the errors are distributed among the observations in the theory of the "method of least squares". The velocities range from 0 to ∞, but the number of those having great velocities is comparatively small." **(I mark this sentence the beginning of the world's morbid fascination with all things infinite.)**

And he wrote down the following expression. Intended no doubt, as a variant on Gauss's formulae, fit not to a macroscopic issue such as star sightings, but rather to a sub-microscopic issue. A population of gas molecules held at constant external parameters such as volume, temperature, and pressure.

James Clerk Maxwell (13 November 1831 - 5 Nov 1879)
Maxwell (1860)=1.0 $\div(\alpha * \sqrt{\pi})*(e^{-(x^2 \div \alpha^2)})$

Some of the errors in this expression are obvious at a glance. We see, for example, on comparison with Gauss's formulae (below) that Maxwell left off the factor ½ from his exponential term without explanation. Moreover, by his light the value for the independent variable, **X**, should be squared. While on the combined authority of De Moivre and Gauss, it is the difference between any given value for the independent variable and the average value for the independent variable **(Xavg – X)^2** which should, instead, be raised to the second power. And further, while Maxwell might have intended his alpha, **α**, to serve as Gauss's sigma, **σ**, the value for the Standard Deviation under a highly specific set of circumstances. Maxwell also forgot to include the number 2 inside the radical of the Stirling De-Moivre approximator.

The Distance Between: Bernoulli, Gauss, and, Maxwell

Just how far Maxwell's otherwise brilliant effort distances us from a Binomial Distribution can be determined by inspecting the following table. Which gives the height of the centermost column of a symmetrical binomial distribution for a number of permutables (think of tossed coins falling on a tray or plate) ranging from one on up to ten. And further, on the assumption that Maxwell's **α** is one and the same with Gauss' **σ**. (In all three expressions when we focus our attention on the average or middle most value the exponential term simplifies to unity.)

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First off, we see through a comparison of the elements in the second and third rows of the table. That calculation's taken off Gauss's **approximator** to Bernoulli's **exact** formula for the Binomial, are burdened down by substantial error. There is a consistent bias in the positive direction which is all the more egregious the fewer the number of permutables in the set.

Table (1) Height of the Centermost Column in a Symmetrical Distribution [Bernoulli, Gauss, Maxwell {p = 0.5, n, 1, 10, 1}]

Permutables	n = 1	2	3	4	5	6	7	8	9	10
Bernoulli	0.5	0.5	.375	.375	.312	.312	.273	.273	.246	.246
Gauss	.798	.564	.461	.399	.356	.327	.302	.283	.266	.252
Maxwell	1.128	.798	.651	.564	.504	.462	.427	.400	.376	.357

Unfortunately, as the entries in the third row make abundantly clear. Maxwell's expression performs even more poorly as compared to the approximator due to Gauss. In fact, for one permutable in the set (**n** = 1, **p** = 0.5) Clerk Maxwell's expression leads to the absurd conclusion that 113% of the molecules under scrutiny flit here and there in the container at the average value for molecular velocity.

And too the remark needs to be made there is no refuge for Maxwell's interpretation of Gauss's formulae in the issue of particle motion in a volume.

Whether we consider the distribution in the X the Y or the Z dimension, the law of probability governing the distribution remains the same. There is no reason to imagine an equation needs to be divided by three, or multiplied by 4π, or any other factor, for that matter, simply because the process occurs in a volume rather than on a plane.

We see then that while Maxwell had in mind the formulaes due to De Moivre and Gauss from the phrase- "*the velocities are distributed among the particles according to the same law as the errors are distributed among the observations in the theory of the "method of least squares"*". Still, his equation falls far short of those of his masters. Maxwell's law of molecular velocity distribution is in no wise as accurate an approximator to Bernoulli's law of the binomial distribution as are the equations derived by De Moivre and Gauss.

Here, below, are the correct formulaes for the bell shaped curve, the approximator to Jacob Bernoulli's exact solution to the binomial distribution. As you can see, Maxwell's formulae bears only a slight resemblance to the truth. Why then, do so many people with tenured faculty appointments claim Maxwell as their inspiration?

Abraham De Moivre (26 May 1667 – 27 November 1754)
DeMoivre(1733) $Y = (2.0 \div \sqrt{2.0 * \pi * n})*(e^{-(((x_{avg} - x)^2) \div (n \div 2.0))})$
Carl Friedrich Gauss (30 April 1777 – 23 February 1855)
Gauss(1809) $Y = (1.0 \div (\sigma * \sqrt{2.0 * \pi}))*(e^{-(1.0 \div 2.0((x_{avg} - x)^2) \div (\sigma^2))})$

The most important point made by the table immediately above these lines. Is that the symbol **'n'** in the formulae due to De Moivre is exactly the same quantity **'n'** in the formulae due to Bernoulli. These two quantities are interchangeable at will. The formulae due to Gauss lays things out in terms of a very popular quantity known as the standard deviation. Unfortunately, there is no convenient path from the standard deviation **'σ'** to the number **'n'** the number of permutables in the set. And thus, there is no easy way to convert a Gaussian distribution to a Binomial Distribution.

Conclusion- Please gentle reader, please take the time to read my essay- **NEOPLASIA MATHEMATICS**. See for yourself how easy it is to explain all the mysteries of cancer cell growth out of a knowledge of Bernoulli's law and the approximators due to De Moivre and Gauss. Thanks- Joel H. Mayer, MD | 15 February 2011 | joelm_armillary@msn.com

It was the remark Maxwell made in 1873 (page 3, above) which led me to these insights. I am in no wise a Maxwell basher. I am as much a Maxwellian as anyone else with a penchant for science and mathematics.

"To sum up, we may say that the characteristic feature of the actual development of the system of theoretical physics is an ever extending emancipation from the anthropomorphic elements, which has for its object the most complete separation possible of the system of physics and the individual personality of the physicist." ...

"Certainly, I might add, each great physical idea means a further advance towards the emancipation from anthropomorphic ideas. This was true in the passage from the Ptolemaic to the Copernican cosmic system, just as it is true at the present time for the apparently impending passage from the so-called classical mechanics of mass points to the General Dynamics originating in the principle of relativity."

Planck, Max (1998) EIGHT LECTURES ON THEORETICAL PHYSICS, translated by A. P. Willis, with an introduction by Peter Pesic, Dover Publications, New York, ISBN: 0-486-69730-4, originally, 1915. The lectures were delivered in New York City in 1909.

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