

On the Origins of Mass

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Abstract

Probability, as manifested through entropy, is presented in this study as one of the most fundamental components of physical reality. It is demonstrated that the quantization of probability allows for the introduction of the mass phenomenon. In simple terms, gaps in probability impose resistance to change in movement, which observers experience as inertial mass. The model presented in the paper builds on two probability fields that are allowed to interact. The resultant probability distribution is quantized, producing discrete probability levels. Finally, a formula is developed that correlates the gaps in probability levels with physical mass. The model allows for the estimation of quark masses. The masses of the proton and neutron are arrived at with an error of under 0.04%. The masses of sigma baryons are calculated with an error between 0.2% and 0.05%. The W boson mass is calculated with an error of under 0.5%. The model explains why proton is stable while other baryons are not, and it gives an explanation of the origins and nature of dark matter. Throughout the text, the article illustrates that the approach required to describe the nature of mass is incompatible with the mathematical framework needed to explain other physical phenomena.

MSC Classification: 65C20 , 81P05 , 81P16 , 81Q50 , 37D45

1 Introduction

Since the conception of the General Relativity Theorem, the idea of establishing a unified model describing the fundamental forces of nature has become an active research topic. At first, the objective was to unify electromagnetism with gravity. Later, the strong and weak interactions became part of the objective.

Einstein was adamant that a single theory must describe all of nature. In his Nobel lecture in 1923, he said “The intellect seeking an integrated theory cannot rest content with the assumption that there exist two distinct fields totally independent of each other by their nature”. So it is a one-hundredth anniversary this year since the quest for a unified theorem became a hot research topic. After 100 years of effort, countless research papers, numerous Nobel prizes awarded for the achievements towards that goal, and still a huge pool of intellectual endeavour invested by the giants of scientific thought into this topic, the theory has not been formulated.

The paper’s conclusions call into question the opinions of many great thinkers. We will try to defend the scientific reasoning within the text, and the only indication of authority that we may summon to the defence of this research may be found at the beginning of a book that is not supposed to be quoted in any scientific research. Namely, we would like to recall that the book of Genesis begins with two statements. The first day is the creation of light, and the second is the separation of water into two bodies. One may think that the creation of light correlates with electromagnetism. But what would those waters be compared to?

Physics employs differentials as one of the most fundamental tools. However, for a function to be differentiable, it needs to be smooth, and the relevant limit needs to exist. When one considers sub-atomic distances, it is not a given that the assumptions of functional smoothness still hold. In particular, why would one expect that the distances below a Fermi can be described by smooth functions? This is why we picked methods of the chaos theory. Those methods employ sequences of numbers, never demanding any form of differentiability from mappings.

The method is a simple one. A researcher constructs some feedback formulae and runs a looping iteration employing a computer, feeding the results of each step as input to the next. The problem is when to stop, or, in other words, when to decide that the iteration is close enough to the limit that it may be terminated. An imperfect but effective method is to look at the sequence. If it stops deviating from some points (assumed to be attractors), then one could decide to terminate the process. In our other research projects, a 50-step iteration was sufficient. Here, we stopped after 200 steps, as this gave us some level of confidence that the limiting values had been achieved.

The paper introduces the concept of a probability field, which is arrived at within the framework of classical physics. It is important to stress that the discussion presented in this paper does not relate to any notions introduced through quantum mechanics. Rather, the probability field introduced here is derived in the context of Boltzmann-Gibbs entropy and is employed through an interaction between two classical probability distributions. Chaos theory is used to model such interactions.

The investigation of entropic forces constitutes one of the most exciting research topics. This is partly because of the evidence of entropy influencing a wide spectrum of reality, but also due to entropy exerting such influence at the most fundamental levels. In physics, it is expected that entropy provides an agent, which is expressed through the four observable forces of nature [1]. Moreover, entropy has been recognised as a major factor in information transmission theory [2] [3].

The paper assumes the validity of some of the currently established entropy theories. In particular, entropic time is associated with entropy production [4] [5] [6], and

consequently, the evolution of the universe is associated with entropy production [7]. Entropy is assumed to constitute a fundamental force underlying physically observable reality [8].

The paper looks at a set of two feedback formulae that are connected through the standard conditional probability relationship. Such a setup models an intra-entropic interaction. The attractor obtained in this way is analysed in the context of the attractor's basin of attraction.

A method of association of quark masses with probability transitions is proposed. The transitions are observed at particularly low values of entropic time, thus allowing us to perceive quark formation in the context of the universe's emergence. In the second part of the paper, the model is employed to assess the masses of composite particles. In particular, the masses of the proton, neutron, sigma, and W boson are calculated. The paper is closed with a discussion of the findings.

2 A note on the Chaos Theory

In mathematics, an infinite sequence of numbers may converge to a specific value, called a limit. A precise definition of a limit was provided by Augustin-Louis Cauchy. The definition assumes that a limit, if it exists for a given sequence, is always a singular number. One of the roots of the chaos theory is the observation that a sequence of numbers may tend to more than one limit, alternatively jumping from one to the next as the sequence progresses. To avoid confusion with the concept introduced by Cauchy, the collection of such limiting numbers is called an attractor, as if to say that these numbers attract the sequence for large n . An attractor can be a singular number, a finite collection of numbers, or an infinite collection, in which case the state while "chaotic" may still be represented through a well-defined orbit.

In many cases, an attractor depends on the initial conditions of the sequence. This leads to the notion of a "basin of attraction". A set of initial conditions that result in the sequence being bounded, that is, when it does not diverge to infinity, belong to the attractors' basin of attraction.

Thus, an attractor may consist of several distinct points. This should not be confused with eigenstates observed in quantum mechanics. In quantum physics, quantization is obtained through the imposition of boundary conditions on a wave function, so these correspond to standing waves. In chaos theory, quantization of an attractor is a result of specific settings of parameters determining the behaviour of the sequence being considered, together with the initial conditions influencing the behaviour of the attractor. [9][10]

3 Materials and Methods

In the case of a two-parameter sequence, for an initial point (p_0, q_0) , the sequence is initiated with (1), followed by (2), and (1), etc. This makes the "p" sequence never exposed to the initial condition of q_0 , as in $q_1(p_0, q_0)$, $p_1(p_0, q_1)$, $q_2(p_1, q_1)$, $p_2(p_1, q_2)$, etc. The sequence is iterated 200 times, and then, depending on the requirements, either the next 200 iterations or the immediately following value is collected. As (1)

is used in the first iteration, the two sequences are asymmetric, with the Q-sequence having an advantage of the first move.

The basin of attraction chart is obtained by setting an equally spaced 1,000x1,000 grid of initial conditions covering the square $(0, 0, p_{\max}, q_{\max}) = (0, 0, 1.2, 1.2)$. Starting from each initial point, a trajectory is calculated and then evaluated at $k = 2.05$.

4 Two Parameter Chaotic Entropy – The Methodology

Let us describe an interaction between two fields, both of which are defined by the Boltzmann-Gibbs entropies and interact with each other via normal conditional relationships.

$$q_{n+1} = P(q|p) = \frac{P(q \cap p)}{P(p)} = \frac{-kq_n p_n \ln(q_n p_n)}{p_n} = -kq_n \ln(q_n p_n) \quad (1)$$

$$p_{n+1} = P(p|q) = \frac{P(q \cap p)}{P(q)} = \frac{-kq_n p_n \ln(q_n p_n)}{q_n} = -kp_n \ln(q_n p_n) \quad (2)$$

where $0 < k < e$ (2.71) and $0 < qp$

(Note: Here, k stands for a parameter that varies between 0 and Euler's number and does not relate to the Boltzmann constant.)

Formulae (1) and (2) constitute a two-dimensional set of feedback sequences. An important point to note is to observe that the formulae, as they stand, do not impose a limiting value of either q or p . The only constraint is the argument under the logarithm, which must be within the open (0,1) interval (otherwise q or p becomes negative and feeds a negative value to the logarithm's argument). In order to recover probabilities from q and p , we scaled them back by dividing each by their sum. These scaled values are used in the subsequent calculations and shown in the figures.

An example of trajectories obtained through (1) and (2) for a sample of randomly selected initial conditions is shown in Figure 1.

The procedure used in the construction of Figure 1 consists of the following steps:

1. Select a random pair of initial conditions (q_0, p_0) with values from the (0, 1) interval.
2. Choose a small value of k .
3. Run the sequence (1) (2) for 200 steps, and then collect the subsequent values of (q_n, p_n) as the attractor.
4. Draw the attractor point(s) with some chosen colour.
5. Increase k by a small step and use the same initial condition for the next run. Again, plot the attractor with the same colour. Repeat until k is close to the Euler's number.
6. Choose another set of initial conditions (q_0, p_0) and repeat steps 2–5, drawing the results in a different colour.
7. Repeat the above with 20 or so different initial conditions. Plot each set of points in a different colour.

The figure clearly consists of three distinct regions. When k is below 2.0, the attractor is represented by a multiple of points aligned along semi-continuous lines. At k between 2.0 and 2.6, the trajectories asymptotically converge to 0 or 1, without attaining either of these values. When k is above 2.6, the sequences become chaotic, and the attractor consists of a collection of seemingly random points.

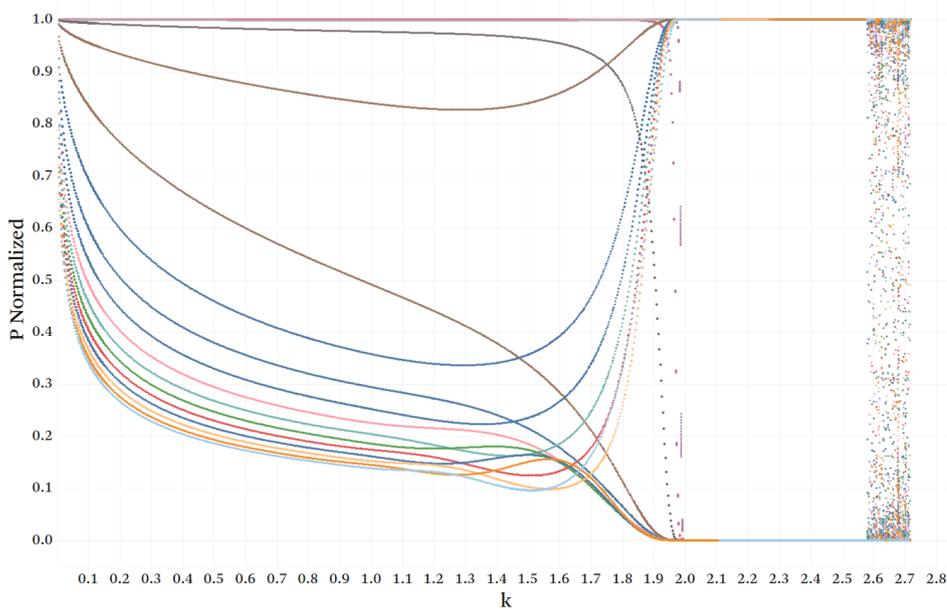


Fig. 1 An example of p -normalized trajectories

5 The banding, error rounding principle and the basin of attraction

The basin of attraction is defined as a collection of initial points that are mapped through the feedback sequence into a specific value of the attractor. It is evident from Figure 1 that for k in the 2.0 to 2.6 range, all trajectories asymptotically tend to the normalized values of either 1 or 0. Therefore, the attractor is either 1 or 0 for k in this interval. Thus, if we demand that the attractor be equal to one of these two values, the collection of the initial points is going to be split into those that lead to 0 and those that lead to 1. Figure 2 illustrates this phenomenon, showing the distinctive banding of the basin of attraction. Here, with k set to 2.1, any initial condition within the green bands leads to the attractors' value of 1, and the initial conditions within the yellow bands lead to the attractors' value of 0.

The error rounding principle is a result of banding and is introduced by observing that, from the attractor's point of view, it is impossible to establish what point within

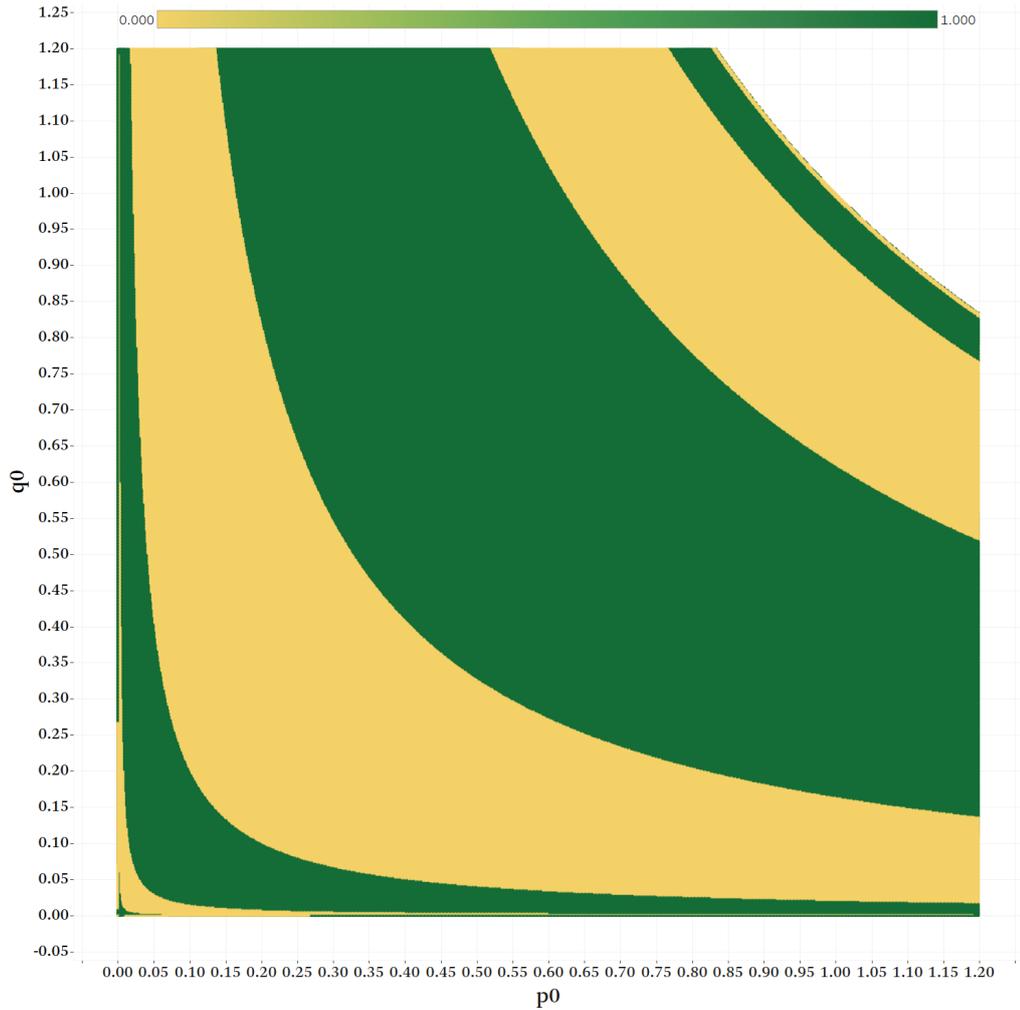


Fig. 2 Close up of the basin of attraction at $k=2.1$ and p_0, q_0 under 1.20 showing attractor bands

a band was used as the initial condition to arrive at this attractor's value. The breadth of the band limits the most precise estimation that can be established.

To arrive at this estimation, we used the $p_0=q_0$ line. This line cuts the bands in their widest region. This allows for the maximal width of each band to be measured, which results in a one-dimensional error-defining parameter.

The next crucial step is the error rounding. One does not consider an error to be a precise number, but rather its magnitude is taken as a representation of its estimation. Therefore, we scale each of the variables by expressing them as multiples of band width. Another way of looking at this problem is to say that, because of the banding, the most precise knowledge one may have about each of the variables can be expressed as a multiple of the band width.

This approach is applied to the values of p, q, and k variables. Thus, when performing a computation, the sequence is run on a computer at the highest precision available. However, the values used to obtain the normalized p, q, and k are scaled through the banding parameter, as in below. In the case of q and p sequences, the integer portion of the scaling is taken to implement rounding. K is set as multiples of the width of each band, splitting the attractor into a collection of distinctive points along the k-axis. When performing the quantization it is essential that the number is rounded to the nearest integer rather than truncated. This operation mimics the most naturally expected behaviour; that is, when introducing quantization, the most likely movement would be towards the closest integer. (The formulae for the q-sequence are shown; the p-sequence is similar.)

$$q_{integer} = Integer(rounded)\left(\frac{q}{(width\ of\ band)}\right) \quad (3)$$

$$q_{scaled} = q_{integer} * (width\ of\ band) \quad (4)$$

$$k_i = (width\ of\ band) * i \quad (5)$$

Thus, the computed number is divided by the width of the band, rounded to the nearest integer, and then multiplied back by the width of the band to arrive at the scaled value. The scaled value expresses both p and q in terms of multiples of the band width. These values are used to normalise q and p, respectively. The attractor charts are plotted for the normalised values of p-normalised and q-normalised against granulated k, as in (5), (6), and (7).

$$q_{normalised} := \frac{q_{scaled}}{q_{scaled} + p_{scaled}} \quad (6)$$

$$p_{normalised} := \frac{p_{scaled}}{p_{scaled} + q_{scaled}} \quad (7)$$

Table 1 lists each band characteristics as measured by setting the trajectories' initial conditions to $p_0=q_0$.

Figure 3 illustrates trajectories for bands 4, 5, and 6 in the region of small k. The error rounding principle results in quantization both along the k-axis as well as p and q normalised values. Now the attractor consists of distinct points, as opposed to the original continuous lines.

5.1 Probability-Mass relationship

Figure 3 shows some form of probability quantization. It would be natural to seek a physical interpretation of this phenomenon as well as a formula that would translate the changes in probabilities into quantities that could be measured physically. In particular, we are interested in how the probability chart could be interpreted in terms of mass.

Let us start with some observations. Firstly, in the very low region of k, when k increases, the probability p also increases. That is, an increase in k results in an entropy increase. So, in light of the Second Law of Thermodynamics, the system should naturally tend to move in the direction of increasing k. We feel strongly that the opposite should be happening. That is, we would like to associate a decrease in k with

Band Id	Lower Edge p_0	Upper Edge p_0	Attractor	Width of Band
1	0.00000001000	0.00000001086	0	0.00000000086
2	0.00000001129	0.00000009492	1	0.00000008363
3	0.00000009535	0.00000078541	0	0.00000069007
4	0.00000078584	0.00000603617	1	0.00000525033
5	0.00000603660	0.00004288499	0	0.00003684839
6	0.00004288542	0.00027871100	1	0.00023582558
7	0.00027872700	0.00163415600	0	0.00135542900
8	0.00163423800	0.00848224000	1	0.00684800200
9	0.00848412000	0.03797004000	0	0.02948592000
10	0.03797192000	0.14073648000	1	0.10276456000
11	0.14073836000	0.40388424500	0	0.26314588500
12	0.40389073800	0.78812363500	1	0.38423289700
13	0.78813012700	0.95861575200	0	0.17048562500
14	0.95861620500	0.99524989500	1	0.03663369000
15	0.99525034700	0.99965653100	0	0.00440618400
16	0.99965657900	0.99998285400	1	0.00032627500
17	0.99998290100	0.99999936400	0	0.00001646300
18	0.99999936400	0.99999998100	1	0.00000061700
19	0.99999998200	0.99999999900	0	0.00000001700

Table 1 Widths of attractor basin bands

the system coming to rest. The way to resolve this is to assume that the probability of a particular state should be measured in the context of p-level distances. Thus, the first two levels, with the smallest values of k , have the largest gap between them, so they are the most probable. Moving to the right, the gaps decrease, so the probabilities decrease accordingly.

Secondly, if we were to apply this to mass, then smaller mass should be more probable than heavier mass. Therefore, some form of inverse relationship between probability and mass would be expected. Thus, we would like to assume that mass is related to some form of the inverse of the gap between the adjacent p-levels.

We would like to present a derivation that leads to a functional form we are inclined to use in this context. We are unable to provide a strict derivation of the formula used later on. The best we can present is a general discussion of the expected form of relationship. The actual formula was found by the trial-and-error method.

Firstly (8), we multiply formulae (1) and (2), then (9) substitute "y" for the product of q and p , and finally (10) rearrange to remove the logarithm and replace it with an exponential power. This gives:

$$p_{n+1}q_{n+1} = k^2 p_n q_n (\ln(p_n q_n))^2 \quad (8)$$

$$y_{n+1} = k^2 y_n (\ln(y_n))^2 \quad (9)$$

$$y_n = \exp\left(\frac{1}{k \sqrt{\frac{y_n}{y_{n+1}}}}\right) \quad (10)$$

Based on the formula (10), we would like to seek a relationship between mass and probability through a formula involving an exponent and an inverse of the square root of the line gap.

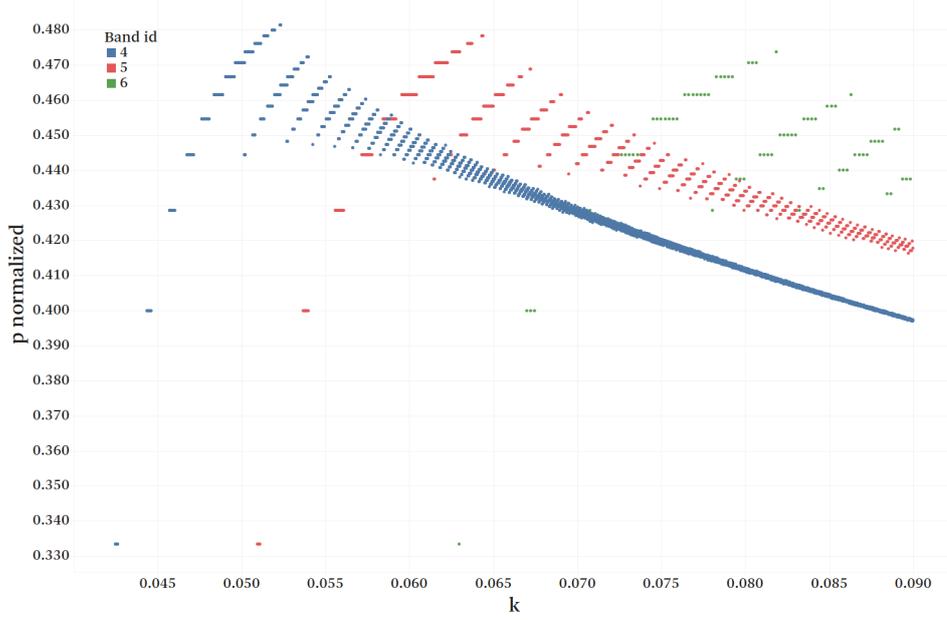


Fig. 3 Trajectories for bands 4, 5, and 6. The central point of each band was used as the initial condition for each trajectory.

6 The Probability Field and the Quark Masses

The following application of the modelling method allows for the retrieval of the quark masses. The initial conditions are set to $q_0 = p_0$ for each trajectory, with values set in the middle of the band. In Figure 4, the trajectory for the 4th band is plotted, and the locations of the lines relevant to the quark positions are indicated. The k -parameter is run from zero, and the p -normalised values are shown when they depart from null. For values of k where a discontinuity of line is apparent, p -normalised attains a value of exactly 0.5. This is not shown to enhance clarity. If 0.5 were to be included in Figure 4, the quark levels would resemble energy wells, all starting from a common 0.5 level.

It is assumed that gaining mass is achieved by transiting from each line to the line above. The change in probability is denoted as $\Delta line$. These changes in probability are associated with the mass through (11) and (12), which show that the gain in mass is exponentially proportional to the inverse of the square root of the probability step.

$$M = M_0 \exp\left(\frac{1}{\sqrt{\Delta line}}\right) \quad (11)$$

$$where M_0 = 0.15014817 \frac{MeV}{c^2} \quad (12)$$

Formula (11) has not been derived, but rather it is proposed. The authors arrived at this relationship by looking at the chart characteristics and the way the data aligns itself. The scaling constant M_0 is found by setting $\Delta line = 2/3$ and assuming that

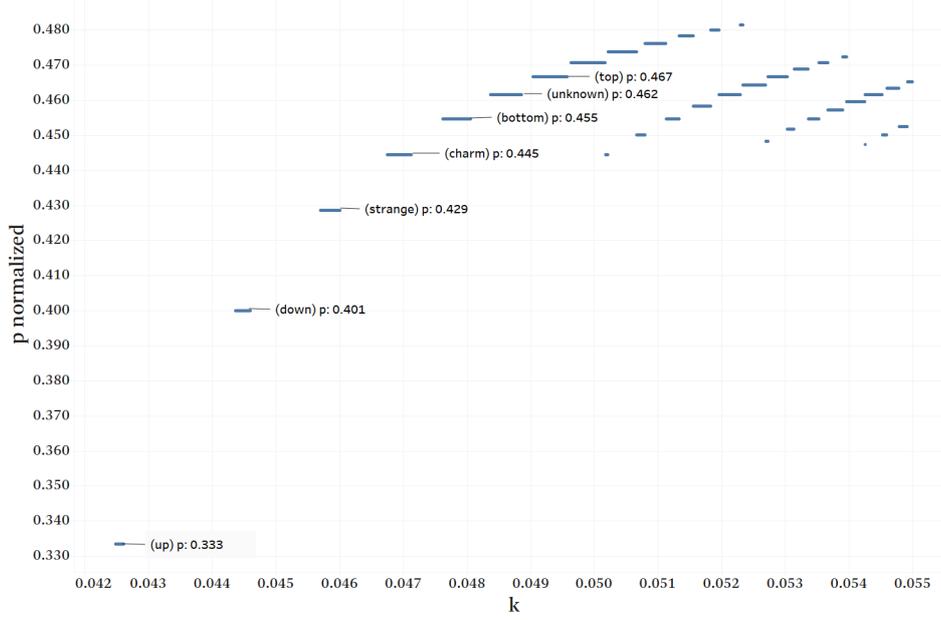


Fig. 4 The trajectory for band 4 with quark levels

such transition corresponds to the mass of an electron, which is known to eight decimal places.

Table 2 compares quark masses found through the model to those that are experimentally measured. The experimental data is as published by the Particle Data Group [11]. Except for the Down quark and the Top, the values proposed by the model undershoot those found experimentally. The difference is indicated in the deviation column.

The model predicts eight quarks rather than the measured six. Between the Bottom and the Top, an extra quark with a mass of roughly $25 \text{ GeV}/c^2$ is expected. Taking into account the data-model relationship's negative bias, its mass has been estimated to be around $28 \text{ GeV}/c^2$, as bracketed at ID 6. Another quark (ID 8) with a mass of roughly $1.3 \text{ TeV}/c^2$ is also expected.

When k increases further, another set of levels appears beneath the initial one. This terminates the sequence (making the total number of quarks eight) and may point to a later set of distinct particles. IDs 9 to 11 represent the first three in this collection. At this point in the investigation, it is unclear how to interpret any further probability gaps.

Figure 5 compares experimentally found quark masses with the values proposed by the model. The chart employs a logarithmic scale which produces a straight line for the model.

ID	K Start	K End	P End	Model	Measured	Deviation(%)	Quark
1	0.0424856851	0.0426116931	0.3333333333	0.85	2.16	-60.71	Up
2	0.0443705542	0.0445963185	0.4	7.22	4.67	54.6	Down
3	0.0457041385	0.0460086578	0.4285714286	55.70	93.0	-40.11	Strange
4	0.0467542049	0.0471269784	0.4444444444	420.36	1,270	-66.9	Charm
5	0.04762576	0.0480562872	0.4545454545	3,145.54	4,180	-24.75	Bottom
6	0.0483765574	0.0488595879	0.4615384615	23,438.33	(28,000)		Unknown
7	0.0490433495	0.0495736331	0.4666666667	174,225.79	172,760	0.85	Top
8	0.049636637	0.0501721709	0.4705882353	1,293,143.65			Uncharted
9	0.0501774212	0.0502141735	0.4444444444	72.86			
10	0.0502194239	0.0506657021	0.4736842105	52.04			
11	0.0506709524	0.0507969604	0.45	99.66			

Table 2 The Model and the Experimental results (mass is in MeV/c^2)

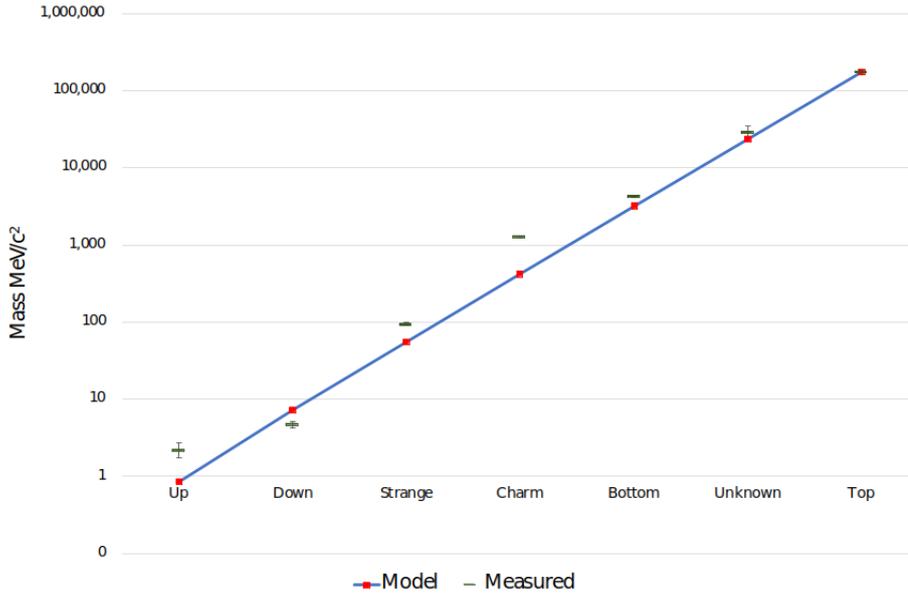


Fig. 5 Reported and Modelled Quark Masses

6.1 Other Considerations – the background energy

The model assumes the existence of two distinct probability fields. After normalisation, these are separated by a 0–1 gap, that is, Δ line equals 1, for their respective base lines. Using Formula (11), one can associate this gap with energy (mass) difference of $0.408145 \text{ MeV}/c^2$. A natural way of thinking would be to associate this energy with some background energy that is present in all mass-related contexts. It could be called background energy or mass, and it is reasonable to think that it may be related to dark matter.

Another observation that needs to be pointed out is the apparent complementary relationship between the Up quark and the electron. The Up quark line gap is $1/3$,

and the electron gap line is 2/3. Therefore, their line gaps add up to unity. This may indicate some fundamental relationship between those two constituents.

7 Baryon masses and weak interactions

Bands 4, 5, and 6 allow for the reproduction of the baryon masses. Band 7 does not contain the up quark due to the width of the band. Table 3 summarises the values obtained here and compares them to the experimental data published by the Particle Data Group [11]. A percentage deviation between the model and the experimental results is presented in the last column.

Particle	Constituents	Model (MeV/c ²)	Experimental (MeV/c ²)	Difference (%)
proton	uud	938.394	938.272	0.013%
neutron	udd	939.897	939.565	0.035%
Σ	uus	1,188.840	1,189.370	-0.05%
Σ	uds	1,193.505	1,192.642	0.07%
Σ	dds	1,199.876	1,197.449	0.20%
W Boson	W	79,920.362	80,379.000	-0.57%

Table 3 Summary of results

The following is the presentation of the method as applied to each calculation.

7.1 Gluons and the probability metric

Quarks interact through the exchange of gluons. This is represented here through a metric (13), which assumes that the interaction requires a gluon's movement along the k-direction and p-direction, both treated as changes in probability, with the absolute value of the product measuring the amount of the movement. The effective probability is the mean of the movements (14).

$$\Delta_{ij} = |(k_j - k_i)(p_j - p_i)| \quad (13)$$

$$\Delta_{line} = \frac{1}{2} \sqrt{\frac{\sum \Delta_{ij}}{N}} \quad (14)$$

In (14), the summation is over all possible movements, and N stands for the number of combinations.

7.2 The composite band error

The calculations are subject to yet another banding-related principle. A baryon consists of three quarks. Each quark is distinct as it is associated with a separate band. The quarks can interact with each other in six ways: (12), (13), (23), (21), (31), and (32). Each interaction involves two moves, one along the k-direction and another along the p-direction, as in (13). Therefore, when calculating the Δ_{line} , there are 12 possible sources of error.

Each movement is subject to an error associated with the width of the band. This error is calculated as the geometric mean of the three widths. Therefore, the maximum

error allowed by the movements is 12 times the geometric mean of the widths. This puts a maximum value on the probability of composite particles. Table 4 compares the sum of the quark probabilities (listed in Table 2 in the column labelled "P End") with the maximum error allowed.

Particle	Quarks	Sum of Quark Levels (P End)	1 + Max Error	Difference
proton	uud	1.067	1.072	-0.005
neutron	udd	1.133	1.072	0.062
Σ	uus	1.095	1.072	0.024
Σ	uds	1.162	1.072	0.090
Σ	dds	1.229	1.072	0.157

Table 4 Composite band error and the particle constituents' probabilities

When one takes a measurement, one allows for a certain degree of error. If the measurement result is within the margin of error, the result is deemed true. In our scenario, we calculate a baryon's composite probability, which is the sum of its three constituent probabilities.

Because the initial conditions were not accurately defined, that measurement has an associated inaccuracy. The breadth of the error is 0.072. In the case of the proton, the constituent probabilities are 2 times 0.333 (up quarks) plus 0.40 (down quark). As a result, the total probability of a proton is 1.066(6), which is greater than one.

That number would appear to be illogical, as probability, by definition, cannot exceed one. However, the measurement error (0.072) surpasses 0.066. As a result, we blame the measurement error for the protons' excess in probability. As a consequence, we may state that the probability of a proton is one while being within the measurement error. Therefore, the proton is stable.

All the other particles listed above have composite probabilities that exceed the measurement error. As a result, they should not appear, and in order for them to exist, even for a brief period of time, something must accommodate the excess in probability. This is also why they must deteriorate.

Table 4 shows that only the proton's total probability imposed through the constituents is less than the maximum error allowed. All other baryons exceed this error, which influences the stability of those particles. This has two consequences. Firstly, the life span of the particle is influenced, with the proton being the only truly stable one. Secondly, in order for the particle to occur, the excess probability must be diverted somewhere.

Granulation in the k direction is introduced through (5). The width of k spacing is dependent on the band considered, with the 4th band producing the least spaced points and the 6th band the most spread out. The number of points is also influenced by granulation. Table 5 lists the number of points on each level, as shown in Figure 6. Only those involved in the subsequent calculations are shown. In the case of the neutron, the down quark on the 4th trajectory includes the 21 extended points, as shown in Figure 6 (at k close to 0.09).

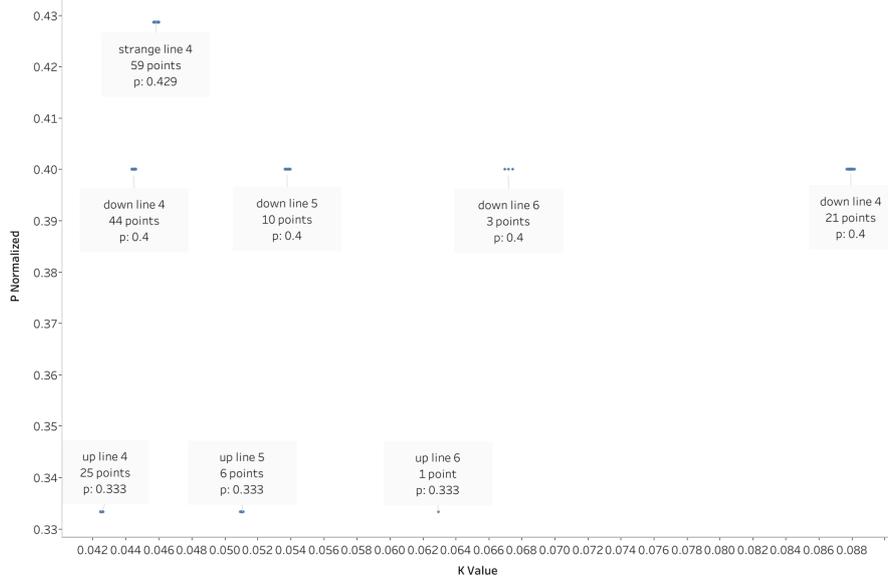


Fig. 6 Quark lines/trajectories 4, 5, and 6 for up, down and strange quarks as used in calculations

quark	W			neutron			proton			sigma		
	4	5	6	4	5	6	4	5	6	4	5	6
s - 0.42857	0	0	0	0	0	0	0	0	0	59	0	0
d - 0.40000	44	10	3	44+21	0	3	0	10	0	0	0	0
u - 0.33333	25	6	1	0	6	0	25	0	1	0	6	1

Table 5 Point counts for levels as in Figure 6

7.3 Proton – $u_4 d_5 u_6$

Proton is obtained by placing the first up quark on the 4th band, the down quark on the 5th band, and the second up quark on the 6th band. The number of gluon combinations N is calculated as a sum of pairwise products, giving $10*1 + 10*25 + 25*1 = 285$. The line width is calculated with (13). These are entered into (14) and (11), which gives the value of M in (15). To obtain the result listed in Table 3, the proton quark-constituent masses of two down quarks and one up quark are subtracted as in (15).

$$protonmass = M - m_u - 2m_d \quad (15)$$

Please note. The proton is composed of one down and two up quarks, but here the masses of one up and two down quarks are subtracted. Why? Why indeed. Also, in all the calculations, the model-arrived quark masses, as listed in Table 2, are used, not the experimentally found values.

7.4 Neutron – $d_4 u_5 d_6$ including the extension of the 4th band

Neutron is obtained by placing the first down quark on the 4th band, the up quark on the 5th band, and the second down quark on the 6th band. The 4th band is expanded to include points on the closest returning curve, as in Figure 3 and Figure 6 (k in the region of 0.088). The expansion is to partially accommodate the excess of probability. The remaining excess of probability modifies the method of combination counting, which is increased by the maximum amount of the available error. The combinations N are counted as: $N = (65*6 + 65*3 + 6*3)* 1.071732166 = 646.254$

The redirection of the excess in probability consists of two processes. Firstly, the neutron increases the gluonic activity through the utilisation of the measurement error, but only to its maximum value. In this setting, gluons are more active than the ordinary combination count would have indicated. The remaining excess of probability expands the k range to include the points on the returning branch of the trajectory. The closest points, which are on the 4th band, are therefore included.

To obtain the line width, the summing is calculated over points that include the expanded 4th band. These, together with the expanded combinations count, are entered into (13) and (14).

To obtain the result listed in Table 3, the neutron quark-constituent masses of two up quarks and one down quark are added to (11). As in the case of the proton, the model-calculated quark masses are entered in (16).

$$neutronmass = M + 2m_u + m_d \quad (16)$$

Here, the result is adjusted by involving the masses of two up and one down quarks. As in the case of the proton, this operation is anti-symmetric with respect to the particle constituents. The overall count of the correction and the constituents comes up to the composition of the deuteron, which is stable and, from the quark's composition point of view, balanced.

7.5 Sigma – uus, uds, dds

Sigma mass is calculated by placing the strange quark on the fourth trajectory and the two up quarks on the fifth and the sixth. The formula (13) is used in the calculation, with the summing run over each pair of quark locations. This yields the M component, which is corrected by adding the respective quark masses. In each scenario, the strange quark's mass is multiplied by two.

$$\Sigma_{uus} = M + m_u + m_u + 2m_s \quad (17)$$

$$\Sigma_{uds} = M + m_u + m_d + 2m_s \quad (18)$$

$$\Sigma_{dds} = M + m_d + m_d + 2m_s \quad (19)$$

The factor of 2 in the above is understood to account for the strange quark being two levels above the up quark location.

7.6 The W Boson u4-d4, u5-d5 and u6-d6 transitions

The mass of the W boson is obtained by limiting the interactions to those that are within each of the three bands. Thus, only u₄-d₄, u₅-d₅, and u₆-d₆ transitions are considered. The line width is calculated using (13) for each transition band independently, and then the results are added together to represent the entire structure. Similarly, the number of combinations is arrived at by adding combinations for each of the bands separately, that is, $44*25 + 10*6 + 3*1 = 1,163$. Formula (14) is employed to calculate the effective width and (11) to arrive at the mass listed in Table 3. No other factors are applied in the calculation.

8 Discussion

Mass is perceived as something solid. The question being asked is how mass came to be. Therefore, whatever originated mass could not have been solid. In other words, before mass came into being, solidity did not exist. Light is not solid, as it does not have the rest mass. The effect is that photons have to move at the speed of light. However, mass can be stationary. Einstein was motivated by the achievements of his Special Relativity Theorem. Space contraction, coupled with the postulation of undistinguishable heavy and inertial mass, gave rise to General Relativity. This allowed for the introduction of non-solid curved space-time as an explanation of the solid mass.

It is difficult to escape from a comment we need to make here. Einstein's way of thinking was like that of a pure mathematician. He demonstrated precise reasoning when deriving his theorems, which is a trademark of this approach. It is most evident in the Special Relativity papers, but he followed that approach in all of them, including the foundation logic of General Relativity. However, when it came to interpretations, he was making errors. Most talked about was the rejection of the probabilistic interpretation of quantum mechanics. Instead, he should have embraced it and applied it to the problems produced by his Special Relativity. If he had done that, he would have arrived at a more general statement, namely that "physical measurement and objective reality do not have to agree with each other." This discrepancy is evident when one considers a system at its limiting boundary. Like extremely small distances (quantum physics), but also at extremely high speeds (close to the speed of light). In general, one could postulate that this phenomenon occurs always, but in common situations, due to the law of large numbers, it is hidden behind the averages.

In other words, any form of physical measurement has an associated probability. In common experiments, a physicist associates an error estimation with it. Thus, the field of statistics and probability estimation became incorporated into any part of physics, not just quantum mechanics. Here, we have taken another step in that direction, postulating that probability and entropy existed as that 'something' that predates the existence of solidity.

We see mass and light as having different underlying natures. Both of these phenomena must have some origin. However, we would expect that these origins differ in character, resulting in the fundamental difference between mass and light. The prior can be stationary, and the latter lacks that ability.

9 Conclusion

The findings presented in the paper are the culmination of years of research into probability and its application to the nature of matter. As our investigation progressed, it became clear that an entirely new philosophical approach was required to confront the failure of the scientific community's quest to establish a unified theory of everything.

The break with the traditional approach to the subject is evident on all fronts. Here we challenge the assumption that inertial and heavy mass are indistinguishable. That assumption was used as the foundation of General Relativity. We break with the notion that entropy is a feature of reality, replacing this with the assumption that entropy is a constituent resulting in physical manifestation. We also discard the traditional mathematical tools used to describe physical phenomena. Instead, we assume that the relationships and mappings that need to be employed are discontinuous, non-differentiable, and chaotic in their nature.

Thus, the work presented here separates inertial mass from other concepts and uses a totally different mathematical framework to describe this phenomenon.

It is postulated here that the inertial mass is a manifestation of two entropic probability fields that interact with each other through conditional probability dependence. This interaction, when quantized, results in probability gaps, which may be associated with the masses of quarks and the electron. In turn, the resultant mass values may be used to reconstruct the masses of elementary particles as measured experimentally.

The model is applied to reconstruct the masses of the proton, neutron, sigma baryon, and W boson. These are provided here as examples to show how the model may be applied. Each calculation differs somewhat from the others, indicating that a certain level of understanding is required in order to apply the model successfully. These examples are provided to open a research field that may be exploited to investigate masses of other elementary particles.

The approach presented here is fresh and new and opens a new avenue for further research. The authors put a great deal of effort into simplifying the presentation of the text to make the paper accessible to a wide audience of readers.

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10 References

- [1] Caticha, A. *Entropic Dynamics Entropy* 2015, 17(9), 6110-6128; <https://doi.org/10.3390/e17096110>
- [2] Shannon, C. E. *Probability of error for optimal codes in a Gaussian channel*, Bell Syst. Tech. J., 1959, vol. 38, pp. 611-656.

- [3] Verdu, S. *Fifty years of Shannon theory*, IEEE Transactions on Information Theory, 1998, vol. 44, no. 6, pp. 2057–2078. <https://doi.org/10.1109/18.720531>
- [4] Martyushev, L.M.; Shaiapin, E.V. *Entropic Measure of Time, and Gas Expansion in Vacuum*. Entropy, 2016, 18, 233. <https://doi.org/10.3390/e18060233>
- [5] Caticha, Ariel, *Entropic Time*, AIP Conference Proceedings, 2011, 1305, pp. 200–207. <https://doi.org/10.1063/1.3573617>
- [6] Martyushev, L.M. *On Interrelation of Time and Entropy*, Entropy, 2017, 19(7), 345. <https://doi.org/10.3390/e19070345>
- [7] Vilenchik, L. and Vilenchik, M. *The Emergence and Evolution of the Universe*, Journal of High Energy Physics, Gravitation and Cosmology, (2019), 5, 884-898. <https://doi.org/10.4236/jhepgc.2019.53044>
- [8] Wissner-Gross, A. D., and C. E. Freer. *Causal Entropic Forces*, Physical Review Letters, (2013), 110.16. <http://hdl.handle.net/1721.1/79750>
- [9] Feigenbaum, M. *Quantitative universality for a class of non-linear transformations*, J. Statist. Phys. (1978), 19, pp. 25–52.
- [10] Luque, B., Lacasa, L., Ballesteros, F. J., Robledo, A. *Feigenbaum graphs: a complex network perspective of chaos* PloS one,(2011), 6(9), e22411. <https://doi.org/10.1371/journal.pone.0022411>
- [11] R. L. Workman *et al.* [Particle Data Group], PTEP **2022**, 083C01 (2022) <https://doi.org/10.1093/ptep/ptac097> web: https://pdg.lbl.gov/2022/listings/contents_listings.html. Accessed 28 November 2023