

Geometric Information: A Paradigm Shift in Energy Conversion Efficiency

Louis M. Houston

Department of Research and Innovation, University of Louisiana, Lafayette, LA, USA

Email: louishouston406@gmail.com

How to cite this paper: Houston, L.M. (2025) Geometric Information: A Paradigm Shift in Energy Conversion Efficiency. *Journal of Applied Mathematics and Physics*, 13, 3202-3212. <https://doi.org/10.4236/jamp.2025.139182>

Received: June 8, 2025

Accepted: September 26, 2025

Published: September 29, 2025

Copyright © 2025 by author(s) and Scientific Research Publishing Inc. This work is licensed under the Creative Commons Attribution International License (CC BY 4.0). <http://creativecommons.org/licenses/by/4.0/>



Open Access

Abstract

This paper introduces a novel concept of information as the logarithm of a countable subset drawn from an uncountable power set, where the countable subset represents “bits” (or mass) and the power set represents the “image” (or structure). Experimentally, the macroscopic deformation of author-related information-bearing materials is reported, showing a physical manifestation of this relationship between information and structure. Theoretically, a multi-directional projection function with floor functions creates directional cuboid volumes, connecting countable information to spatial structures. The observed conversion of information to mechanical energy associated with this deformation displays energy scales much greater than the thermodynamic limits set by Landauer’s Principle for information erasure. This significant increase indicates a potentially different and more efficient mechanism for utilizing the physical consequences of information, suggesting a potential change in the approach to energy transduction.

Keywords

Dimensional Projection, Cuboids, Vector Spaces, Information, Entropy, Isobaric, Energy Conversion

1. Introduction

The energetic implications of information processing are conventionally understood through the lens of Landauer’s Principle [1], which posits a minimal thermodynamic cost for information erasure rooted in entropy increase. In contrast, this work explores a fundamentally different regime by conceptualizing information as the logarithm of a countable subset derived from an uncountable power set [2], where the countable part represents discrete “bits” or mass (a bit = 1 of 2 equally probable choices) and the uncountable power set encompasses the “im-

age” volume or structural complexity. Such bits or mass geometrically manifest into Shannon Entropy [3]. We present experimental evidence of macroscopic deformation in author-related information-bearing materials, demonstrating a direct conversion of information into mechanical energy. The theoretical framework, employing a multi-directional projection function [4] with floor functions to generate spatial structures from countable information, provides a potential mechanism for this conversion. Strikingly, the energy scales associated with this observed macroscopic deformation are orders of magnitude larger than the minuscule energies dictated by Landauer’s Principle. This extreme augmentation of information-to-mechanical energy conversion suggests a pathway to harness the physical content of information with unprecedented efficiency, potentially bypassing the inherent thermodynamic limitations of information erasure and signifying a revolutionary shift in our understanding of information and energy transduction.

This relationship invites reconsideration of how dimensionality interacts with physical systems, suggesting that current paradigms may overlook vital aspects of geometric influence. By emphasizing the interplay of structure and information, a pathway emerges for redefining how we conceptualize dimensional extensions in mathematical and physical contexts. The implications extend to energy systems, where geometry-driven mechanisms could challenge conventional interpretations of spatial compression and expansion. Such an approach requires rigorous mathematical foundations to ensure compatibility with established physical laws and to propose viable alternatives to traditional theories.

2. Multidimensional Projection

Normally, dimensional extensions beyond a point, line-segment, square, or cube increase inwardly. This is illustrated in a tesseract [5] or 4-dimensional cube, shown in **Figure 1**.

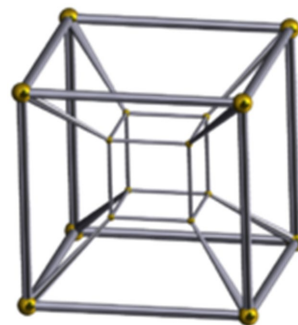


Figure 1. A four-dimensional cube known as a “tesseract”.

We argue that since such extensions do not expand, but compress “volume”, which is not consistent with the first 4 physical extensions, that expand orthogonally, then there must be an alternative method of expanding or compressing dimensions that is consistent, while remaining compatible with both mathematics

and physics. The latter condition is a result of geometry that images structure with lines, which are visible as edge effects.

We will first prove the Projection Theorem [6]. This theorem derives the mathematics needed to expand a positive integer into a finite sum of a predetermined length.

3. Theorem 1

If $n, k \in \mathbb{Z}^+ \cup 0$ and $m \in \mathbb{Z}^+$.

Then

$$n = \sum_{k=0}^{m-1} \left\lfloor \frac{n+k}{m} \right\rfloor$$

With $\lfloor \cdot \rfloor$ representing the greatest integer function (*i.e.*, floor function).

PROOF:

Let:

$$S = \left\lfloor \frac{n}{m} \right\rfloor + \left\lfloor \frac{n+1}{m} \right\rfloor + \left\lfloor \frac{n+2}{m} \right\rfloor + \dots + \left\lfloor \frac{n+m-1}{m} \right\rfloor$$

Case (1): $n \leq m$:

We can rewrite S as:

$$S = \left[1 + \frac{n-m}{m} \right] + \left[1 + \frac{n-m+1}{m} \right] + \left[1 + \frac{n-m+2}{m} \right] + \dots + \left[\frac{n}{m} \right]$$

If $n = m$, then $S = m$. If $n = m - 1$, then $S = m - 1$. If $m = 1$, then $S = 1$.

Case (2): $n > m$:

Let $S = mP + R$, $R < m$. Then S can be written as:

$$S = \left[1 + \frac{mp+R-m}{m} \right] + \left[1 + \frac{mp+R-m+1}{m} \right] + \dots + \left[1 + \frac{mp+R-1}{m} \right]$$

$$S = mp + \left[1 + \frac{R-m}{m} \right] + \left[1 + \frac{R-m+1}{m} \right] + \dots + \left[1 + \frac{R-1}{m} \right]$$

Which reduces to

$$S = mP + R \quad \square$$

Hence, when R is restricted within the bounds of m, the projection results in a cyclical alignment owing to the modular arithmetic principles governing the sequence. Each incremental shift of R contributes to the refinement of the corresponding n-dimensional volume compressed into m-dimensional space. This compression serves as the basis for defining transformations that preserve essential characteristics while reducing dimensions.

Corollary:

$$x^n = x^{\sum_{k=0}^{m-1} \left\lfloor \frac{n+k}{m} \right\rfloor}, x \in \mathbb{R} \tag{1}$$

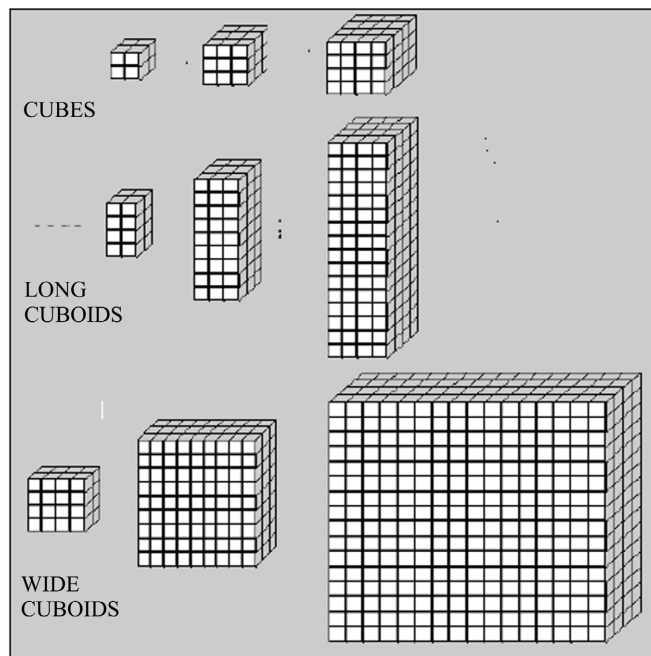
More specifically,

$$x_m^n = x^{\left\lfloor \frac{n}{m} \right\rfloor} * x^{\left\lfloor \frac{n+1}{m} \right\rfloor} \dots x^{\left\lfloor \frac{n+m-1}{m} \right\rfloor} \tag{2}$$

To understand the implications of the corollary, let us delve deeper into the mathematical relationship between n and m in these projections. When defining the transformation, the interplay between dimensions highlights the inherent reduction or preservation of volume depending on the relative values of n and m . It becomes evident that the range of R , where $R < m$, plays a pivotal role in determining the sequence alignment within the projection calculations. Such nuances form the backbone of how these projection systems operate mathematically.

We define $\frac{n}{m}$ as the projection ratio.

This sequence projects an n -dimensional “volume” into an m -dimensional “volume”. We note that this can be visualized by building the images with unit cubes or voxels (see **Figure 2**).



Note the self-similarity in the horizontally organized cuboids.

Figure 2. Some examples of cuboids (cubes, long cuboids, and wide cuboids) produced by the finite series given in (1).

If we project from an $n = 3$ -dimensional volume, (2) becomes:

$$x_3^3 = x^{\lfloor \frac{3}{3} \rfloor} * x^{\lfloor \frac{3+1}{3} \rfloor} * x^{\lfloor \frac{3+2}{3} \rfloor} \tag{3}$$

or

$$x_3^3 = x^{\frac{3}{3}} \tag{4}$$

Expanding upon these principles, the projection for $m = 3$ yields an intriguing insight into the modular behavior of dimensions. By employing voxels as visualization units, the projection illustrates the inherent symmetry and cyclic arrangement of sequences. This method, grounded in modular arithmetic, ensures both

precision and mathematical elegance when compressing higher dimensions into reduced ones. The visualization of cuboidal structures in this projection lays the groundwork for understanding transitions between states of dimensionality. The interplay between the ranges of R and m becomes increasingly vital in decoding the patterns of sequence alignment, particularly when visual configurations are applied to higher-dimensional volumes.

This projection behavior becomes increasingly intriguing when considering higher-dimensional transformations. The elegance of the projection ratio is evident as it governs the reduction or preservation of dimensional integrity. For example, in the case where n exceeds m , the inherent structure of the sequence undergoes a fundamental shift. This transition highlights the critical importance of sequential alignment and the geometric interplay between dimensions. Furthermore, the sequence alignment illustrated through cuboids in various configurations demonstrates the underlying mathematical harmony that emerges, even amidst dimensional reduction.

If we project from an $n = 6$ -dimensional volume, (3) becomes:

$$x_3^6 = x^{\lfloor \frac{6}{3} \rfloor} * x^{\lfloor \frac{6+1}{3} \rfloor} * x^{\lfloor \frac{6+2}{3} \rfloor} \quad (5)$$

$$x_3^6 = x^{\frac{6}{3}} \quad (6)$$

or a projection ratio = 2.

The self-similarity observed in these cuboids suggests a recursive pattern intrinsic to multi-dimensional projections. This phenomenon resonates with concepts in fractal geometry, where structures exhibit repeating patterns at varying scales. Such projections are not only of theoretical interest but also hold practical applications in data compression and visualization, enabling the encapsulation of higher-dimensional data within comprehensible three-dimensional representations. This aligns with the mathematical framework underpinning projection ratios, which facilitate the translation of complex spatial arrangements into quantifiable formats.

Image information is defined as countable volume, with its “mass” being the logarithm, base 2 of this volume. Wheeler’s concept [4] about “it” from “bit” is geometrically shown in **Figure 3**, suggesting that “mass” comes from information. Note that the cuboids are spatially ordered and not temporally ordered. This is consistent with Schrodinger’s time-independent equation in quantum mechanics.

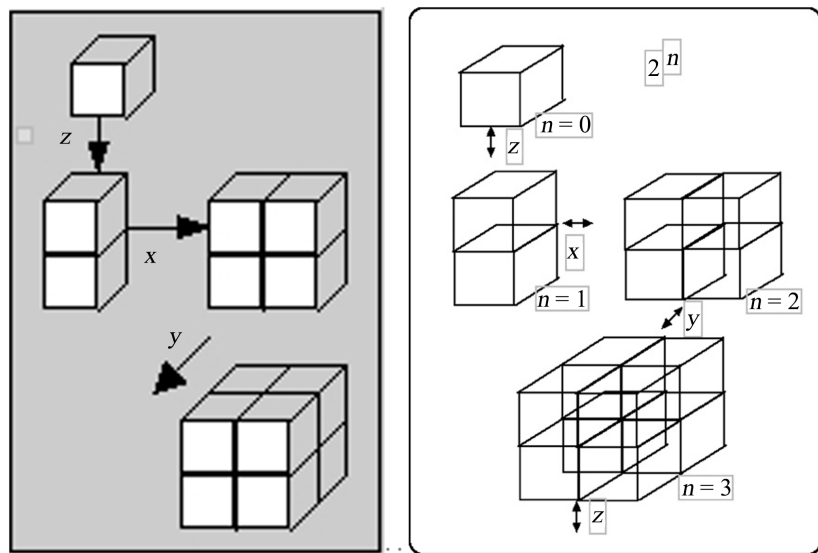
4. Comparison to Matrix Mechanics

Recall Equation (3): $x_3^n = x^{\lfloor \frac{n}{3} \rfloor} * x^{\lfloor \frac{n+1}{3} \rfloor} * x^{\lfloor \frac{n+2}{3} \rfloor}$. We can construct a diagonal matrix representation from (3), adding directions, via unit vectors i, j and k : (*i.e.*, $\hat{x}, \hat{y}, \hat{z}$).

Consider the following example case for a projection of image data from n -dimensions to 3-dimensions;

$$\begin{aligned}
 \mathbf{B}(3, n, x) = & \begin{pmatrix} x^{\lfloor \frac{n}{3} \rfloor} & 0 & 0 \\ 0 & x^{\lfloor \frac{n+1}{3} \rfloor} & 0 \\ 0 & 0 & x^{\lfloor \frac{n+2}{3} \rfloor} \end{pmatrix} \begin{pmatrix} i \\ j \\ k \end{pmatrix} + \begin{pmatrix} x^{\lfloor \frac{n+2}{3} \rfloor} & 0 & 0 \\ 0 & x^{\lfloor \frac{n}{3} \rfloor} & 0 \\ 0 & 0 & x^{\lfloor \frac{n+1}{3} \rfloor} \end{pmatrix} \begin{pmatrix} k \\ i \\ j \end{pmatrix} \\
 & + \begin{pmatrix} x^{\lfloor \frac{n+1}{3} \rfloor} & 0 & 0 \\ 0 & x^{\lfloor \frac{n+2}{3} \rfloor} & 0 \\ 0 & 0 & x^{\lfloor \frac{n}{3} \rfloor} \end{pmatrix} \begin{pmatrix} j \\ k \\ i \end{pmatrix}
 \end{aligned} \tag{7}$$

Given a $(3 \times n)$ data matrix A , the expectation of A 's image in the information space involves the density operator and trace (sum of diagonal elements). **Figure 3** shows that local Euclidean spaces are directionally cyclic. Since local inner products are zero, Equation (5) defines a vector space. Time is not an observable like position or momentum in standard quantum mechanics [5].



Note that n indicates the number of bits. Also observe that the objects are geometrically cyclic, characteristic of phase changes.

Figure 3. Some examples of cuboids (cubes, long cuboids, and wide cuboids) illustrated as a vector space, produced by the finite series given in (1). The phases evolve vertically, from top to bottom or devolve from bottom to top.

5. Comparison to Shannon Entropy, H (Binary Case)

Shannon entropy is an average information approximation.

$$H_n = -\sum_1^n p_i \log_2 p_i \tag{8}$$

$$H_2 = -p_1 \log_2 p_1 - p_2 \log_2 p_2 \tag{9}$$

In which normalization requires that the total probability is one:

$$p_1 + (1 - p_1) = 1 \tag{10}$$

If we let the probability amplitudes be equal, we get:

$$p_1 = p_2 = \frac{1}{2} \tag{11}$$

Thus,

$$H_2 = \frac{1}{2} \log_2(2) + \frac{1}{2} \log_2(2) \tag{12}$$

$$H_2 = 1 \text{ bit.} \tag{13}$$

The 2-D image volume is:

$$I(2, n, x) = x^{\lfloor \frac{n}{2} \rfloor} * x^{\lfloor \frac{n+1}{2} \rfloor} \tag{14}$$

$$I(2, 2, 2) = 2^{\lfloor \frac{2}{2} \rfloor} * 2^{\lfloor \frac{3}{2} \rfloor} \tag{15}$$

$$I(2, 2, 2) = 2^1 * 2^1 = 4 \text{ voxels (i.e., the countable volume)} \tag{16}$$

Think of sweeping a line segment of length 2 orthogonally through a distance of 2. This yields the image.

Consequently, the image magnitude is:

$$\log_2(I(2, 2, 2)) = \log_2 4 \tag{17}$$

$$\log_2(I(2, 2, 2)) = 2 \text{ bits} \tag{18}$$

6. Classical Mechanics: The Geometry of Macroscopic Information

Based on the fact that cuboids are scale invariant (or that the density is variable), we show in **Figure 4**. That the path traced out by macroscopic cuboids (large n) is approximately that of a simple helix:

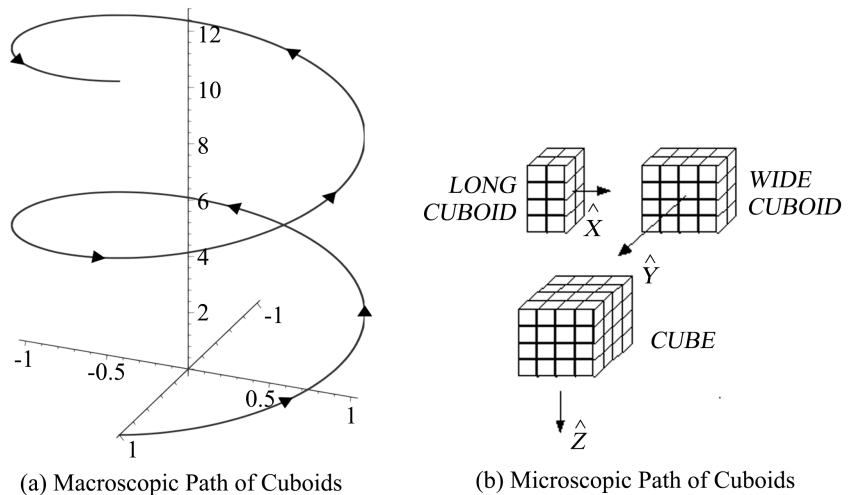


Figure 4. The simple helical approximate path of cuboids at the macroscopic level is shown in (a) (courtesy of Wikipedia). The path is similar to the path of an electron in a magnetic field, solenoidal current, the DNA molecule and various and sundry mechanical objects like screws. (b) shows the exact microscopic path of cuboids.

7. The Conversion of Information into Energy: Some Experimental Evidence

The following examinations that we are calling experimental evidence are presented without rigorous details, but are sufficient to display essential information about future, more intense analysis. The major goal of this paper was to introduce a new, wholly physical definition of information that the addition of geometry creates. **Figures 5-8** attempt to illustrate that claim.



Figure 5. A single initial undeformed business card sitting on a non-reflective surface for ~5 minutes. The card remained undistorted during that time interval.



Figure 6. Experiment 2: Several cards independently deforming on the top and several cards independently deforming on the bottom. Photos taken after ~8 hours.

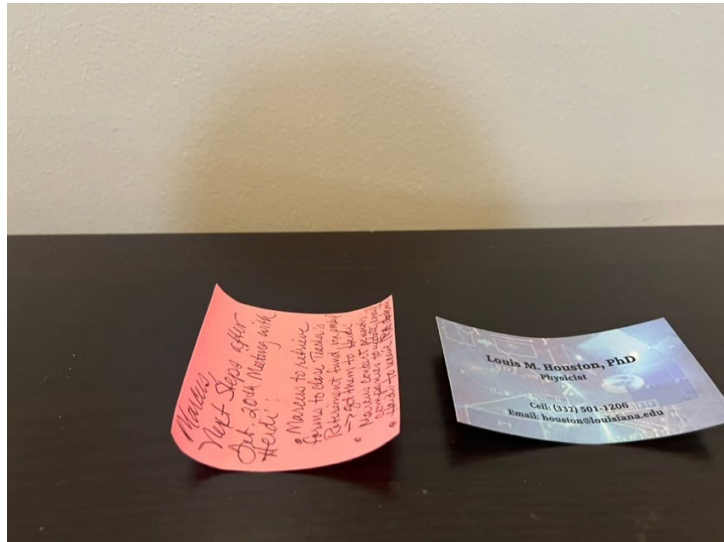


Figure 7. Experiment 3: Deformation of two very different materials; thin, pink, paper on the left versus thicker cardboard on the right. On the left, handwritten notes filling the area. On the right, machine-written identity information filling about one half of the area. In addition, the information is oriented orthogonally between the cards.

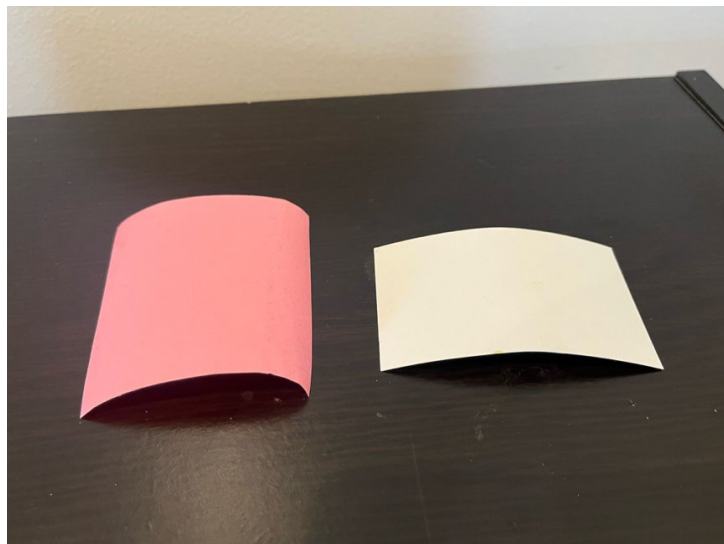


Figure 8. Experiment 4. A presentation of the cards in **Figure 7** after a vertical flip.

In **Figure 5**, we show a business card on a dark, non-reflective surface. Undisturbed for about 5 minutes:

The two card shapes (*i.e.*, concave and convex) are simply due to the same attractive force of information existing on only one side of the cards.

8. Calculations of Energy due to Newly Defined Information

From physics, we know the relationship:

$$E = P \times V \tag{19}$$

where E is energy, P is pressure and V is volume.

Let the process be isobaric, with constant pressure causing concave or bending, depending on which side contains information.

$$\Delta P = 0 \quad (20)$$

$$E_n = P \times V_n \quad (21)$$

For $n = 0, 1, 2, \dots$.

Apply the new definition: information \equiv the logarithm of countable volume.

$$I_n = \log_2(V_n * [\text{m}^{-3}]) \quad (22)$$

$$2^{I_n} = V_n * [\text{m}^{-3}] \quad (23)$$

Substitute (24) into (22):

$$E_n = \langle P \rangle \times 2^{I_n} [\text{m}^3] \quad (24)$$

P is in Pascals, with units:

$$[P] = [\text{N}/\text{m}^2] = [1 \text{ Joule}/\text{m}^3] \quad (25)$$

The average atmospheric pressure is

$$\langle P \rangle = 101325 \text{ N}/\text{m}^2 \quad (26)$$

The experiment involves ID cards inscribed with information on a non-reflective surface.

The area of the information on the card is $5.5 \text{ mm} \times 2.5 \text{ mm} = 13.7 \text{ mm}^2 = 13.7 \times 10^{-6} \text{ m}^2$.

The energy within one bit is determined as follows. Recall Equation (24):

$$E_n = \langle P \rangle \times 2^{I_n} [\text{m}^3] \quad (27)$$

$$E_1 = (101325 \text{ N}/\text{m}^2) \times 2 [\text{m}^3] \quad (28)$$

$$E_1 = (202650 \text{ N}/\text{m}^2) * [\text{m}^3] \quad (29)$$

$$E_1 = (202650 \text{ N} \cdot \text{m}) * 1.37 \times 10^{-5} \text{ m}^2 \quad (30)$$

$$E_1 = 277630.5 \times 10^{-5} \text{ N} \cdot \text{m} \quad (31)$$

$$E_1 = 2.78 \text{ J} \quad (32)$$

or

$$E(1 \text{ bit}) = 2.78 \text{ J} \quad (33)$$

Compare this to the Landauer limit [1]:

$$E(1 \text{ bit}) = 4 \times 10^{-21} \text{ J} \quad (34)$$

This is an example of an experimental study that provided direct evidence supporting Landauer's principle at the single-bit level. Clearly, our results greatly augment their evidence, with much more efficiency.

9. Conclusions

The central focus of our research was to establish a direct, physical, non-stochastic

interpretation of information. Our insight was to show that, essentially, image information is not statistical, but an exact measure in a vector space of countable volume or cuboids, derived from multi-dimensional projections, which are both physical and mathematical. Nonetheless, statistical measures, like entropy can give accurate results for the magnitude of information.

The experimental observation of macroscopic deformation, coupled with the theoretical demonstration of cuboid volume generation through floor functions, suggests a novel physical phenomenon and a significant improvement over computer processing limits due to Landauer's Principle. The proposed framework, involving geometric quantization and multi-dimensional space, provides a potential foundation for understanding this interaction.

10. Future Work

Future studies will focus on the quantitative measurement of the bending deformation and cuboid dimensions, allowing for a detailed analysis of the relationship between the cuboid volumes and the bending. An investigation of the spatial frequency and its correlation with deformation will be conducted. The effect on other materials will be explored, and a more comprehensive theoretical model incorporating the observed phenomena will be developed. This model will refine the mathematical description of the force, and further experiments will characterize its properties and limitations. Exploration of the connection between this force and existing theories of gravity and quantum mechanics will be undertaken, and the impact of different information patterns on the force's behavior will be examined.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

- [1] Bérut, A., Arakelyan, A., Petrosyan, A., Ciliberto, S., Dillenschneider, R. and Lutz, E. (2012) Experimental Verification of Landauer's Principle Linking Information and Thermodynamics. *Nature*, **483**, 187-189. <https://doi.org/10.1038/nature10872>
- [2] Halmos, P.R. (1960) Naive Set Theory. Van Nostrand Company.
- [3] Houston, L.M. (2023) Projections between Euclidean Volumes with Information Due to Spontaneous Symmetry Breaking. *Journal of Applied Mathematics and Physics*, **11**, 3519-3528. <https://doi.org/10.4236/jamp.2023.1111223>
- [4] Barzegar, A., Shafiee, A. and Taqavi, M. (2020) "It from Bit" and Quantum Mechanics. *Foundations of Science*, **25**, 375-384. <https://doi.org/10.1007/s10699-019-09644-1>
- [5] Busch, P., Grabowski, M. and Lahti, P.J. (1995) Operational Quantum Physics. Springer-Verlag. <https://doi.org/10.1007/978-3-540-49239-9>
- [6] Houston, L.M. (2024) Imaging n-Dimensional Spaces within m-Dimensional Spaces: An Extension of Hinton's Method. *Applied Physics Research*, **16**, 209-214. <https://doi.org/10.5539/apr.v16n1p209>