

Research Essay

Binding Energy of the Human Brain

Mirosław Kozłowski^{*1} & Janina Marciak-Kozłowska²

¹Warsaw University, Warsaw, Poland

²Institute of Electron Technology, Warsaw, Poland

Abstract

In this paper, we calculated the binding energy of the human brain and volume occupied by matter in the brain. It turns out that the binding energy - 10^{30} GeV- is the first and fundamental quantum property of the brain. The structure of the brain is rather strange. The matter is from macroscopic point of view absent! Human brain is empty of the matter. We argue that considering mass contents human brain is the sphere of the radius of 0.1m with nucleus of the radius of $(10^{-15} \text{ m}^3)^{1/3} = 10^{-5} \text{ m}$.

Keyword: Brain, binding energy, neurons.

1. Introduction

Good design is created when awareness brings the subconscious to the forefront. When we consider all the information contained within your perceptual context, it is really quite complex: background, foreground, specific objects, relationships between those objects, the parts those objects are made up of, their order—well, you get the idea. That we are able to make sense of any of this is really quite a feat. Most of it is far too detailed to register at the conscious level, but when involved in the process of intentional design, the principles must be taken into consideration and can be realized with a little effort. Our investment of effort to make the viewer's experience effortless is well worth the response to your design (Marciak-Kozłowska, J., Kozłowski, M., 2016)

The word gestalt is derived of a German word meaning "shape, form, figure, configuration, or appearance" and is also tied to the more obsolete term stellen, which means "to place or arrange." Most simply put, gestalt is the arrangement of form in various patterns. Gestalt theory has traditionally been used by psychologists as a way to assemble an entire picture of a personality. But it has evolved into becoming relevant to anything that uses the context of basic principles to define highly detailed or complex relationships and how they are expressed as a "whole" composite.

* Correspondence: Mirosław Kozłowski, Prof. Emeritus, Warsaw University, Poland. Email: m.kozłowski934@upcpoczta.pl

2. Historical perspective

In the preface to the first (German) Edition of the book “Collected Papers on the Quantum Mechanics” , Zurich 1926 E Schrodinger wrote: a young lady friend recently remarked to the Author (Schrodinger) “When you began this work you have no idea that anything so clever would come out of it , had you.”

This unorthodox comparison between scientific and purely aesthetic communication is able to provide a first clue towards criteria distinguishing good fantasy in science from bad. Science as a crowning intellectual achievement is essentially disciplined; but it is not always easy to realize the need for an equally severe discipline in the domain of the imaginative arts. Imagination and intellect, however, are not always in antithesis to one another.

Reason implies not only a capacity for logical sequence of argument, but also a sensitivity to balance and contrast a trained intuition without untrained intuition s arrogant claims to short-circuit the discipline of the intellect When the imagination thus becomes disciplined, and undertakes the severest obligations inherent in perfecting the pattern of an art-form, it has taken the essential step towards security against the weaknesses of fantasy. Structure as disciplined as that of a mathematical argument is capable of transfiguring the merest nonsense into divine nonsense.

Modern physics might well be regarded as study of the structure of matter and of the behavior of radiation. A criterion for success pursuit of the former study demands that analysis of material structures into atoms and molecules, and of these into nuclei with groups of associated electrons, must be capable of giving rise to verifiable prediction of the bulk properties of matter, mechanical, thermal, chemical, and electrical.

Criteria for theories as to the behaviour of radiation are that the phenomena of light, colour, radio, X-rays, heat radiation, must become explainable by some single mechanism; the only mechanism so far successful has been the propagation of electric and magnetic quantities with a unique and universal speed which is accurately measurable. This speed exceeds that of the fastest material particles, as a limit towards which the latter can only approach. Within the scope of these two most general schemes, the structure of matter has been a prime example of pattern since D Mendelejev in XIX century arranged all the then known chemical species or elements into a two- dimensional framework.

Written down in a table of horizontal rows and vertical columns, the chemical elements were found to repeat certain properties periodically, much as the harmonic properties of the notes on a piano keyboard repeat themselves at intervals of octaves. To form the gross substances which we distinguish by touch, smell, taste, etc., the affinities for chemical combining of atomic species

are found to wax and wane with precise regularity throughout the periods of this table. The whole assemblage of empirically periodic patterns is now understood as manifesting the way in which successive electrons can become associated with atomic nuclei of definite mass: these additions proceed until one after another their possible federations into electrically and mechanically stable groups or sub-patterns are.

There have been eras in which an educated man could only live up to his standard if he were at the same time a poet and a philosopher and an experimental or mathematical researcher. E. Schrodinger is a good example. He attended a gymnasium, which emphasized the study of *Greek* and *Latin* classics. His book *Nature and the Greeks* published in 1948 is an elegant exposition of ancient physical theories and their relevance. Schrodinger wrote in 1925 an intensely account of his beliefs, *Seek for the Road*. The book was influenced by *Hinduism* and is an argument for the essential oneness of human consciousness.

3. The beautiful mathematics/physics

During my work as a lecturer in Physics Department, Warsaw University, I like very much the Kepler – Copernicus (Kopernik in Polish) - Newton panorama of the planet moving. I started as usual with historical facts and write the basic equations. Considering the FQXI community, I left of all steps and start from the equation:

$$\frac{d^2u}{d\Theta^2} + u = -\frac{m}{L^2} \frac{1}{u^2} F\left(\frac{1}{u}\right),$$
$$u = \frac{1}{r}. \tag{1}$$

Equation 1 is the master equation which describes the movement of the body with mass m in the field of central forces $F(1/u)$. We can imagine the following functions $F(1/u)$

$$F\left(\frac{1}{u}\right) = K_1 u^\pi, \quad K_2 u^3, \quad K_3 u^2, \quad K_4 u^{0.64}, \quad K_5 u^{-4.62}. \tag{2}$$

We can imagine the “other” universes for which the central forces have the different $F(1/u)$. But can life be originated and developed in all these universes? This question is answered by the anthropic principle and will be discussed later on. For the moment we can say the following: Macroscopic structure of the Universe we live in can be understood with just two forces: Newton and Coulomb. For both forces

$$F\left(\frac{1}{u}\right) = Ku^2. \tag{3}$$

Why? With the forces described by formula (3) we obtain for equation (1)

$$\frac{d^2u}{d\Theta^2} + u = -\frac{Km}{L^2}. \quad (4)$$

with constant on the right hand side of the equation- only for quadratic in u forces Only for that force! Can you imagine! This is miracle, is not?

This beautiful equation describes the classical motion of the planets, and electrons round the source of the force $F = Ku^2$. Moreover, the equation (4) in fact is the harmonic oscillator equation, which can be solved at once the solution to the eq. (4) can be written as

$$u = A \cos(\Theta - \Theta_0) - \frac{mK}{L^2}, \quad (5)$$

or

$$r = \frac{1}{A \cos(\Theta - \Theta_0) - \frac{mK}{L^2}}. \quad (6)$$

Equation (6) describes the conic curves: ellipse, parabola and hyperbola depending on constants A, Θ_0 , m, K and L. We can choose our coordinate axes so that $\Theta_0 = 0$ to simplify things just a little:

$$r = \frac{1}{A \cos \Theta - \frac{mK}{L^2}}. \quad (7)$$

This is a conic sections. From plane geometry, any conic section can be written as

$$r = r_0 \frac{1+e}{1+e \cos \Theta}, \quad (8)$$

where e is called the eccentricity of the orbit.

4. Other dimensions

In any higher organism, a large number of cells must be inter-counted by nerve fibers. If space had only two dimensions, an organ-ism could be only a two-dimensional configuration and its nerve paths would cross. At the intersections, the nerves would have to penetrate each other, for absence of a third dimension would not permit a fiber to be led above or below another one. As a consequence nerve impulses would mutually interfere. The existence of a highly developed organism having many non-intersecting nerve paths is thus possible only in a space having at least three dimensions.

As we know both the Newtonian gravitational force and electrostatic force can be described in the three dimensional space (formula (9))

$$F = \frac{K}{r^2}, \quad n = 3, \quad (9)$$

where n is the number of dimension of space. For $n \neq 3$ the natural generalization of formula (1.180) is

$$F = (n - 2) \frac{K}{r^{n-1}}, \quad n \neq 2. \quad (10)$$

The impossibility of stable planet orbit for $n > 3$ can be seen in an elementary way. Let m be the mass of planet and L angular momentum (which is constant for the central force (1.181))

$$L = mr^2 \dot{\Theta} = \text{const.} \quad (11)$$

The gravitation potential for the conservative force will be

$$V = -\frac{K}{r^{n-2}}. \quad (12)$$

At the extreme distances from the central body for a planet with mass m , we have

$$\frac{dr}{dt} = 0. \quad (13)$$

The kinetic energy T at such points is

$$T = \frac{p^2}{2m} = \frac{1}{2} mr^2 \dot{\Theta}^2, \quad (14)$$

then

$$T = \frac{L^2}{2mr^2}. \quad (15)$$

By conservation of mechanical energy $T + V = \text{constant}$, or

$$\frac{L^2}{2mr_1^2} - \frac{K}{r_1^{n-2}} = \frac{L^2}{2mr_2^2} - \frac{K}{r_2^{n-2}}, \quad (16)$$

where r_1 is the minimum distance from the central body and r_2 is the maximum distance, perihelion and aphelion respectively.

The equation (16) shows that for $n = 4$ there can be a finite, positive solution only if $r_2 > r_1$. For $n > 4$ it can be shown that an orbit in which r oscillates between two extremes is likewise ruled out.

In general the centripetal force in a circular orbit is

$$F_c = mr^2 \dot{\Theta}^2. \quad (17)$$

Using Eq. (15) this becomes

$$F_c = \frac{L^2}{mr^3}. \tag{18}$$

In the actual eccentric orbit, the attractive force must be less than this centripetal force at perihelion, for then the planet is about to move outward. At aphelion, it is just the other way around.

These conditions can be expressed respectively by the following inequalities

$$F < F_c$$

$$\frac{(n-2)K}{r_1^{n-1}} < \frac{L^2}{mr_1^3} \quad \text{or} \quad \frac{K}{r_1^{n-2}} < \frac{L^2}{(n-2)mr_1^2}, \tag{19}$$

$$F > F_c$$

$$\frac{(n-2)K}{r_2^{n-1}} > \frac{L^2}{mr_2^3} \quad \text{or} \quad \frac{K}{r_2^{n-2}} > \frac{L^2}{(n-2)mr_2^2}. \tag{21}$$

$$\frac{L^2}{2mr_1^2} - \frac{L^2}{(n-2)mr_1^2} < \frac{L^2}{2mr_2^2} - \frac{L^2}{(n-2)mr_2^2}. \tag{22}$$

and

$$\frac{L^2}{mr_1^2} \left(\frac{1}{2} - (n-2)^{-1} \right) < \frac{L^2}{2mr_2^2} \left(\frac{1}{2} - (n-2)^{-1} \right). \tag{23}$$

This relation obviously cannot be true for $n = 4$, for then each of the brackets becomes zero. Remembering that $r_2 > r_1$ it also cannot be true for any $n > 4$, which makes the values of the brackets less than $\frac{1}{2}$. Thus, the existence of an elliptic orbit for $n \geq 4$ is ruled out. The results for planetary orbits are collected in Table 1.

1. Planetary orbits

Phenomena	Cases thus excluded
Bio-topology (existence of a highly developed organism)	$n < 3$
Stability of planetary orbits	$n > 3$ Possible only for circular orbit $n = 4$ orbit $n > 4$ Excluded if the potential is too vanish at ∞ $n < 3$

In conclusion, it may be said that stable elliptical planetary orbits can exist and support the existence of the highly developed organisms only in three dimensional space. The second miracle!

5. Human Brain

According to general idea of Gestalt we look for Design in Human brain It is well known that the mass of human brain equals 1,5 kg, On another side human brain consists of 10^{11} neurons with mass of each equals 10^{-8} kg. (Kandel E R, 2012) We have the serious problem: mass of all neurons is equal 10^3 kg – is impossible great and is greater than the full body of an adult human. When I consult this fact with many neurologists they do not refuse my calculation and do not find out the solution.

Our hypothesis is: the formula for the mass of human brain is not complete. My new formula for the human brain is

$$M_{HB} = N_N \cdot 10^{-5} g - B_E \tag{24}$$

In formula (24) M_{HB} denotes Human brain mass, N_N is the number of neurons in human brain and B_E is human brain binding Energy. The binding energy can be calculated as (see Table 1 for numbers)

Table 1

	Mass	Mass in energy units, c=1
Proton	10^{-27} kg	~ 1 GeV
Human brain	1.5 kg	~ $1.5 \cdot 10^{27}$ GeV
Neuron	10^{-5} g	~ 10^{19} GeV

$$\begin{aligned}
 B_G &= -M_{HB} + N_N \cdot 10^{-5} g \\
 B_G &= -1.5kg + 10^3 kg = 998,5kg = 9.98 \cdot 10^{29} M_p \\
 B_G &= 9.98 \cdot 10^{29} 1GeV
 \end{aligned} \tag{25}$$

From formula (25) we conclude that the binding energy contributes about 99% of the mass of human brain Binding energy is the *biological dark energy*. The same situation is for proton structure. The mass of a proton is about 980 MeV. By comparison the “bare” mass of an up

quark is around 2 MeV and the bare mass of down quark is 5 MeV. A proton has two up quarks and one down quark, which combined contribute to only about 10 MeV. The rest of the mass about 970 MeV, comes from binding energy.

We can calculate binding energy per neuron:

$$\frac{9.98 \cdot 10^{29} \text{ GeV}}{10^{11}} = 9.98 \cdot 10^{18} \text{ GeV} \quad (26)$$

It occurs that binding energy per neuron in human brain is equal to mass of Planck particle; ($M_p=10^{19} \text{ GeV}$) the building block of the Universe

6. Void of Human Brain

Let us start with the inner structure of human brain. Average human brain volume is equal $1.2 \cdot 10^{-3} \text{ m}^3$. On the another hand the volume occupied by all protons in human brain is $10^{30} \times 10^{-45} \text{ m}^3 = 10^{-15} \text{ m}^3$ (Table2) Rest of volume of human brain is empty of matter and consist of biding energy. As it concerns matter human brain is void!

Table 2. Radiuses

Nucleus	10^{-15} m
Atom	10^{-10} m
Human brain	10^{-1} m

7. Conclusions

In this paper, we calculated the binding energy and volume occupied by matter in the brain. In the case of brain the binding energy is the first and fundamental quantum property of the brain. The structure of the brain is rather strange. Matter is from macroscopic point of view absent! Human brain is empty of the matter. We argue that considering mass contents human brain is the sphere of the radius of 0.1m with nucleus of the radius of $(10^{-15} \text{ m}^3)^{1/3} = 10^{-5} \text{ m}$. We have possibility to separate brain (the neurons, axons ...) and mind (binding energy of the brain). We argue that binding energy is the nest of consciousness. If we consider that number of humans is growing up - the global binding energy as the sum of all human brain binding energy is also growing up.

References

Kandel E R et al., Principles of Neural Science, Fifth Edition, McGraw-Hill, USA, 2012.

Marciak-Kozłowska, J, Kozłowski M, Extrasensory perception phenomena, Lambert Academic Publishing, (and references therein), 2016.