# Mathematics, Physics, and Plants: A Case Study of Fibonacci Series

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**Abstract**

There were eras where an educated man could only live up to his standard if he was a poet and a philosopher at the same time, or an experimental or a mathematical researcher. I argue that it is time to return back and look into the areas of physics, mathematics, and botany from different perspective of Fibonacci series.

**Keywords:**

*Number rules the Universe*
Pythagoreans (ca. 530-510 B.C)

## Introduction

In the preface of the first (German) Edition of the book "Collected Papers on the Quantum Mechanics" by Zurich in 1926, E Schrodinger (1986) wrote concerning a young lady friend recently remarked by the Author (Schrodinger). However, Schrondinger (1986) stated: "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 by distinguishing between good and bad fantasy in science. Science as a crowning intellectual achievement is essentially disciplined. However, it is not always easy to realize the need for an equally severe discipline in the domain of the imaginative arts. Consequently, imagination and intellect are not always in antithesis to one another. The reasons imply that there is not only a capacity for logical sequence of argument, but also a sensitivity to balance and contrast a trained intuition without untrained intuition arrogant. Thus, this claims to short-circuit the discipline of the intellect. This occurs when the imagination thus becomes disciplined, and undertakes the severest obligations inherent in perfecting the pattern of an art-form. Thus, it has taken essential step towards security against the weaknesses of fantasy. Structure, which is as disciplined as that of a mathematical argument, is capable of transfiguring the merest nonsense into divine nonsense.

Modern physics might as well be regarded as the study of the structure of matter and of the behavior of radiation. A criterion for success pursuit of the former study demands that the analysis of material structures into atoms and molecules, 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 properties. Criteria for theories as to the behaviour of radiation are that the phenomena of light, colour, radio, X-rays, heat, and radiation must become explainable by some single mechanism. The only mechanism which has been 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 it serves 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 Mendeleyev 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. This occurs as 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 to be manifesting the way in which successive electrons can become associated with atomic nuclei of definite mass. Subsequently, these additions proceed until, one after another, their possible federations into electrically and mechanically stable groups or sub-patterns are achieved.

In addition, 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. In 1925, Schrodinger wrote an intense account of his beliefs, *Seek for the Road*. However, the book was influenced by *Hinduism* and is an argument for the essential oneness of human consciousness.

**1. The Beautiful Mathematics/Physics**

During my work as a lecturer in the Physics Department of Warsaw University, I like the Kepler very much – Copernicus (Kopernik in Polish), Newton panorama of the planet moving (M.Kozlowski, 2012). I started as usual with historical facts and wrote the basic equations. Considering the FQXI community, I left out all steps and started from the equation as shown below:

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

$$u=\frac{1}{r}. \tag{1}$$

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). Thus, we can imagine the following functions F(1/u):

$$F\left(\frac{1}{u}\right)=K_1u^{\pi},\quad K_2u^3,\quad K_3u^2,\quad K_4u^{0.64},\quad K_5u^{-4.62}. \tag{2}$$

We can imagine the “other” universes for which the central forces are different, F(1/u). However, 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 that the macroscopic structure of the Universe we live in can be understood with just two forces: Newton and Coulomb. For both forces, it is as shown below:

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

Why?

With the forces described by formula (3), we obtain for equation (1);

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

This is 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 a miracle! Is it 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. Therefore, the solution to the equation (4) can be written as shown below:

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

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, $\Theta_0$, m, K, and L. Therefore, we can choose our coordinate axes such that $\Theta_0$= 0 to simplify things just a little. Thus:

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

This is a conic section. 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.

**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 organism could be only a two-dimensional configuration and its nerve paths would cross. At the intersections, the nerves would have to penetrate each other. Therefore, the 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.

Therefore, both the Newtonian gravitational force and the electrostatic force can be described in the three dimensional space (formula (9)).

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

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

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

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

$$L = mr^2\dot{\Theta} = \text{const.} \tag{11}$$

Therefore, the gravitation potential for the conservative force will be given as:

$$V = -\frac{K}{r^{n-2}}. \tag{12}$$

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

$$\frac{dr}{dt} = 0. \tag{13}$$

The kinetic energy T at such points is then given as:

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

which by equation (15) becomes;

$$T = \frac{L^2}{2mr^2}. \tag{16}$$

By conservation of mechanical energy T + V = constant, or

$$\frac{L^2}{2mr_1^2} - \frac{K}{r_1^{n-2}} = \frac{L^2}{2mr_2^2} - \frac{K}{r_2^{n-2}}, \tag{17}$$

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

The equation (17) shows that for n = 4, there can be a finite positive solution only if $r_2 > r1$. 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 given as:

$$F_c = mr^2\dot{\Theta}^2. \tag{18}$$

Using Eq. (1.182), this becomes:

$$F_c = \frac{L^2}{mr^3}. \tag{19}$$

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.

Therefore, these conditions can be expressed respectively by the following inequalities

(20)

$$F < F_c$$

$$\frac{(n-2)K}{r_1^{n-1}} < \frac{L^2}{mr_1^3} \quad \text{or} \quad \frac{K}{r_1^{n-2}} < \frac{L^2}{(n-2)mr_1^2}, \tag{21}$$

$$F > F_c$$

$$\frac{(n-2)K}{r_2^{n-1}} > \frac{L^2}{mr_2^3} \quad \text{or} \quad \frac{K}{r_2^{n-2}} > \frac{L^2}{(n-2)mr_2^2}. \tag{22}$$

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

and

$$\frac{L^2}{mr_1^2}\left(\frac{1}{2} - (n-2)^{-1}\right) < \frac{L^2}{2mr_2^2}\left(\frac{1}{2} - (n-2)^{-1}\right). \tag{24}$$

Subsequently, 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. Therefore, this makes the values of the brackets to be less than ½.

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<br>n = 4<br>n >4<br>n < 3 | <br>Possible only for circular orbit<br>Excluded if the potential is too vanish at $\infty$ |

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

## The Fibonacci Series

Here, we have the series of numbers:

- **2** - Gravity and electromagnetic fields
- **3** - Structure of the Universe, the next must be 5- I suspect.
- **5**- This is the dimension of space time in which gravity and electromagnetic can be unified (Kaluza-Klein scenario). Enough is enough! But wait! What does 8 means?

- **8** -N = 8 Supergravity in 4 Dimensions[18]. and
- In botany, the phenomenon of *phylotaxis* is well known. The leafs are placed according to the rules of Fibonacci series![19] Does the flowers knows the mathematics? Certainly not! They do not attend *maths or physics* classroom. Now, we have real problem, who teaches plants and what about *the unreasonable effectiveness of mathematics in physics, botany, medicine* … Take a radical step. There are no medicine, botany, mathematics, and physics as the separated part of SCIENCE. The Universe has only four pillars with N= 2,3,5,8 respectively. However, this can be seen to be at the Level IV (Max Tegmark, 2014). It is worth to add that the ancient Egyptians depicted a cosmos with a heavenly roof which is "supported by 4 women at the cardinal points" (E.T. Bell, 1933).

** More generally, the term may refer to an eight-dimensional vector space over any field, such as an eight-dimensional complex vector space which has 16 real dimensions. It may also refer to an eight-dimensional manifold, such as an 8-sphere or a variety of other geometric constructions.*

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[18] *N=8 Supergravity is the most symmetric quantum field theory which involves gravity and a finite number of fields. It can be found from a dimensional reduction of 11D supergravity by making the size of 7 of the dimensions go to zero. It has 8 supersymmetries which any gravitational theory mostly can have since there are 8 half-steps between spin 2 and spin -2. (A graviton has the highest spin in this theory which is a spin 2 particle). More supersymmetries would mean the particles would have superpartners with spins higher than 2. The only theories with spins higher than 2 which are consistent involve an infinite number of particles (such as String Theory).*

[19] *The beautiful arrangement of leaves in some plants, called phyllotaxis, obeys a number of subtle mathematical relationships. For instance, the florets in the head of a sunflower form two oppositely directed spirals: 55 of them are clockwise and 34 counter clockwise. Surprisingly, these numbers are consecutive Fibonacci numbers. The ratios of alternate Fibonacci numbers are given by the convergents to* $\phi^{-2}$*, where* $\phi$ *is the golden ratio, and are said to measure the fraction of a turn between successive leaves on the stalk of a plant: 1/2 for elm and linden, 1/3 for beech and hazel, 2/5 for oak and apple, 3/8 for poplar and rose, 5/13 for willow and almond, etc. A similar phenomenon occurs for daisies, pineapples, pinecones, cauliflowers, and so on. Lilies, irises, and the trillium have three petals; columbines, buttercups, larkspur, and wild rose have five petals; delphiniums, bloodroot, and cosmos have eight petals; corn marigolds have 13 petals; asters have 21 petals; and daisies have 34, 55, or 89 petals--all Fibonacci numbers.*

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