Article

Planetary Masses and Quark Masses Follow Fibonacci Numbers

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Abstract: In this paper the author investigates why planets and particles have exactly those masses. The study shows a possible analysis of the relative value of any planet (particle) mass to any other one. The author is able to find that any two planetary masses or two particle masses are in ratio like two Fibonacci numbers. Specifically, the author shows to be able to find one planet (or particle) mass starting from the biggest mass of the planet system (or the biggest mass among quark and leptons) and a Fibonacci number. Specifically, two planetary masses or two particle masses are in ratio like two Fibonacci numbers. The author shows this result for all the masses in the Solar System and for all masses of quarks and leptons. These work can give insights to the Origin of Masses and the Generations of Matter problems.

Keywords: quark masses; planet masses; solar system gravitation; Fibonacci numbers; golden ratio

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1. Introduction

There are still important questions in Physics that need to be solved. One of them is the Origin of Masses, that is a theory that describes the origin of mass from the fundamental laws of physics. Physicists have proposed a number of models that advocate different views of the origin of mass. The problem is complicated because the primary role of mass is to mediate gravitational interaction between bodies, and no theory of gravitational interaction reconciles with the Standard Model of particle physics. Some open problems in Physics related to the latter are the matter-antimatter asymmetry/symmetry and the Generations of Matter ("Is there a theory that can explain the values for the masses of quarks and leptons in particular generations from first principles?"). Quarks are believed to be fundamental constituents of matter. They are classified in 3 generations (particles within a generation differ by their flavor quantum number and their mass, but their interactions are identical). It is a mystery of nature why there are 3 generations and why the quarks have exactly those masses. "It is hoped that a comprehensive understanding of the relationship between the generations of the leptons may eventually explain the ratio of masses of the fundamental particles and shed further light on the nature of mass generally, from a quantum perspective" ([1] and [3]).

The author shows here some striking resemblance between the relative values of planetary masses with the ratio of two Fibonacci numbers (Fibo-numbers). Similarly, the author shows some tight relationship between the relative values of particle masses with the ratio of two Fibonacci numbers. In other words, the author proves that any two of all the masses of leptons and quarks (of all three generations) are in ratio as two Fibo-numbers.

The findings in this paper might indicate a likely possibility that masses are generated with a process that follows Fibonacci numbers. These findings might give insights on open problems such as the Origin of Masses and the Generations of Matter.

2. Methods and Results

<u>The masses of planets in the Solar System resemble the Fibonacci sequence.</u> The author shows in the following that the mass of a planet can be estimated as the mass of the Sun multiplied by a constant ($\pi/3$) and a Fibo-number (shown in Table 1). Therefore, for any two planets, their masses are in a ratio like two Fibo-numbers. These estimations have an average relative error of 7.5% (last row

of Table 1, single errors in the last column of Table 1). Note that the only three planets whose masses are estimated with a semi-Fibo-number (equivalent to the half of the (n+2)-Fibo-number) have a rotation (revolution around their own axis) that is counterclockwise – this is the case for Venus, Neptune and Pluto! - while the rotation of all other planets are clockwise. The reason is considered for future research. From Table 1 it is clear that *any two planetary masses are in ratio as the ratio of two Fibo-numbers*. In future articles the author might show that also planetary diameters are in ratio as the ratio of Fibo-numbers.

Table 1. The mass values of all planets in the Solar System follow the Fibonacci sequence. The second column represents the experimental value for the mass of the planet indicated in the first column. The ratio of this value to the mass of the Sun is shown in the third column. The estimation for this mass ratio of a planet is a Fibo-number (reported in the 5th column) multiplied by a constant and is shown in the 4th column. These estimates lead to the conclusion that any planet mass can be found from the solar mass divided by a Fibo-number. This is equivalent to say that any two of all planets' masses are in the same ratio as two Fibo-numbers. The relative error of our estimation of each planet's mass is shown in the last column. In the last row the average error of these estimations is reported. Data from [2].

Planet	Mass (Kg)	Sun's Mass / Mass	Estimation of Sun's Mass / Mass = ⚜/3 · Fibo-number	Fibo-number used	Relative error (%)
Mercury	$3.33 \cdot 10^{23}$	$5.97 \cdot 10^{6}$	$5.97 \cdot 10^{6}$	$F_{34} = 5702887$	0 (1)
Venus	$4.87 \cdot 10^{24}$	$4.09 \cdot 10^{5}$	$4.36 \cdot 10^{5}$	$(F_{28} + F_{29})/2 = 416020$	6.7
Earth	$5.97 \cdot 10^{24}$	$3.33 \cdot 10^{5}$	$3.33 \cdot 10^{5}$	$F_{28} = 317811$	0
Mars	$6.42 \cdot 10^{23}$	$3.10 \cdot 10^{6}$	$3.69 \cdot 10^{6}$	$F_{33} = 3524578$	19
Jupiter	$1.90 \cdot 10^{27}$	$1.05 \cdot 10^{3}$	$1.03 \cdot 10^{3}$	$F_{16} = 987$	1.3
Saturn	$5.69 \cdot 10^{26}$	$3.50 \cdot 10^{3}$	$2.71 \cdot 10^{3}$	$F_{18} = 2584$	23
Uranus	$8.68 \cdot 10^{25}$	$2.29 \cdot 10^{4}$	$2.43 \cdot 10^{4}$	$(F_{22} + F_{23})/2 = 23184$	6.0
Neptune	$1.02 \cdot 10^{26}$	$1.94 \cdot 10^{4}$	$1.86 \cdot 10^{4}$	$F_{22} = 17711$	4.5
Pluto	$1.30 \cdot 10^{22}$	$1.53 \cdot 10^{8}$	$1.40 \cdot 10^{8}$	$(F_{40} + F_{41})/2 = 133957148$	8.1
					average error = 7.5 %

(1) less than error on the experim. data.

<u>The masses of quarks and leptons resemble the Fibonacci sequence.</u> The author points out a first observation. If one considers the system made from the three masses {up-quark, up-quark, down-quark} - system that forms a proton - it can be pointed out that it resembles the Fibo-sequence {1,1,2}, since the masses of the up-quark and the down-quark are in a ratio 1:2. In the following the author proposes that the masses of quarks and leptons follow the Fibo-sequence (Table 2) in the same way the masses of planets do (as shown in Table 1). The author proves that *any two of all the masses of leptons and quarks (of all three generations) are in ratio as two Fibo-numbers* (shown in Table 2). In particular, the author shows that the ratio between any particle mass and the biggest mass - the top-quark mass - is close to 1/Fibo-number (Table 2). The author estimation of the mass is shown in the fourth column in Table 2, while the experimental value for the mass is shown in the third column. The estimation of each ratio using a Fibo-number, calculated for all particles, has an average relative error of only 6% (last row in Table 2). Therefore, the ratio of any two masses of quarks or leptons is very close to the ratio of two Fibo-numbers. These estimates lead to the conclusion that ***all*** masses of quarks and leptons are in ratios as two Fibo-numbers. The method is consistent with the one used for estimating the planetary masses described before (Table 1). We can imagine that during a particle formation (at the time of the Big Bang or in any transition) the mass is distributed in separate

structures of area (/mass) equal to a Fibo-number. Few times the author has shown an estimation using the average of subsequent Fibo-numbers. It is not a coincidence that all the three particles that had required to use an average of subsequent Fibo-numbers (quark d, quark s and quark b) have in common to be "down-particles", that is, they all have a negative charge and a negative weak Isospin (in the following we will call "half-Fibo-number" any average between two subsequent Fibo-numbers). The reason is unknown and left for future research. However, the same finding has been found for the planets, if we allow the analogy between "Isospin" and the direction of a planetary rotation (see the above discussion about Venus, Neptune and Pluto). This finding - that is, when a "half-Fibo-number" was used to find the mass ratio of a particle/planet with the biggest particle/planet, the particle/planet Isospin/rotation-direction assume a negative value - seems to give support to the theory. It is also relevant that all quarks that required the use of an average of subsequent Fibo-numbers are the quarks that appear in the CKM matrix as quarks j (with V_{ij} the transition probability of the decay from quark j to quark I) and these are the quark d, quark s and quark b. Related to this, in another work the author will show a relationship between the CKM matrix and Fibonacci numbers [second_paper submitted].

Table 2. The mass values of quarks and leptons follow the Fibonacci sequence. The first column shows the quark or lepton considered. The second column indicates the number of the generation the particle (of column 1) belongs to. The experimental value of the mass of the particle is reported in the 3rd column. The estimation for the mass of the particle is shown in the 4th column. The estimated mass is the mass of the top-quark divided by a Fibo-number (reported in the 6th column). The Fibo-number used in the estimation is shown in the 5th column. The relative error of the estimation for each particle mass is shown in the last column. The average error is shown in the last row.

Quark or lepton	Generation	Mass (MeV/c²)	Estimated mass = massa top-quark / Fibo-number (MeV/c²)	Fibo-number used	Relative error (%)
up	I	2.3	$m_{\text{top-quark}}$ / 75025 = 2.3	F_{25} = 75025	0 [(2)]
down	I	4.8	$m_{\text{top-quark}}$ / [(46368 + 28657)/2] = 4.6	(F_{23} + F_{24})/2 = 37512.5	4.0
electron	I	0.511	$m_{\text{top-quark}}$ / 317811 = 0.545	F_{28} = 317811	6.7
charm	II	1275	$m_{\text{top-quark}}$ / 144 = 1203	F_{12} = 144	5.7
strange	II	95	$m_{\text{top-quark}}$ / [(1597+2584)/2] = 83	(F_{17} + F_{18})/2 = (1597+2584)/2	13
muon	II	105.658	$m_{\text{top-quark}}$ / 1597 = 108.460	F_{17} = 1597	2.7
top	III	173210	$m_{\text{top-quark}}$ / $m_{\text{top-quark}}$	F_1 = 1	NA
bottom	III	4180	$m_{\text{top-quark}}$ / [(34+55)/2] = 3892	(F_9 + F_{10})/2 = (34+55)/2	6.9
tau	III	1776	$m_{\text{top-quark}}$ / 89 = 1946	F_{11} = 89	9.5
					average error = 6.0 %

(2) less than error on the experim. data.

3. Conclusions

In the present study, the author shows interesting findings about the relationship between the masses of planets, as well as the relationship between the masses of quarks and leptons. The author showed that any two planetary masses in the Solar System are in ratio as the ratio between two Fibonacci numbers and, similarly, any two particle masses (quarks or leptons) are in ratio like two

Fibonacci numbers. These findings provide some insights for a possible new theory on the generation of the particle/planet masses.

This work sheds light on the nature of mass and gives insights on the Generations of Matter problem (“Is there a theory that can explain the values for the masses of quarks and leptons in particular generations from first principles?”). It is a mystery of nature why there are 3 generations of quarks and leptons and why they have exactly those masses. “It is hoped that a comprehensive understanding of the relationship between the generations of the leptons may eventually explain the ratio of masses of the fundamental particles and shed further light on the nature of mass generally, from a quantum perspective” ([1] and [3]). The author gives insights on these open problems by showing here a striking resemblance with the Fibonacci sequence. The author has shown estimations for the values of the masses using Fibonacci number or the average of subsequent Fibonacci numbers. The reason why average of subsequent Fibonacci numbers (also equal to half of the next Fibo-number) are used is unknown. However the author gives an analogy with a seashell surface. The masses found with a regular Fibo-number are like a sand particle on the external surface of a spiral seashell (e.g. a screw shell or a Nautilus shell) while the masses found with a half Fibo-number are interpreted to behave like a sand particle moving in the “internal spiral”: the spiral trajectory in the inner surface of a seashell is the trajectory made of points positioned between successive loops of the spiral of the outside surface, approximately half way between successive loops and a sand particle following the spiral internal trajectory would rotate counterclockwise/clockwise compared to a sand particle that move along the external spiral trajectory that would rotate in the opposite direction (clockwise/counterclockwise). The author speculates on this idea since all the planets whose masses are estimated with a semi-Fibonacci number (equivalent to the half of the (n+2)-Fibo-number) have a rotation (revolution around their own axis) that is counterclockwise – this is the case for Venus, Neptune and Pluto – while the rotation of all other planets is clockwise. The author also showed that all three particles that had required to use an average of subsequent Fibonacci numbers have in common to be “down-particles”, that is, they all have a negative weak Isospin. The author interprets this with the appealing conjecture of the “internal spiral”: a sand particle on the internal surface of a ‘seashell’ move in a counterclockwise direction going towards a lower gravitational potential, at the same time sand particles on the external surface of the ‘seashell’ move in a clockwise direction. The same finding has been shown for the planets, if we allow the analogy between “Isospin” and the direction of the rotation. This is just an analogy to illustrate how some planets (particles) move clockwise (have a positive Isospin) or in the other direction (opposite sign).

In conclusion, the findings that any two masses (either planets either quarks) are in ratio as the ratio between two Fibonacci numbers are presented. These results convey the idea that one can find all masses of a system starting from just one mass, from first principles (i.e. dividing by a Fibonacci number to obtain another mass). The author speculates that these are broad phenomena, that can be verified in many other gravitational systems and galaxies.

Conflicts of Interest: The authors declare no conflicts of interest.

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