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Masses of Virtual Quarks

Abstract: The values of quark masses have been determined.

Keywords: Bošković, Virtual particle, Quark

> *Any particle of matter is connected with every other particle, no matter how great is the distance between them, in such a way that, in accordance with a change in the position, no matter how slight, of any one of them, the factors that determine the motions of all the rest are altered ;...*
>
> Roger Joseph Boscovich, [1, article 2]

1. Virtual particles in Bošković's Theory

Let's quote from the introduction of the English translation of Bošković's Theory, [1]:

- *To sum up, it would seem that the curve of Boscovich is an acceleration-interval graph; and it is a mistake to refer to his cosmic system as a system of „force-centres".*

Bošković often uses the word ***propensity***, for example [1, article 9]:

9. I therefore consider that any two points of matter are subject to a determination to approach one another at some distances, & in an equal degree recede from one another at other instances. This determination I call ' force '; in the first case ' attractive ', in the second case ' repulsive '; this term does not denote the mode of action, but the ***propensity****...*

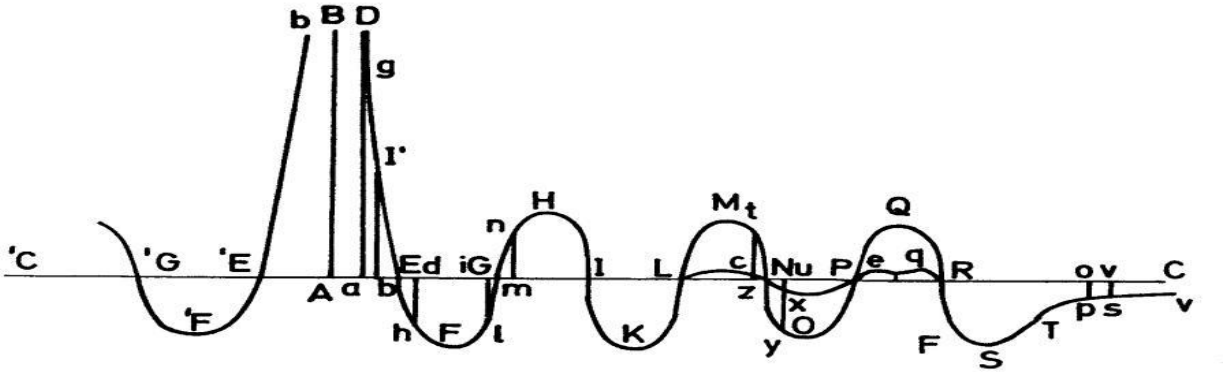

Figure 1 - General shape of Bošković curve show the change of attractive and repulsive forces with the change of distance (abscissa) between the elementary points of matter,

In Quantum Field Theory [6], we call the emergence of real mass from virtual mass an ***excited state***, let's quote:

Quantum field theory treats particles as ***excited states*** (also called ***quanta***) of their ***fundamental fields***, which are, in a sense, more fundamental than the underlying particles.

"Fundamental fields": in this paper are ***virtual quarks*** which are shown in Table 2.

Note that in Figure 1, a large number of virtual particles (***fundamental fields***) are possible, so it would be more natural, instead of the terms: ***fields*** to use the Bošković ***limits*** which are substitute for all fields, they are more comprehensive preceded ***Quantum Field Theory*** by two centuries.

How virtual (unexcited) points are excited will be left for another time, and here we will pay attention to virtual particles.

2. Formulas for virtual quarks

I understand Bošković's quote at the beginning: as a fundamental feature of the universe that it constantly self-adjusts according to an all-valid pattern and what else is that but mathematics. For Bošković, these are: geometry, algebra and God. Many say that the universe is a mathematical creation; moreover, here we will apply it to the relations of virtual quarks.

Data from Table 1 were taken from CODATA 2018, [2]: inverse fine structure constant ά, proton mass - pr and proton/electron mass ratio - μ. The mass ratio of Tau and Muon lepton –T: is different than in [2] because the improvement from [3] was used. Dimensionless: β and σ are determined from previous data, and mass: P = σ 1/3*β-2/3*(pr/2π), will appear often. Coefficient K_f – converts masses from: [kg] to [GeV/c2], in which usually quarks are shown.

Table 1 Dimensionless constants and *masses*

Constants		***[kg]***	***[GeV/c^2]***
Two pi	2π =	6,283185307	
Fine structure inverse	ά =	137,035999084	
Tau / Muon mass ratio	T =	16,816735060	
Proton	*pr =*	*1,67262192E-27*	*0,9382720885*
Proton / electron mass ratio	μ =	1836,15267343	
$\beta = \mu / (2\pi\acute{\alpha}) =$	*β =*	2,1325255860	
$\sigma = 2^{\wedge(2*(2-1/(2\pi\beta+2))/3)} =$	*σ =*	2,4453494201	
$P = \varsigma^{1/3} * \beta^{-2/3} * (2\pi)^{-1} * pr =$	P =	*2,16472164E-28*	*0,1214319782*
$K_f =$		1,7826619E-27	

The quark masses - m_o are shown in column 1 of Table 2 from Wikipedia as given in [MeV/c^2] or [GeV/c^2], based on the latest measurement results, (bottom, strange, down, top, charm, up).

Table 2 Masses of quarks

1	2	3	4	5	6
m_o [MeV/c^2], [GeV/c^2]		$m_v = (ά^a * T^b * 2^c)^{1/3} * P$	a	b	c
4.18 +0.04; −0.03	bv	4,1857705337	4	-1	-9
95 +9; −3	sv	0,0969744679	1	-1	-4
4.7 +0.5; -0.3	dv	0,0046449801	-2	1	-4
172.76 ± 0.3	tv	174,454908321	4	1	-1
1.275+0.025; −0.035	cv	1,2730589735	1	1	-1
2.2 +0.5; -0.4	uv	0,0023224900	-2	1	-7

In column 3, the masses m_v are obtained by a single speculative or intuitive formula in the header, thanks to [1]: with the accuracy of the input data. Where **a, b, c** in columns 4, 5, and 6 are the corresponding exponents over the dimensionless constants: ά, T, and "2". Formula applied in column 3 is correct by definition, only the question arises: what does it represent? Let's call those masses: virtual masses $\mathbf{m_v}$. That masses $\mathbf{m_v}$ are close to $\mathbf{m_o}$ in column 1, is only an indication for formula in header to be the way to obtain correct formula for real quarks. We won't do that here because it's not the topic of the article, but let's just note that there is a rational explanation why the top quark masses (real and virtual) differ significantly and not the others, based on [1]:

3. Virtual quark mass relations

For virtual quarks (suffix v in quark designation): it is easy to show that the relations shown in column 1 of Table 3 and calculated in columns 2 and 3 hold.

Table 3 Mass relations of virtual particles

$tv / bv = 2^{8/3} * T^{2/3}$	**41,678086966**	**41,678086966**
$cv / sv = 2*T^{2/3}$	**13,127774772**	**13,127774772**
$bv/sv = ά * 2^{-5/3}=$	**43,163634960**	**43,163634960**
$tv / uv = 4* ά^2$	**75115,460180**	**75115,460180**
$tv * sv / cv*bv = 2^{5/3}$	**3,174802104**	**3,174802104**
$tv / cv = ά$	**137,03599908**	**137,03599908**
$bv/dv=ά^2*T^{-2/3}*2^{-5/3}$	**901,13853164**	**901,13853164**
$tv/bv * sv/cv * dv/uv = 2^{8/3}$	**6,349604208**	**6,349604208**
$(dv/uv)^{5/3} * bv*tv / (cv*sv) = ά^2$	**18778,865045**	**18778,865045**

Where it is indicative in the last formula that: the first generation has an exponent of 5/3 while the others have 1. I leave the analysis of other relationships to the reader.

4. Conclusion

• For four quarks, the ratio of masses of Tau and Mion leptons is proportional, and for two, inversely proportional (column 5, Table 2);

• Virtual quarks are related to: integer exponents a, b and c in columns 4, 5 and 6 of Table 2, which is an expected quantum property;

• Bošković's position from the beginning was confirmed: *"Each particle of matter is connected with every other"*.

• The article has been reduced to a minimum to make it easier to follow the main flow of the presentation.

1. References

[1] Boscovich J. R.: (a) "Theoria philosophia naturalis redacta ad unicam legem virium in natura existentium", first (Wien, 1758) and second (Venetiis, 1763) edition in Latin language; (b) "A Theory of Natural Philosophy", in English, The M.I.T. Press, Massachusetts Institute of Technology, Cambridge, Massachusetts and London, England, first edition 1922, second edition 1966.

[2] http://physics.nist.gov/cuu/Constants/, *CODATA internationally recommended values of the Fundamental Physical Constants*, values of the constants (2018)

[3] Improving the Koide Formula, https://vixra.org/pdf/1509.0135v1.pdf

[4] Masa Neutrona iz Masa Kvarkova, Kako? (Serbian), https://www.gsjournal.net/Science-Journals/Research%20Papers-Mathematical%20Physics/Download/8398

[5]**.** https://www.wolframalpha.com/

[6] https://en.wikipedia.org/wiki/Quantum_field_theory

[7] https://en.wikipedia.org/wiki/Elementary_particle

[8] https://en.wikipedia.org/wiki/Feynman_diagram