Galactic Route to the Strong Coupling Constant $\alpha_s(m_z)$

Hans Hermann Otto

Materials Science and Crystallography, Clausthal University of Technology,
Clausthal-Zellerfeld, Lower Saxony, Germany

E-mail: hhermann.otto@web.de

Abstract

We derive the word average value of interaction coupling constant $\alpha_s(m_z)$ from the observed maximum galactic rotation velocity $|\beta_g| = \frac{|v_g|}{c}$ by the simple relation $\alpha_s(m_z) = \frac{|\beta_g|}{\beta_0} \cdot \frac{1}{\alpha} = 0.117005223$, where $\beta_0 = \frac{\sqrt{3}}{2}$ is the velocity, at which the difference between galactic rotation velocity and *Thomas* precession is equal, and α is *Sommerfeld*'s constant. The result is in excellent agreement with the value of $\alpha_s = 0.1170 \pm 0.0019$, recently measured and verified via *QCE* analysis by *CERN* researchers. One can formulate a reciprocity relation, connecting α_s with the circle constant: $\pi \cdot \alpha_s \approx \frac{1}{\pi \cdot \beta_0}$. It is the merit of *Preston Guynn* to derive the *Milky Way* maximum value of the galactic rotation velocity β_g, pointing to its 'extremely important role in all physics'.

Keywords: Strong Coupling Constant, Sommerfeld' Constant, Gravitational Coupling Constant, Galactic Velocity, Structure-Matter Theory, Reciprocity Relation, Goldem Mean, Gyromagnetic Factor, Unification of Science.

1. Introduction

Recently, significant experimental as well as theoretical advances have been made in relation to coupling constants that determine the strength of forces exerted in a physical interaction. In relation to the strength of the forces one usually decides strong coupling constant α_s, electromagnetic *Sommerfeld* constant α, weak coupling constant α_w, and gravitational constant α_g. In this contribution we relate the strong coupling constant $\alpha_s(m_z)$, responsible for nuclear stability and taken at the *Z*-bosom mass scale m_z, to the galactic rotation velocity $|\beta_g| = \frac{|v_g|}{c}$ and to *Sommefeld*'s constant α [1], thereby using results of *Guynn*'s excellent structure of matter and space approach [2]. Our numerical result can be compared with α_s recently measured and verivied by *QCE* analysis given by *CERN* researchers [3]. These results were compared to *Mozafari*'s extended coupling constant approach [4] and to the unification attempt given by *Pellis* [5] [6]. Last but not least, the intrinsically local *IRT* theory of *Suleiman* in its application to disk galaxies can deliver comparable results for the strong coupling constant [7]. We are dealing with very simple mathematical relationships as already

given in a recent publications [8] [9]. As a summary, it can be seen that we are on the rigth route towards a unification of physical science without the nonsence of complex physical theories like *QED* [7]. The simplicity in the scaling of interacting rotating entities from particles to galaxies shows the beauty of our cosmos. The given approach should be applied also to the gravitational coupling constant, thereby continuing the work of *Pellis* [5] [6] respectively *Maruani* [10].
This contribution pursues and upgrades a recently given one [8] and prearranges an upcoming contribution incorporating discoveries of the past.

2. Galactic Route to the Strong Coupling Constant

In the following we apply the new structure of matter and space approach of *Preston Guynn* [2], based on the seminal idea to consider the action of *Thomas* precession [11] in difference to the rotation velocity $\beta = v/c$ of moving bodies (entities) from particle scale to galactic one. His result for the difference velocity β_d is given by the equation

$$\beta_d = \beta\left(2 - \frac{1}{\sqrt{1-\beta^2}}\right) = \beta(2-\gamma) \tag{1}$$

where γ is the *Lorentz* factor. **Figure 1** depicts the difference velocity curve with its maximum $ß_m$ and the fundamental velocity $\beta_0 = \frac{\sqrt{3}}{2}$, where β_d becomes zero. The maximum at $\beta_1 = 0.6083087004577$ has the value

$$\beta_m = \sqrt{3}\left(\sqrt[3]{2} - 1\right) = 0.450196459 \tag{2}$$

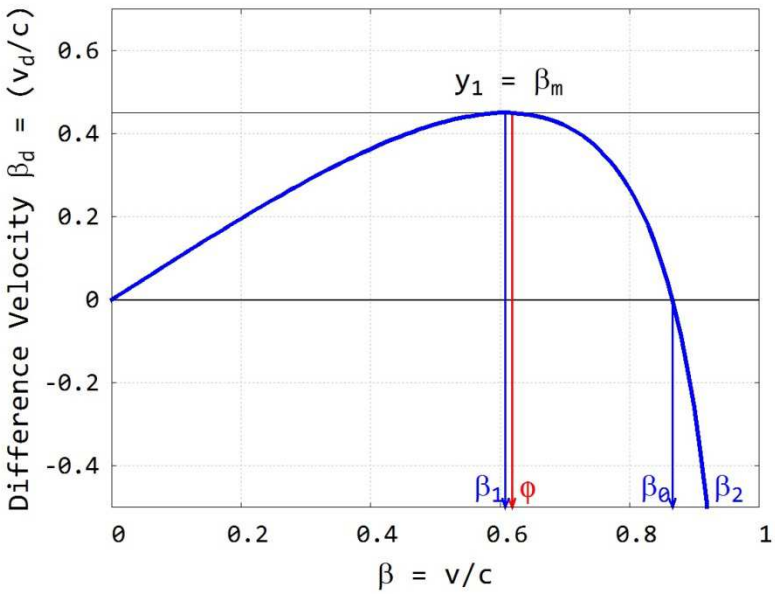

Figure 1. Difference velocity $ß_d$ versus rotation velocity $ß$ after *Guynn* [2]
The red arrow points to the value of the golden mean φ near β_1.

For upcoming calculations we point to the vicinity of β_1 to the golden mean $\varphi = \frac{\sqrt{5}-1}{2} = 0.6180339887$.

The maximum galactic rotation velocity β_g of spiral galaxies like the *Milky Way* star system was given by *Guynn* in terms of the *Lorentz* transform, taken over the electron cyclotron rotation between β_0 and a slightly adapted β_2' (see **Figure 1**) [2]

$$\beta_g = \frac{1}{\pi}\left(1 - \frac{1}{3\sqrt{\theta_{ec}}}\right) \approx -0.000739437964740 \tag{3}$$

where $$\theta_{ec} = \int_{\beta_0}^{\beta_2'} \frac{1}{\sqrt{1-\beta^2}}\, d\beta = 0.11059667926806 \tag{4}$$

For sake of upcoming use we share the interesting integration of β_d between zero and β_0 giving exactly

$$\int_0^{\beta_0} \beta\left(2 - \frac{1}{\sqrt{1-\beta^2}}\right) d\beta = \frac{1}{4} \tag{5}$$

Now we use *Sommerfeld*'s constant α as well as ßm, β_0 and β_g to develop simple relations between coupling constants like the world average value of the strong interaction coupling constant $\alpha_s(m_z)$. A first relation is

$$\alpha_s(m_z) \approx \frac{\beta_m^2}{\sqrt{3}} = \frac{\beta_m^2}{2\beta_0} = 0.117055 \tag{6}$$

One can formulate another numerical relation for the strong coupling constant $\alpha_s(m_z)$

$$\alpha_s(m_z) \approx \frac{2}{\sqrt{3}\pi^2} = \frac{1}{\pi^2 \cdot \beta_0} = 0.1169956 \tag{7}$$

Using this result, the galactic velocity β_g can be rewritten into [3]

$$|\beta_g| \approx \frac{\sqrt{3}}{2} \cdot \alpha \cdot \alpha_s = \beta_0 \cdot \alpha \cdot \alpha_s = 0.000739403 \tag{8}$$

or vice versa

$$\alpha_s(m_z) = \frac{|\beta_g|}{\beta_0} \cdot \frac{1}{\alpha} = 0.117005223 \tag{9}$$

This may serve as a determination equation for the strong coupling constant at the Z-boson mass scale, because the *Milky Way* maximum galactic rotation velocity is obviously accurate to eight decimal places [2]. This value for $\alpha_s(m_z)$ was precisely confirmed by measurement besides *QCD* analysis at *CERN* [3]:

$$\alpha_s(m_z) = 0.1170 \pm 0.0019 \tag{10}$$

with uncertainties $\pm 0.0014(fit) \pm 0.0007(model) \pm 0.0008(scale) \pm 0.0001(param)$.

As in the case of *Sommerfeld*'s constant [1] [8], one can formulate a reciprocity relation by connecting α_s with π. Both reciprocity relations may be compared in the following [9]

$$\pi \cdot |\beta_g| \approx \frac{1}{\pi \cdot \alpha^{-1}} \tag{11}$$

$$\pi \cdot \alpha_s \approx \frac{1}{\pi \cdot \beta_0} \tag{12}$$

3. Alternative Approaches for $\alpha_s(m_z)$

Mozafari recently published an interesting conjecture about the existence of fifth and subsequent forces beyond the known four ones (strong, electromagnetic, weak, and gravitational) [4]. His approach for the strong coupling constant α_s leads to the relation

$$\alpha_s(m_z) = \frac{\sqrt{\pi}}{10 \cdot \sqrt{ln(10)}} = 0.1168065 \tag{13}$$

Turning to results of the *IRT* theory and matter – dark matter coupling in disk galaxies [7], one can give a further relation for α_s

$$\alpha_s \approx \frac{1}{5} \cdot \frac{r_c}{r_s} = \frac{1}{5}\left(\frac{\ln(3)}{\ln(2)} - 1\right) = 0.1169925 \tag{14}$$

where r_c is the core radius of the galaxy, representing the distance from the galaxy center to the core where matter density is one half of the central matter density, and r_s is the half-velocity radius.

A golden mean based geometrical suggestion for the value of α_s used a simple reciprocity relation already applied in [12]. One can split this relation delivering a term that represents the inverse circumsphere radius $\frac{1}{r_{circ}} = \frac{2}{\sqrt{3+\varphi}}$ of a regular icosahedron of unit edge length

$$\frac{1}{5\sqrt{\frac{2}{\varphi} - \frac{\varphi}{2}}} = \frac{1}{5}\sqrt{\frac{\varphi}{2}} \cdot \frac{2}{\sqrt{3+\varphi}} = 0.116900 \tag{15}$$

Importantly, the structure of the electron was recently described as an icosahedral *Moebius* ball [13].

4. Gravitational Invariant α_g

The hierarchy of coupling constants could be continued with the given $|\beta_g|$ approach. However, first the previous work of *Pellis* [5] [6] and that of *Maruani* [10] should be quoted here. For α_g we have the known relation

$$\alpha_g = \frac{G \cdot m_e^2}{\hbar \cdot c} \tag{16}$$

where G is the gravitational constant, m_e the electron mass, $\bar{h}$ the reduced *Planck* constant, and c the speed of light. Some years ago, *Pellis* contributed an elaborated unification of coupling constants and dimensionless physical constants [5] [6]. In this work he linked, for instance, *Sommerfeld*'s constant α with the *Planck* length l_{Pl} and the electron radius r_e to the relation

$$\alpha_g = (\alpha \frac{l_{Pl}}{r_e})^2 \tag{17}$$

Maruani has derived an impressive reciprocity relation between gravitational force F_g, electromagnetic force F_e, and *Planck* force F_P [10]

$$\delta = a_g = \frac{1}{\alpha}\frac{F_e}{F_P} = \alpha \frac{F_g}{F_e} \tag{18}$$

The reader may study the original work of *Pellis* respectively *Maruani* to learn more about details of their work.

5. Reciprocity Relation between Cosmic Mass Constituents

Whereas we have completed the coupling constant formulas with reciprocity relations (11) respectively (18), there are further such relations, with which the present author has described, for instance, the fifth power of the golden mean based mass respectively energy constituents of the cosmos [14] [15] [16]. Such quantum gravity formulas were obtained by a probabilistic quantum entanglement calculation [17] [18].
Recasting the matter amount e_M respectively the dark matter amount e_{DM} giving

$$e_M = \frac{1}{10}5\varphi^5 = 0.04508, \qquad e_{DM} = \frac{1}{10}(5\varphi^5)^{-1} = 0.22180 \tag{19}$$

a reciprocity relation was confirmed between e_M and e_{DM} indicating a persuasive result for the pure dark energy e_{PD} [3]

$$e_{PD} = 1 - \frac{1}{10}\,(5\varphi^5 + (5\varphi^5)^{-1}) = 0.73311\ (73.31\%) \tag{20}$$

In an upcoming contribution we will link all these results to a common picture [19]. In this way, the unification of physics is steadily progessing, because the basis of our world is simpler than expected.

6. Conclusion

If we want to follow the path of a unification of physics, then a holistic approach always provides examples for the conjecture that things are simpler than assumed. The present work describes simple reciprocity relationships of coupling constants determining the strength of forces exerted in physical interactions. Such relationships exist for *Sommerfeld*'s constant α, the strong coupling constant $\alpha_s(m_z)$, and also for the gravitational coupling constant α_g. The present work based on the new structure of matter and space approach of *Guynn.* It underlines

the importance of his galactic difference rotation velocity β_g indicating ones more its impact on modern physics.

Conflicts of Interest

The author declares no conflict of interests regarding the publication of this paper.

References

[1] Sommerfeld, A. (1919) Atombau und Spektrallinien. Friedrich Vieweg & Sohn, Braunschweig.

[2] Guynn. P. (2018) Thomas precession is the basis for the structure of matter and space. *viXra*: 1810.0456, 1-27.

[3] Tumasyan, A. et al. (2022) Measurement and QCD analysis of double-diffential inclusive jet cross sections in proton-proton collisions at $\sqrt{s}$ = 13TeV. *Journal of High Energy Physics* **142**, 1-66. https://doi.org/10.1007/JHEP02(2022)142

[4] Mozafari, K. (2022) Unified Equation of Fundamental Forces' Coupling Values, and the Existence of Subsequent, Fifth and Other, Forces. *Journal of Applied Mathematics and Physics* **10**, 2499-2507.

[5] Pellis, S. (2022) Unity formulas for the coupling constants and the dimensionless physical constants. *ResearchGate*.

[6] Pellis, S. (2022) Dimensionless Unification of the Fundamental Interactions. *ResearchGate*, 1-49

[7] Suleiman, R. (2022) Dark Matter Is What Tells Matter How to Move and How Fast. *ResearchGate* 1-16.

[8] Otto, H. H. (2022) Comment to Guynn's Fine-Structure Constant Approach. *Journal of Applied Mathematics and Physics* **10**, 2796-2804.

[9] Otto, H. H. (2022) A Primer of Important Natural Numbers and Revisited Fundamental Physical Constants. *viXra*:2209.0170

[10] Maruani, J. (2018) The Dirac electron and elementary interactions: the gyromagnetic factor, fine-structure constant, and gravitational invariant-deviations from whole numbers. *Progress in Theoretical Chemistry and Physics* **31** https://doi.org/10.13140/RG.2.2.28134.29764

[11] Thomas, L. H. (1926) The motion of the spinning electron. *Nature* **117**, 514.

[12] Otto, H. H. (2021) Nuclear Fusion Research and Development Need New Relativistic Mass and Energy Corrections Given by the Information Relativity Theory. *Journal of Applied Mathematics and Physics* **10,** 1813-1836. https://doi.org/10.4236/jamp.2022.105125

[13] Otto, H. H. (2022) Golden Quartic Polynomial and Moebius-Ball Electron. *Journal of Applied Mathematics and Physics*, Volume **10,** 1785-1812.

[14] Otto, H. H. (2018) Reciprocity Relation between the Mass Constituents of the Universe and Hardy's Quantum Entanglement Probability. *World Journal of Condensed Matter Physics* **8**, 30-35.

[15] Otto, H. H. (2020) Reciprocity as an Ever-Present Dual Property of Everything. *Journal of Modern Physics* **11**, 98-121.

[16] Otto, H. H. (2020) Phase Transitions Governed by the Fifth Power of the Golden Mean and Beyond. *World Journal of Condensed Matter Physics* **10**, 135-159.

[17] El Naschie, M. S. (2004) A Review of E-Infinity and the Mass Spectrum of High Energy Particle Physics. *Chaos, Solitons & Fractals* **19**, 209-236.

[18] El Naschie, M. S. (2017) Elements of a New Set Theory Based Quantum Mechanics with Application in High Quantum Physics and Cosmology. *International Journal of High Energy Physics* **4**, 65-74.
[19] Otto, H. H. (2022) Golden Ratio Signature Behind *Guynn*'s Matter/Space Approach. *Journal of Applied Mathematics and Physics* **10**, to be published.