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# Alternative Reflections on "Titius-Bode Law

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## Abstract

**For more than 300 years there has been evidence for relationships between the radii of planetary orbits in the solar system, known since about 1766 as the TitiusBode Law, (TBL). According to this law, the radii increase exponentially in equidistant steps. Due to recent findings, substantial modifications of this law seem to be appropriate:**

- **Not the radii, but the period lengths are correlated.**
- **Resonant ratios of the period durations determine the behavior.**
- **In more and more exosolar planetary systems and planet-moon systems this behavior is registered.**
- **Which unknown coupling mechanism causes this resonance?**

**Neither in its original form, nor in its "generalized" form, TBL can be explained on the basis of classical gravitational theories. On the basis of ARG, TBL may very well be expected, with all the details given above. Thus TBL, older than "Mach's Priciple" and "Foucault Pendulum", may well be counted among the effects which are particularly well suited as a litmus test for all theories of gravitation.**
***Keywords: Exosolar; Planetary orbits; Solar System; Lunar***

## Introduction

For more than 300 years there has been evidence for relations between the radii of the planetary orbits in the solar system. This is documented at Wikipedia with works of David Gregory from the years 1702 and 1715 [1]. A descriptive mathematical formula is dated 1766 and is known today as the Titius-Bode Law. More recently, due to increasingly better observational methods, there is even evidence that such a relationship exists in extrasolar planetary systems, and even in the lunar systems around planets [2]. But even today there is no derivation of these relations on the basis of classical gravitational theories. And there is also no known basis for such a derivation, as one can read in the German version of Wikipedia: "No physical mechanism is known so far which produces a certain series of distances of the planets". And just because such a mechanism is not known until today, a derivation of the TBL relation on the basis of long known classical gravitational theories can hardly be expected in the near future [3]. The first hints in 1702 on correlations of planetary orbits in our solar system appeared only 15 years after Newton had published his law of gravitation in 1687. Considering the tremendous importance Newton's law still has today, one should probably wonder what fundamental importance the TBL relationship would have today if only there had been a rationale for it.

Just in recent time the indications increase that probably considerable corrections to TBL are appropriate:

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- Not the radii of the planetary orbits, but the periods are correlated.
- Not logarithmically equidistant, but resonant ratios of the periods determine the
- behavior.
- In more and more exosolar planetary systems and lunar systems this behavior is
- observed.
- Which unknown coupling mechanism causes this resonance?

## Literature Review

On these points, we will specifically cite only two recent papers that provide detailed information: Bovaird and Lineweaver on Exoplanetary Systems in 2013 and Aschwanden in 2017 [4]. Both papers include the note that TBL is classically "not fully" or "poorly" understood. there is information about resonant ratios of planetary periodicities under "Titius-BodeReihe". The new knowledge about these harmonic resonances can be easily derived on the basis of the results of modern observational methods. But in all three papers there is no explanation of which coupling effect necessary for such resonances is responsible for it. To explain this problem, an example of harmonic resonances in coupled systems is described in the following section.

**Harmonic resonances of coupled systems**

Instead of analytical calculations or numerical simulations on the topic of this section, a video of a real experiment shall be considered. On youtube.org many videos exist under the term "Barton`s Pendulum", of which only one, will be discussed here [5]. Several similar thread pendulums, slightly different in length, hang at equal distances from a horizontally stretched string. After excitation of the system on another, heavier pendulum, only one of the other pendulums shows a clear resonance: the pendulum of the same length in a 1:1 resonance. Responsible for this is obviously the coupling of all pendulums via the common horizontal suspension cord. Is there a comparable coupling as cause for TBL?

**Classical gravitation theories and TBL**

Already in an earlier own work on "Speed of Gravity" it was discussed that on the basis of classical theories the stability of a planetary orbit can be possible only with a propagation speed of the gravitational forces far higher than the speed of light c. Laplace mentioned already in 1805 a value of $7\times10^{6}\times c$, the astrophysicist T. von Flandern in 1998 even a value higher than c by a factor of $2\times10^{10}$. For a system like the earth and sun an aberration of 20 arc seconds is calculated. Every other planet is subject to a different aberration adapted to its orbit [6]. There is no coupling between the orbits of the planets. The classical theories of gravity have not only a problem with the "Speed of Gravity", but also with a missing coupling as a cause for the harmonic resonance of the periods of the planetary orbits.

**Considerations to TBL on the basis of the ARG**

Instead of analytical calculations or numerical simulations, only plausible causes for the existence of TBL can be considered here. As in a previous paper on "Speed of Gravity" a planetary system with the following data will be considered here: A star of mass M and a planet of mass m1 and an observer are in an (x,y,z) coordinate system in the (x,y) plane. The zero point is the center of gravity of M and m1. The observer is at position $(x_0,0)$, the planet at position $(0,y_1)$, $(y_1<x_0)$, on its circular orbit with radius $R_1=y_1$ around the zero point, and the star thus at position $(0,-y_1\times m_1/M)$. The observer feels very different attractive forces of M and $m_1$ in

direction to the zero point, but no component transverse to it, because the effect from the product of mass and aberration of both bodies balance to zero.When the planet rotates around the star, the observer registers its accelerating and decelerating forces along the orbit caused by its aberration. But after one full orbit of the planet its effect has compensated to zero. Likewise, the accelerating or decelerating effect caused by the star's aberration on the planet's orbital velocity compensates to zero after one full period of the planet's orbit, ensuring a stable orbit for a long time. Neither the mass of the planet nor its orbital radius play a role here. However, the value for the radius R1 is coupled to the value of the period T1. Thus, it can be explained that TBL versions have been formulated with both periods and radii of the planets as parameters. For another planet the above considerations are valid as well. With an orbital radius $R_2 > R_1$ a higher period T2 results. A harmonic resonance is to be expected, if at the same time T both planets have passed full n1 respectively n2 periods: $T = n_1 \times T_1 = n_2 \times T_2$. Here, the most effective resonance effect can be expected at the lowest possible times, i.e. low values of n1 and n2. This corresponds also according to the observations with values of $n_1/n_2$=(3: 2),(5:3),(2:1),(5:2),(3:1).

**TBL in planetary moon systems**

Of course, the above considerations apply not only to the planetary system around our Sun, but also to such systems around any other star. Since the absolute values of the central mass do not matter, even if a central body with lighter mass than a star gravitationally binds even lighter bodies to circular orbits, the same resonance behavior is to be expected. So, for example, for a system of lighter moons around a heavier planet. And just such systems could be discovered recently, as documented.

**Coupling system for harmonic resonances**

Systems with harmonic resonances are obviously stable systems. But what causes these resonances? The often used term "Harmonic Resonances of Coupled Systems" gives a hint: a coupling mechanism is required to produce these resonances. As mentioned in section 3, on the basis of classical gravitational theories such a mechanism could not be found until today. On the basis of the ARG, however, such a mechanism very well exists. Each planet in the solar system provides its contribution to the aberration of the sun. Its total value determines the influence on each planetary orbit, and not the contribution of the individual planet. This coupling of the planetary orbits via the aberration of the sun can be compared with the coupling at "Barton`s Pendulum" in section 2. by the common horizontal suspension cord [7].

## Conclusion

For the preparation of this paper, one fortunate circumstance is of paramount importance: Recent findings just in the last approximately 10 years on this phenomenon known for more than 3 centuries. The classical version of the TBL with the increase of the orbit radii in logarithmically equidistant steps is not only classically not explainable. Even on the basis of the ARG no plausible solution is recognizable. Therefore, this effect is not yet mentioned in the update to the ARG in 2015. An explanation of TBL would have fitted very well to the explanations of the less long known effects with the names of well-known astrophysicists: Foucault Pendulum and Mach's Principle, which are both also classically hardly explainable**.**

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