TITLE: THE TITUS-BODE LAW AND THE POSSIBILITY OF RECENT LARGE
SCALE EVOLUTION IN THE SOLAR SYSTEM

AUTHOR(S): Michael Martin Nieto

SUBMITTED TO: Invited paper to be given at the symposium on
"Velikovsky and the Recent History of the Solar
System".

By acceptance of this article for publication, the publisher recognizes the Government's (license) rights in any copyright and the Government and its authorized representatives have unrestricted right to reproduce in whole or in part said article under any copyright secured by the publisher.

The Los Alamos Scientific Laboratory requests that the publisher identify this article as work performed under the auspices of the U. S. Atomic Energy Commission.

MASTER

los alamos
scientific laboratory
of the University of California
LOS ALAMOS, NEW MEXICO 87544

NOTICE

This report was prepared as an account of work sponsored by the United States Government. Neither the United States nor the United States Atomic Energy Commission, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness or usefulness of any information, apparatus, product or process disclosed, or represents that its use would not infringe privately owned rights.

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

GG

THE TITIUS-BODE LAW AND THE POSSIBILITY OF RECENT LARGE SCALE EVOLUTION IN
THE SOLAR SYSTEM

Michael Martin Nieto

Los Alamos Scientific Laboratory, University of California

Los Alamos, New Mexico 87544

ABSTRACT

I point out that it is by no means clear that the Titius-Bode Law of Planetary Distances is indeed a "Law" , even though there are enticing indications. Given this, I argue that if one assumes that the Law is a "Law" and that the planets obey it, then this argues against recent large scale evolution in the solar system. Put another way: one can believe in the Titius-Bode Law or in recent large scale evolution or in neither of them. But it appears difficult to believe in both of them.

I have been asked to talk today on if the Titius-Bode Law of Planetary Distances might shed any light on whether or not there has been any recent large scale evolution in the composition of the solar system. I will aim to stick directly to this question--even though it may not be a question. Let me explain that inigmatic statement.

Before we can know if the subject of this talk means anything, we have to know if the "Titius-Bode Law of Planetary Distances" is indeed a "Law". If it is not a "Law", then clearly the "Law" says nothing about anything, we can skip the rest of this talk, drop the discussion, and concentrate on something useful, like Watergate.

Whether the Titius-Bode Law is a Law, is only one aspect of this topic which has been surrounded by controversy ever since the Law was discovered by Titius in 1766. An example is the way in which Bode eventually received most of the credit after he stole the idea in 1772.

In modern notation, the original Law can be stated as, the distance to the n th planet is

$$R_n = (4) + (3)(2)^n, \quad n = -\infty, 0, 1, 2, \dots \quad (1)$$

where $n = -\infty$ for Mercury, 0 for Venus, 1 for Earth, etc. The Law is normalized to 10 for the Earth. It "predicted" the discovery of the asteroid belts, Uranus, and was used as the basis for computations to discover Neptune, even though it failed badly for Neptune and Pluto. (See Table I).

Planet	n	Distance	Titius-Bode Law
Mercury	$-\infty$	3.9	4
Venus	0	7.2	7
Earth	1	10.0	10
Mars	2	15.2	16
(Ceres)	3	(27.7)	28
Jupiter	4	52.0	52
Saturn	5	95.5	100
(Uranus)	6	(192.0)	196
(Neptune)	7	(300.9)	388
(Pluto)	8	(395)	772

TABLE I.

A comparison of the original Titius-Bode Law with observation. The planets in parentheses were not known in 1766.

The question thus arises if the early successes of the Law were just coincidences, the true worth of the Law being the "failures" for Neptune and Pluto.

As I emphasized in my recent book on the subject,¹ before one can begin to answer that question one must realize that Eq. (1) with its ad hoc first term should not be thought of as the only possible parametrization, but only as a first guess. In fact, if one looks at the actual distances of the planets from the Sun and searches for the best pure geometric progression fit, one finds that the geometric progression

$$R_n = 3.34 (1.73)^n, \quad n = 0, 1, 2, \dots \quad (2)$$

gives the fit shown in Fig. 1. The actual distances oscillate about the pure

FIG. 1

A semi-log plot of distance in astronomical units vs. ordinal number, for the planets. The straight line fit has a slope of 1.7275.

geometric progression, so that one can represent the "true" curve as

$$R_n = 3.34 (1.73)^n f(n) , \quad (3)$$

where $f(n)$ is a function which oscillates about 1. (Similar distributions can be made for the satellite systems of the major planets.)

From all this, can we decide whether or not the "Law" is a "Law"?

The answer, unfortunately, is "No." The "predictions" of the Law are tantalizingly close to the observations (especially when given the early history of the Law as having predicted Uranus and the asteroids). But they are not right on top of the planets. Further, by the time you add in the periodic oscillation about the geometric progression one is left with "intuition" as to the over all validity, and "intuition" presently goes both ways. One needs a theory that predicts (in whatever mathematical format) both the progression and the oscillations about it.

My own feelings are¹ that if the Law is a "Law", then the split into the geometric progression and the oscillation come from two separate processes. The geometric progression, I feel, would come from the early history of the solar system, when the material that would eventually form the planets, was in the form of a rotating disk of gas and dust around the proto-Sun. Then, as in a theory like Hoyle's, energy and angular momentum would be transferred to the disk by the "magnetic brake" mechanism. This mechanism is possible because the whole system would be a plasma, so that a magnetic coupling could be made between the rapidly rotating proto-Sun and the disk. This would slow down the Sun and speed up the disk and make it larger.

In such a system, turbulence would be set up. Further, it is known that such systems can set up regular turbulence patterns, which in turn would lead to preferred condensation at the edges of the patterns. This, as explained elsewhere,¹ could in principle set up the geometric progression.

The point I have made¹ is that I do not see how point gravitational and/or tidal interactions either as or after the planets were formed could set up the geometric progression. The problem there is that such interactions tend to set up resonances and/or stable patterns that have preferred or

antipreferred distances which involve ratios of periods of orbits--not a geometric progression of 1.73. (Examples of this phenomena are the rings of Saturn and Mimas or the Trojan asteroids and Jupiter.)

The oscillation about the geometric progression represents, I believe, a point-gravitational or tidal evolution starting from after the planets were formed, and slowly reaching equilibrium. Calculations that have been performed on the time scales of such evolutions all seem to indicate that this evolution would have been completed long ago.

Thus, always keeping in mind that we don't know if the Titius-Bode Law is a Law, if one can believe in the Law then this would indicate that there has been no large scale evolution in the composition of the solar system in the recent past.

Now let me come to two discussions of the Titius-Bode Law which would take exception with these conclusions:

The first was put forward by Bailey,² just before the first Apollo landing on the Moon, in 1969. It raised an old question which dates back centuries, the idea of a missing planet in the interior of the solar system. Bailey proposed that perhaps the moon is a lost planet "Luna", which perhaps once existed in an unstable orbit between Mercury and Venus, and which was captured by the Earth. Bailey did not date this process, only to state that capture should have occurred in the last half the age of the solar system.

The connection with the Titius-Bode Law comes about by considering the original form, Eq. (1) and then figuring out what changes in Mercury's orbit would have occurred by the transfer and capture. Bailey fits the original form with the "original location" of Luna and the "original location" of Mercury. The problems are what I consider to be the ad hoc nature of the first term in the Titius-Bode Law, and the detailed problems of how and when

capture occurred. If one were to choose, one could like the capture to have been recent, but one just cannot show it.

The other theory involving the Titius-Bode Law was put forward recently by Roy Ovenden.³ He placed in a new perspective the idea of Olbers that the asteroid belts are the remnants of an ancient planet which was disrupted, for some reason. Ovenden tried to explain the Titius-Bode Law by looking at the gravitational evolution of the solar system from a set of initial conditions to its present configuration. He found that he could do that if he assumed that there used to be a planet of 90 earth masses where the asteroid belts now exist, and that 16 million years ago the planet, for some unexplained reason, disrupted, leaving the remaining system to evolve gravitationally to the present configuration.

The critical point, of course, is what could have caused the explosion, and left the asteroid belts with only 0.1 solar masses, all essentially in the plane of the ecliptic? Napier and Dodd⁴ looked into this question and, given the energy and angular momentum constraints, decided that the event was almost impossible to reconstruct using gravitational, nuclear, or chemical interactions.

So there you have it. The Titius-Bode Law, since its validity as a physical law is by no means proved, cannot give you a definite answer as to implications for possible recent large scale evolution of the solar system. But I think you can make the statement that if you argue that the Law is indeed a Law and that the solar system obeys this Law, then it bespeaks against recent large scale evolution.

Let me put it this way: If God were to come and tell us that the Law is a Law and that the planets obey it, then the present configuration of the planets is something which "had to come about". On the other hand, since

recent large scale changes in the configuration of the solar system would have to be a random or accidental event (something like just happening to be under a rock when it fell), how could this chance happening have finally brought the planets into agreement with a Law which they already were supposed to obey independently?

To sum up, I think you can believe in the Titius-Bode Law, or recent large scale evolution, or neither of them. But I don't think you can believe in both of them.

References

* Work performed under the auspices of the U. S. Atomic Energy Commission.

1. M. M. Nieto, The Titius-Bode Law of Planetary Distances: Its History and Theory (Pergamon Press, Oxford, 1972).
2. J. Martyn Bailey, "The Moon may be a Former Planet", Nature 223, 251-253 (1969).
3. M. W. Ovenden, "Bode's Law and the Missing Planet", Nature 239, 508-509 (1972).
4. W. McD. Napier and R. J. Dodd, "The Missing Planet", Nature 242, 250-251 (1973).