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A VARIANT OF THE TITIUS-BODE LAW

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RESUMEN

En el estudio de la distribución geométrica de los planetas invariablemente se menciona la ley de Titius Bode como un intento de clasificar *grosso modo* sus distancias heliocétricas mediante una sucesión de números enteros. Con el descubrimiento de un gran número de objetos planetarios ahora se sustenta, en cierta medida, el principio básico de dicha ley al través de la determinación de más elementos orbitales. Abordamos brevemente una clasificación de los parámetros orbitales utilizando la constante de proporcionalidad de Kepler y discutimos el problema de la aplicación de la ley TB a sistemas extrasolares. También analizamos las funciones propuestas por diversos autores las cuales reproducen las distancias heliocéntricas de los planetas, y efectuamos una comparación con la variante a la ley Titius Bode que proponemos aquí.

ABSTRACT

The study of the geometric distribution of the planets invariably mentions the Titius Bode law as an attempt to classify their heliocentric distances through a succession of integer numbers. With the discovery of more planetary objects better support is given to the basic principle of the law through their orbital parameters. We briefly refer to a classification of orbital parameters using Kepler's proportionality parameter and discuss the problem of applying the TB Law to extrasolar systems. We also review work by various authors who have proposed functions which reproduce with some degree of certainty the planetary heliocentric distances, and we compare them to our variant of the Titius-Bode Law.

Key Words: planets and satellites: formation — planets and satellites: general — solar system: general

1. INTRODUCTION

In the late eighteenth century Johann Daniel Tietz proposed a numerical sequence with which he tried to reproduce the heliocentric distances of the planets, and which was included in the compendium *Contemplation of the Nature* written by Charles Bonnet in 1764. In 1772 the famous German astronomer Johann Bode included Titius' ideas (*Latin conversion of Tietz*) in his texts on astronomy. According to Titius' scheme, the mathematical formulation is written in terms of the parameter N given by the integers 0, 3, 6, 12, 24, 48, 96 and 192 according to the order of the planets Mercury, Venus, Earth, Mars, Jupiter, Saturn and Uranus.

In terms of powers of two (2^n), the orbital parameters are determined by the equation $R_n = 4 + 3 \cdot 2^n$ where $N = -\infty, 0, 1, 2, 3, ...$, also in the order of the planets (Nieto 1970) or as proposed most recently $R_n = 0.4 + 0.3 \cdot 2^{n-2}$ with $n = 1, 2, 3, ...$ (Holton & Brush 2001). An interesting historical analysis of the progression was presented by Jaki (1972). Many discussions have arisen around the Titius-Bode model like those of Ovenden (1972, 1975) who analyzed the evolution of the circular and elliptical orbits and found that a Titius-Bode planetary distribution is a distribution of least interaction action between the planets, as well as how they evolve numerically into a resonant system from arbitrary initial conditions of position and velocity. Nieto (1970, 1975) made a detailed study of the Titius-Bode Law, and Horedt, Pop, & Ruck (1977) described a numerical application of the generalized Titius law for more than nine

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