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Verification of Titius-Bode Law in exoplanetarian system and determination of functions that describes star-planets distances

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Abstract. The Titius-Bode Law can determinate the star-planets distances of the Solar System planets with precision. However, this law does not work in exoplanetiarian systems. This project discovered that using equations of degrees 2 to 6 is possible to determinate the star-planets distances with precision in relation with the data disclosed by NASA Exoplanet Archive

Resumo. A Lei de Titius-Bode consegue determinas as distâncias planetas-estrela dos planetas do Sistema Solar com precisão. Entretando, tal lei não funciona em sistemas exoplanetários. Este projeto descobriu que, utilizando equações de graus 2 até 6, é possível determinar as distâncias planetas-estrela com precisão em relação aos dados divulgados pela NASA Exoplanet Archive

Keywords. Planets and satellites: detection – History and philosophy of astronomy – History of Astronomy

1. Introduction

In 1766, Johan Daniel Tietz began calculations to determine the distances between planets and Sun (From Mercury to Uranus). In 1766, Johann Bode improved the calculations that become known as Titius-Bode Law. Compared to the current data, the formula, described by $d_n=4+3\cdot2^n$, can determine the star-planets distances, without exceeding 5.5% of the actual values. However, from the planet Neptune, the calculated values diverge more than 29.08%.

2. Methodology

The initial objective of this project was to verify if the Titius-Bode Law applies to exoplanetary systems with more than three planets. Fifteen exoplanetary systems were selected. As the formula, even when altered to adapt itself to the exoplanetarian system, did not obtain accurate results in the selected sample, we started to describe the star-planets distances based on linear and non-linear regression, plotted in scatter plots. After the tests, a low margin of error was obtained in linear systems, however, a high margin of error was obtained in non-linear systems. Then, other formulas were created based on polynomial calculations of degrees 2 to 6 to adquire more precise results to non-linear systems.

3. Conclusion

It was found that equations of second and third degree have the most accurate results compared to degrees 3 to 6. In addition, compared with the NASA Exoplanet Archive, the calculations presented a smaller margin of error or equal to the data disclosed by that institution. The exception occurred with thirds and fourths planets, where the error reaches more than 8% of the reveled by NASA. However, due to the diameter of the planets, even the thirds and fourths planets are found using the equations of each system. About the firsts and seconds planets, it is not possible create equations for them due to insufficient number of elements to assemble a chart. As a result, with the project effectiveness it is possible to determine star-planet distances regardless of the exoplanetarian system.

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