Mass – Radius Relationship in Extrasolar Planets

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Abstract

The increasing number of Extrasolar planets observed in the last years makes important to define, as soon as possible, a mass – radius relationship, and so, we adjusted an planetary constitution independent experimental equation derived from [1]

$$R_p \propto M^{\beta} \quad (1)$$

Using the latest database [2] of Extrasolar planets, a bi-logarithmic graphic (Fig 1) was plotted that represents the mass - radius relationship where we adjusted a polynomial equation, which better suited the sample of Extrasolar planets at current time.

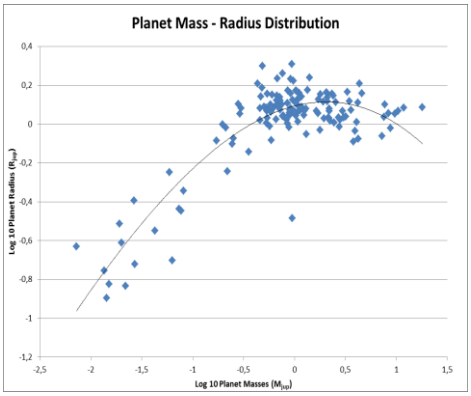

Figure 1 – *Mass–Radius Relatonship for Extrasolar planets in the logarithmic plane where an 3º order polynomial equation (2) was adjusted. The values are expressed in Jupiter masses and radius*

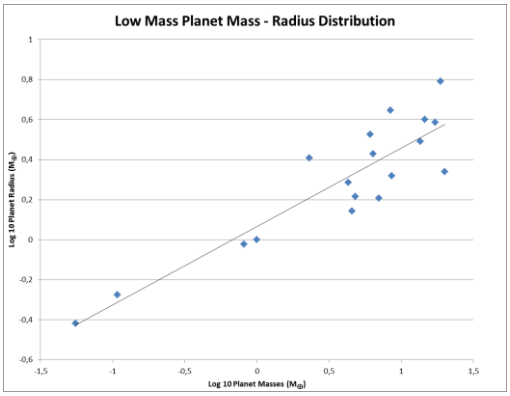

Figure 2 – *Mass-Radius Relationship for low mass Extrasolar planets, where a linear equation was adjusted. The values are expressed in Earth masses and radius*

The adjusted equation was (Fig.1)

$$log_{10}R = a1(log_{10}M)^3 + a2(log_{10}M)^2 + a3log_{10}M + a4 \quad (2)$$

Where

a1=0,0186; a2=0,2071; a3=0,1346; a4=0,0931 (3)

This is a general experimental equation, that disregards the composition of the planets, but we are further interested in the low mass planets, as low as 20 Earth masses, so a new bi-logarithmic graphic was plotted representing only this planets (Fig. 2). Then a linear equation was adjusted to this smaller sample of planets.

$$log_{10}R = 0{,}3916(log_{10}M) + 0{,}0669 \quad (4)$$

This after inversion gives us

$$R\ \alpha\ M^{0.391} \quad (5)$$

The equation (2) adapts well to the measured values as seen in (Figure 1), and is accurate predicting masses and radius giving us a good experimental relation for all Extrasolar planets, not looking at their constitution. But as we are more interested in low mass planets, increasing in number every day, the equation (5), that takes us back to the theoretical equation(1), is an accurate equation to determine masses and radius to this planets, as its very close experimental approach to the already known theoretical relation[1].

References

[1] Valencia, D., O'Connell, R. J., & Sasselov, D. D. 2006, Icarus, 181, 545
[2] Enc. Plan. Extrassolares - http://exoplanet.eu/index.php
[3]Guillot, Tristan, Annu. Rev. Earth Planet. Sci. 2005. 33:493–530