The Role of Powers of 2 in Physics

The purpose of this article is to highlight the role of powers of 2 in physics.

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1. Formulas Containing Powers of 2

The following list, which is not exhaustive, contains six equations based on powers of 2. Appendix 1 contains the nomenclature used in this paper.

1. The Titus-Bode Law

The Tutus-Bode Law predicts the distances of the planets from the sun in astronomical units.

Summary

<table>
<thead>
<tr>
<th>Discovered by</th>
<th>Gregory, Wolff, Titus and Bode [1]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year of discovery</td>
<td>1715?</td>
</tr>
<tr>
<td>Physical proof</td>
<td>Not known</td>
</tr>
</tbody>
</table>

Formulas

\[ a = 0.3 \times 2^n + 0.4 \]  
\[ a = 0.3 \times 2^{n-2} + 0.4 \]  

Author's version (2015):

\[ a = 0.3 \times 2^n + 0.4 - 0.1 \times 2^{n-5} + 0.003 \times n^4 \]  

Note

The relative error of versions 1 and 2 (both formulas are equivalent) is less than 20% for 7 planets, while the relative error of version 3 is less than 20% for 8 planets. The following table shows the data produced by each version. The relative error corresponding to the data shown in red is greater than 20%.

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Table: Predicted values of $a$ from the Titus-Bode's Law and from the author's corrected law (version 3)

<table>
<thead>
<tr>
<th>Planet</th>
<th>$n$ formula (versions 1 and 3)</th>
<th>$n$ formula (version 2)</th>
<th>Predicted Distance (AU) (version 1 and 2)</th>
<th>Predicted Distance (AU) (version 3)</th>
<th>Actual Average Distance (AU)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mercury</td>
<td>-1</td>
<td>1</td>
<td>0.55</td>
<td>0.55</td>
<td>0.39</td>
</tr>
<tr>
<td>Venus</td>
<td>0</td>
<td>2</td>
<td>0.7</td>
<td>0.70</td>
<td>0.73</td>
</tr>
<tr>
<td>Earth</td>
<td>1</td>
<td>3</td>
<td>1.0</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Mars</td>
<td>2</td>
<td>4</td>
<td>1.6</td>
<td>1.61</td>
<td>1.93</td>
</tr>
<tr>
<td>(Ceres)</td>
<td>3</td>
<td>5</td>
<td>2.8</td>
<td>2.87</td>
<td>2.77</td>
</tr>
<tr>
<td>Jupiter</td>
<td>4</td>
<td>6</td>
<td>5.2</td>
<td>5.36</td>
<td>5.22</td>
</tr>
<tr>
<td>Saturn</td>
<td>5</td>
<td>7</td>
<td>10.0</td>
<td>9.98</td>
<td>9.57</td>
</tr>
<tr>
<td>Uranus</td>
<td>6</td>
<td>8</td>
<td>19.6</td>
<td>18.3</td>
<td>19.26</td>
</tr>
<tr>
<td>Neptune</td>
<td>7</td>
<td>9</td>
<td>38.8</td>
<td>31.15</td>
<td>30.17</td>
</tr>
<tr>
<td>Pluto</td>
<td>8</td>
<td>10</td>
<td>77.2</td>
<td>50.69</td>
<td>39.60</td>
</tr>
</tbody>
</table>

2. Formula for the Electron spin g-Factor

The formula for the electron spin g-factor predicts the value of the so called electron spin g-factor, at least, to 12 decimal places and is based on four powers of the fine-structure constant inside a 4096 root, which is a power of 2: $2^{12} = 4096$

**Summary**

<table>
<thead>
<tr>
<th>Discovered by</th>
<th>The author [2]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year of discovery</td>
<td>2012</td>
</tr>
<tr>
<td>Physical proof</td>
<td>Not known</td>
</tr>
</tbody>
</table>

**Formula**

$$ g_e = 2 \left( 2^{12} \left( \frac{1}{\alpha^{0.09}} - \frac{1}{\alpha^{0.1}} + \frac{1}{\alpha^{0.03}} + 0.00002 \right) \right) $$

3. Formula for the Fine-Structure Constant Based on the Number pi and Powers of 2

This formula predicts the value of the fine-structure constant. The accuracy of the formula is 10 decimal places.
4. Formula for the Fine-Structure Constant Based on the Number pi, Powers of 2 and Powers of 10

This formula predicts the value of the fine-structure constant. The accuracy of the formula is 6 decimal places.

\[ \alpha = \frac{1}{\left(2^4 + 2^{-6} + 2^{-8} + 2^{-10} + 2^{-14} + 2^{-16} + 2^{-17} + 2^{-18} + 2^{-22}\right)\frac{15}{\pi}} \]

5. The Lepto-baryonic Formula for the Fine-Structure Constant

This formula predicts the value of the fine-structure constant.

\[ \alpha = \frac{2^{10} - 10^3}{\left(\pi + 3\right)2^{10} - 3 \times 10^3} \]

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6. The Lepto-Baryonic Formula for the Mean Lifetime of the Proton

This formula predicts the value of the mean lifetime of the proton. The predicted value is $7.1236 \times 10^{34}$ years

**Summary**

<table>
<thead>
<tr>
<th>Discovered by</th>
<th>The author [5]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year of discovery</td>
<td>2011-2015</td>
</tr>
<tr>
<td>Physical proof</td>
<td>Not known</td>
</tr>
</tbody>
</table>

**Formula**

$$\tau_p \approx 12 \times 2^{216} \left( \frac{m_n - m_p}{m_e - m_l} \right) \frac{\hbar}{m_p c^2}$$

2. Conclusions

The Titus-Bode law has defied physical proof for over 300 years. A modified and more accurate version of this law could, one day, be derived from a new quantum gravity theory. Should the new version prove correct, the status of the Bode's law would change from numeric to approximate law of reality.

**Appendix 1**

**Nomenclature**

The following are the symbols used in this paper

**Titus-Bode's Law**

- $a = \text{mean predicted distance of the planet from the sun [major semi axis in astronomical units (AU)]}$
- $n = \text{integer (this is in fact a gravitational quantum number)}$
- $\text{AU} = \text{astronomical units}$

**Formula for the Electron spin g-Factor**

- $\alpha = \text{fine structure constant, electromagnetic coupling constant, atomic structure constant}$
- $g_e = \text{electron spin g-factor}$
Formula for the Fine-Structure Constant Based on the Number \( \pi \) and Powers of 2 and
Formula for the Fine-Structure Constant Based on the Number \( \pi \), Powers of 2 and Powers of 10

\[ \alpha = \text{fine structure constant, electromagnetic coupling constant, atomic structure constant} \]

The Lepto-baryonic Formula for the Fine-Structure Constant

\[ \alpha = \text{fine structure constant, electromagnetic coupling constant, atomic structure constant} \]
\[ m_e = \text{electron rest mass} \]
\[ m_i = \text{electrino rest mass} \]
\[ m_n = \text{neutron rest mass} \]
\[ m_p = \text{proton rest mass} \]

The Lepto-Baryonic Formula for the Mean Lifetime of the Proton

\[ \hbar = \text{reduced Planck's constant} \]
\[ c = \text{speed of light in vacuum} \]
\[ \tau_p = \text{mean lifetime of the proton} \]

REFERENCES


