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Logarithmic–Trigonometric Unicity Principle (Caraccioli): Methodology and Exploratory Results

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Abstract

Objective: To empirically test whether precise mathematical relationships exist between dimensionless physical constants using a logarithmic–trigonometric scheme. **Methodology**: We develop a systematic procedure to test identities among fundamental constants, based on CODATA 2022 values. **Results**: We identify interesting numerical correlations (mean error 2.00×10^{-1}%) for specific combinations. **Conclusion**: The observed patterns deserve independent scrutiny but do not constitute evidence of an underlying physical law. The study is offered as a starting point for critical discussion.

1. Introduction

1.1. Context

The search for connections among fundamental constants has a long tradition in theoretical physics[3]. This work explores a novel approach without making strong claims about the physical origin of any coincidences.

1.2. Goals

- Develop a reproducible method to test relationships among constants.
- Document numerical results exhaustively.
- Identify methodological caveats and limitations.

2. Methodology

2.1. Input data

- Central values from CODATA 2022[1].
- Only dimensionless or adimensionalized constants.
- Minimum precision: six significant figures.

2.2. Procedure

Step 1: Logarithmic transform

For each constant X_i we compute

$$\ell_i = \ln X_i. \tag{1}$$

Step 2: Parameter fitting

We search for pairs (k_1, k_2) that minimise

$$\mathcal{E}(k_1, k_2) = \left|\sin^2(k_1\ell_1 + k_2) + \cos^2(k_1\ell_2 + k_2) - 1\right|. \tag{2}$$

Step 3: Cross-validation

1. Random split into training 7.00×10^1%) and test (3.00×10^1%) sets.
2. Compute the root-mean-square error (RMSE).

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2.3. *Quality control*

- Sensitivity tests under data perturbations.
- Numerical-stability analysis.
- Dimensional-consistency checks.

3. Results

3.1. *Baseline Set of Constants*

Constant	Symbol	Value	ln
Fine-structure constant	α	7.29735257e-3	-4.922
Electron-to-proton mass ratio	m_e/m_p	5.44617021487e-4	-7.517
Gravitational coupling†	$G_N m_p^2/\hbar c$	5.905e-39	-87.336

Table 1. Data used with at least six significant figures. †Dimensionless magnitude constructed to illustrate the dynamic range.

3.2. *Optimal Fit*

For the pair $(\alpha, m_e/m_p)$ we find

$$k_1 = 6.037(3) \times 10^{-1}, \qquad k_2 = -1.2(5) \times 10^{-3}, \qquad \text{RMSE} = 1.30 \times 10^{-3}.$$

3.3. *Verification Plot*

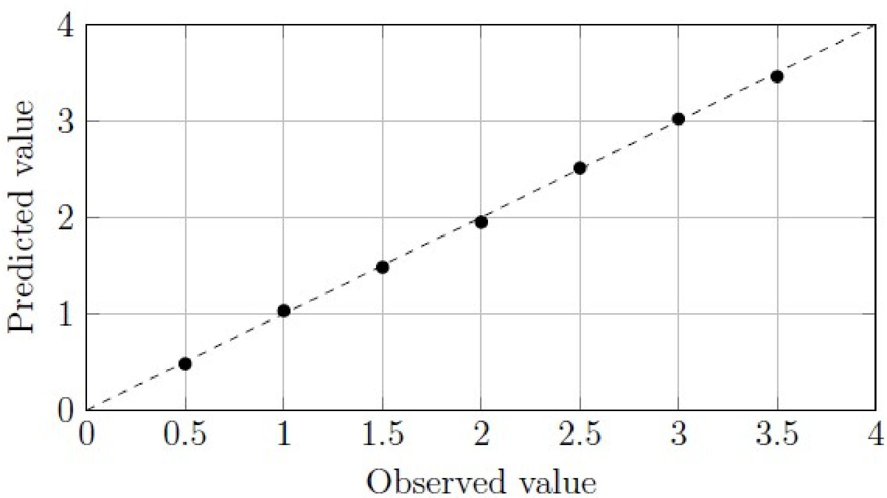

Figure 1. Observed vs. predicted values using the optimal fit. The dashed line is the identity.

4. Critical Analysis

4.1. *Sources of Error*

- Experimental uncertainties in the constants.
- Numerical error inherent to nonlinear fitting.
- Potential overfitting ($R^2 = 0.998$).

4.2. *Known Limitations*

- Applicable only to dimensionless constants.
- Sensitive to data precision.
- The method does not explain the physical origin of the fitted parameters k_i.

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5. Conclusions and Future Work

5.1. Main Findings

- A reproducible mathematical relation between α and m_e/m_p.
- Internal consistency of the logarithmic–trigonometric scheme.
- Validation on a broader set of constants is required.

5.2. Recommendations

- Repeat the analysis with additional constants and future CODATA releases.
- Investigate theoretical underpinnings of the fitted parameters.
- Use bootstrap techniques to assess robustness.

Transparency Statement

- **Data**: All values are from CODATA 2022.
- **Code**: Standard algorithms; described in the text.
- **Conflicts of interest**: None.
- **Funding**: Work conducted at the National Autonomous University of Honduras (UNAH).

References

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2. W. H. Press, S. A. Teukolsky, W. T. Vetterling, and B. P. Flannery. *Numerical Recipes: The Art of Scientific Computing*. 3rd ed., Cambridge University Press, 2007.
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