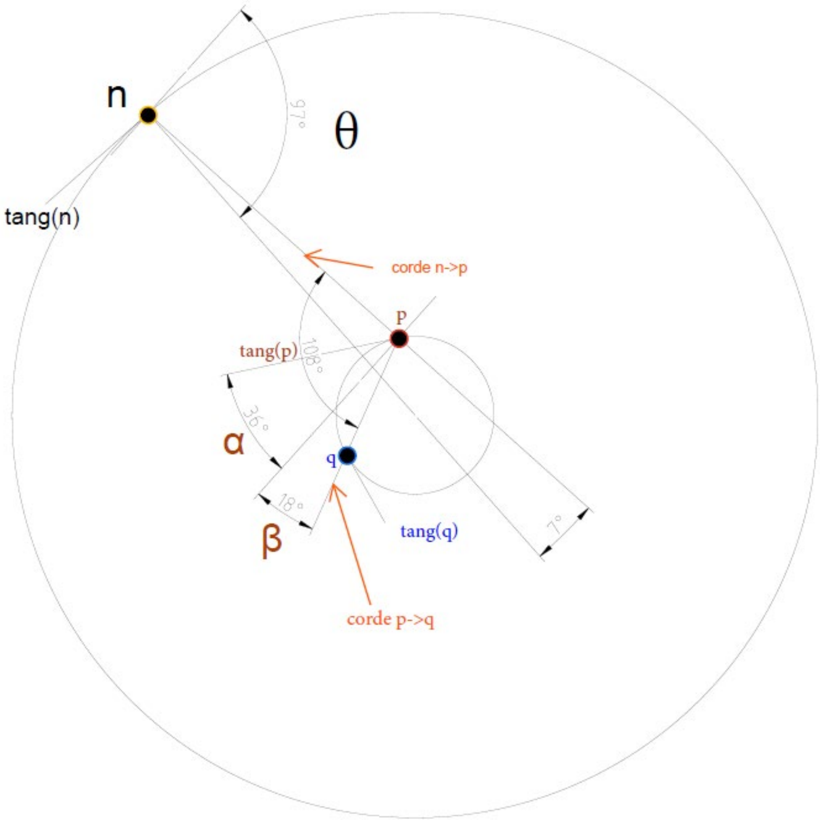
Dyadic Phase Transport in Semiprime Integers

1. Dataset and scope

We analyze a dataset of **500,000 semiprime integers** $n = pq$, restricted to the **64-bit regime**, where p and q are prime factors, started with this conceptual's representation show bellow.



For each triplet (n, p, q), the dataset contains:

- the dyadic level $k_x = \lfloor \log_2 x \rfloor$,
- angular quantities θ_n, $\theta_{p_{\min}}$,
- and a normalized intra-dyadic imbalance flag allowing identification of the smaller and larger factor.

All arithmetic relations were validated:

- $n = pq$ holds for 100% of entries,
- both factors are prime,
- dyadic levels match bit-length definitions exactly.

This ensures that all observed effects are **structural**, not artefacts of corrupted data.

2. Phase composition hypothesis

Let us associate to each integer $x$an angular quantity $\theta_x \in [0,2\pi)$, interpreted as a *phase coordinate* on its dyadic circle.

We test the hypothesis that the phase of a semiprime integer is governed by a **composition law** of the phases of its prime factors:

$$\theta_n \approx \mathrm{wrap}_{2\pi}(\theta_p + \theta_q)$$

This relation is **not imposed** by construction:
we previously verified that $\theta_n$is neither the trivial fractional logarithmic phase of n, nor a local geometric angle derived from the direct chord $n \to p$.

3. Empirical phase alignment

Define the residual phase error:

$$\delta = \mathrm{wrap}_{\pi}(\theta_n - (\theta_p + \theta_q))$$

Over the full dataset, we observe:

- mean absolute error:

$$\langle | \delta | \rangle \approx 0.162 \text{ rad}$$

- median absolute error:

$$\mathrm{median}(| \delta |) \approx 0.124 \text{ rad}$$

- 90th percentile:

$$P_{90}(| \delta |) \approx 0.374 \text{ rad}$$

The signed residual is centered near zero:

$$\mathbb{E}[\delta] \approx 0.014 \text{ rad}$$

This demonstrates a **strong phase alignment** between $\theta_n$and the composed phase $\theta_p + \theta_q$, with no systematic angular bias.

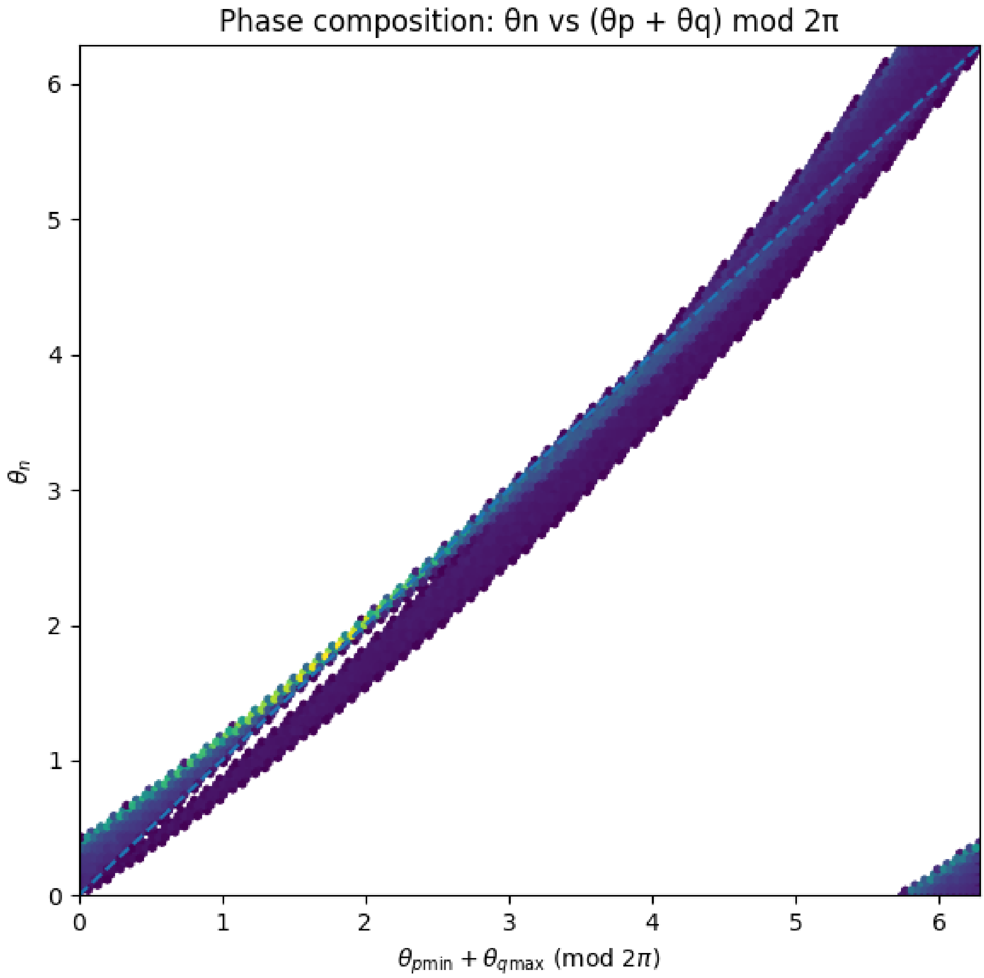


Fig1. Phase of Phase of semiprime integers versus the composed phase of their prime factors. Each point represents a semiprime $n=pq$. The horizontal axis shows the composed phase $(\theta p\min+\theta q\max) \bmod 2\pi$, while the vertical axis shows θn. The clear alignment along the diagonal indicates that the phase of a semiprime is strongly governed by the sum of the phases of its prime factors.

4. Dyadic carry bifurcation

When both prime factors lie in the same dyadic band $k_p = k_q = k$, the product satisfies:

$$\log_2 n = 2k + (u_p + u_q)$$

leading to two possible dyadic levels:

$$k_n \in \{2k,\ 2k+1\}$$

Segmenting the dataset accordingly yields:

Dyadic case	median $\lvert\delta\rvert$	mean $\lvert\delta\rvert$
$k_n = 2k$	~0.218 rad	~0.228 rad
$k_n = 2k+1$	~0.081 rad	~0.120 rad

The **carry case** $k_n = 2k + 1$exhibits a **significantly tighter phase locking**.

This establishes that **dyadic carry is not a passive arithmetic effect**, but directly influences angular transport.

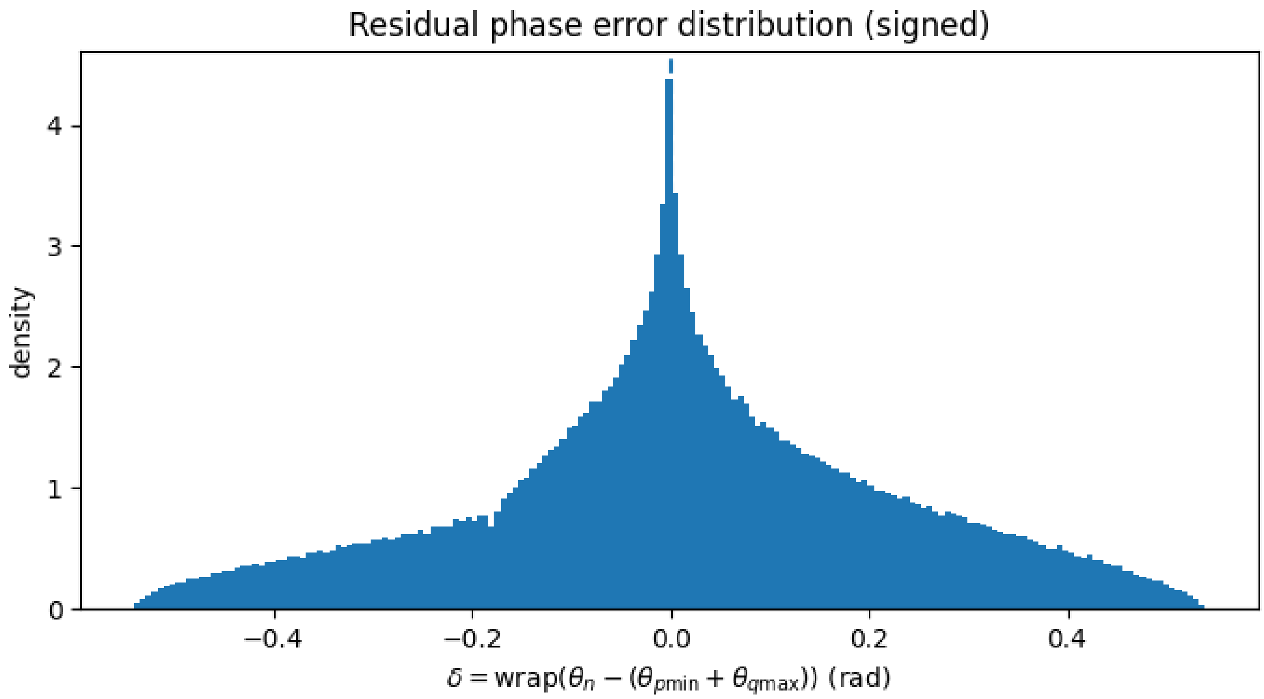


Fig2 Distribution of the signed residual phase error. The histogram shows δ=wrap(θn−(θpmin+θqmax)). The distribution is centered near zero with finite dispersion, indicating unbiased but non-exact phase transport from the factors to the semiprime.

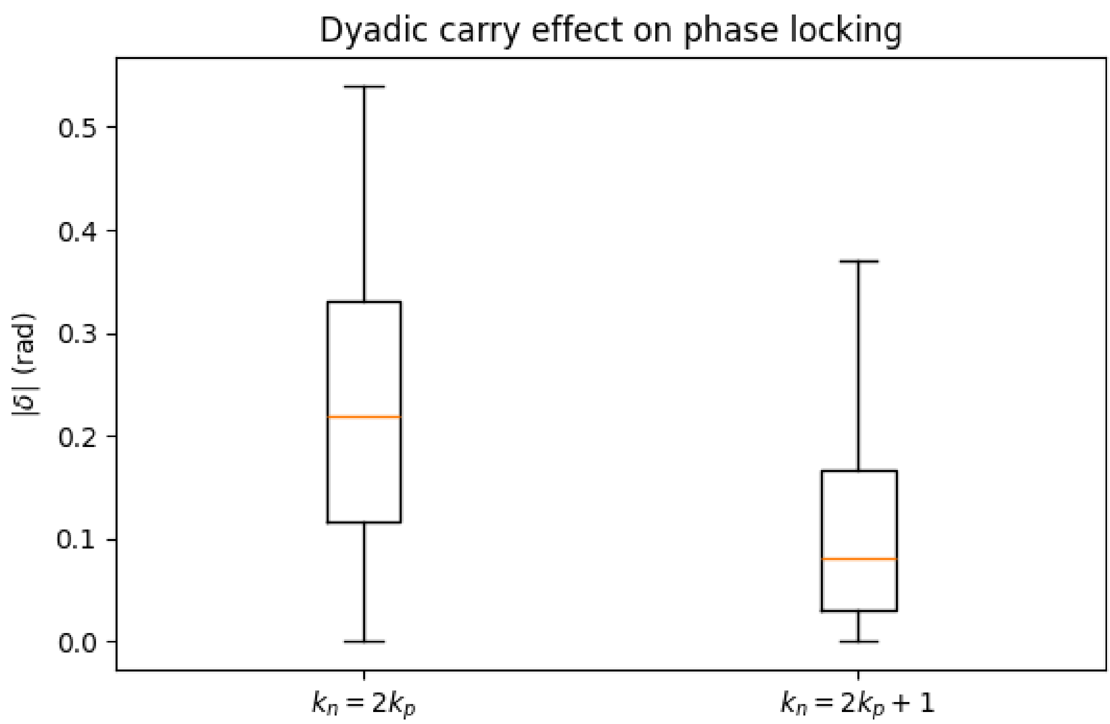


Fig3 Effect of dyadic carry on phase locking. Boxplots of the absolute residual $|\delta|$ are shown for two dyadic cases: kn=2kp (no carry) and kn=2kp+1 (carry). The carry case exhibits significantly tighter phase alignment, demonstrating that dyadic sca

5. Dependence on factor imbalance

Define the intra-dyadic imbalance:

$$\Delta u = | u_p - u_q | \text{ with} u_x = \log_2 x - \lfloor \log_2 x \rfloor$$

We observe a strong monotonic relationship between phase error and imbalance:

- Pearson correlation:

$$\mathrm{corr}(| \delta |, \Delta u) \approx 0.374$$

Binned medians show a clear increase:

Δurange	median $| \delta |$
0.0 – 0.1	~0.12 rad
0.4 – 0.5	~0.13 rad
0.6 – 0.7	~0.19 rad
0.8 – 0.9	~0.37 rad
0.9 – 1.0	~0.47 rad

Thus:

- **balanced factors** ($u_p \approx u_q$) yield strong phase coherence,
- **unbalanced factors** lead to progressive phase dispersion.

6. Canonical formulation

The observed behavior is compactly summarized by:

$$\boxed{\theta_n = \theta_p + \theta_q \ + \ \varepsilon(\Delta u,\, \text{carry})}$$

where:

- $\varepsilon \to 0$as $\Delta u \to 0,$
- $|\ \varepsilon\ |$increases monotonically with factor imbalance,
- the dyadic carry case $k_n = 2k + 1$minimizes $|\ \varepsilon\ |$.

This defines a **dyadic phase transport law** for semiprime integers.

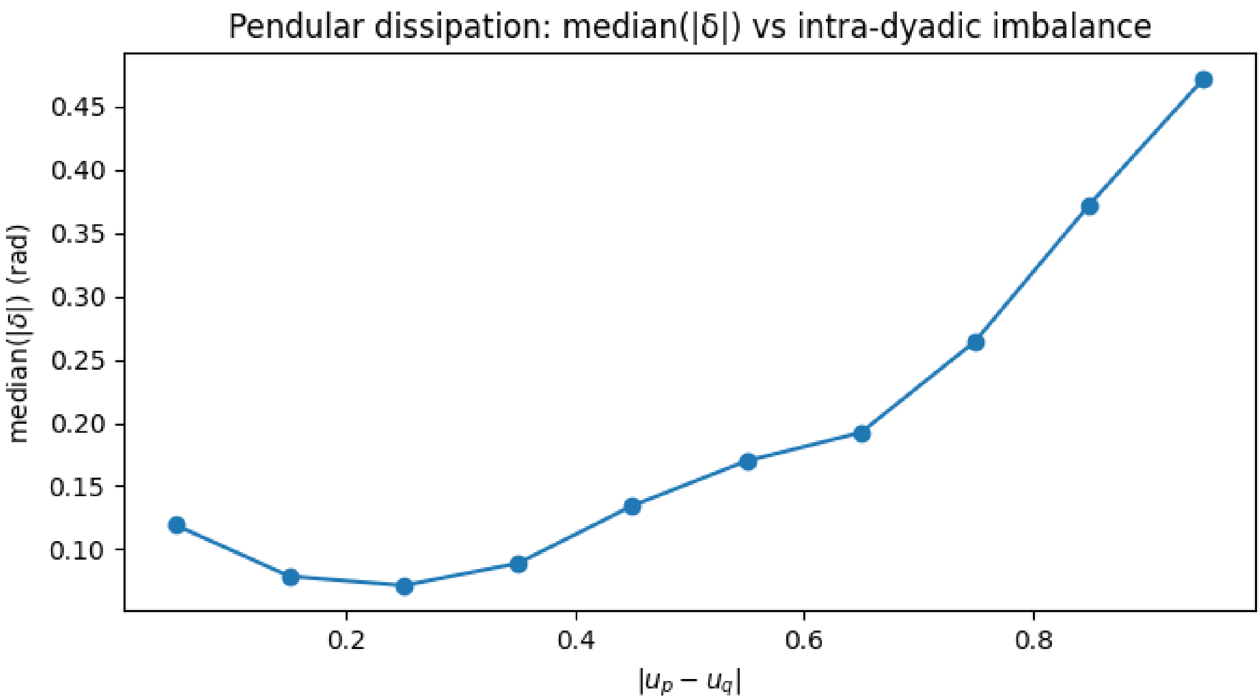


Fig4 Phase dispersion as a function of intra-dyadic factor imbalance. The plot shows the median absolute residual median(|δ|) as a function of the imbalance |up−uq|, where ux=log2(x)−⌊log2(x)⌋. Phase dispersion increases monotonically with factor imbalance, revealing a pendular dissipation law: balanced factors yield strong phase coherence, while unbalanced factors progressively weaken phase locking.

7. Interpretation (kept deliberately minimal)

These results show that:

- multiplication of integers induces a **non-local angular structure**,
- semiprimes inherit a **composed phase** from their factors,
- dyadic scaling governs the stability of this transport.

No appeal is made here to analytic continuation, zeta functions, or spectral conjectures.
The phenomenon is **empirical, geometric, and reproducible**.