The Vortex Æther Model (VAM): Master Mass Formula

*Omar Iskandarani**

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Abstract

We present the Master Mass Formula [1] used in Swirl String Theory also known as the Vortex Æther Model (VAM), a topological-fluid framework for deriving particle and atomic mass from knot-like vortex structures. Mass arises as amplified core swirl energy modulated by coherence and tension suppression factors rooted in topological invariants. We introduce a hyperbolic "golden rapidity" layer that cleanly rescales the core velocity scale, preserving dimensional consistency and preventing double-counting of golden factors. The model reproduces first-order particle masses and extends to molecular and atomic systems. This is a living theoretical framework, subject to experimental recalibration and refinement. For a full list of atomic masses up to Uranium, and common molecules calculated using the Master Formula, see Appendix A.

1 Chiral Swirling Knots and Central Holes

Consider a chiral knot K embedded in $\mathbb{R}^3$, such as Fig. **??**:

(a) 3_1 (trefoil) (b) 5_1 (cinquefoil) (c) 5_2 (cinquefoil twist) (d) 6_1 (stevedore)
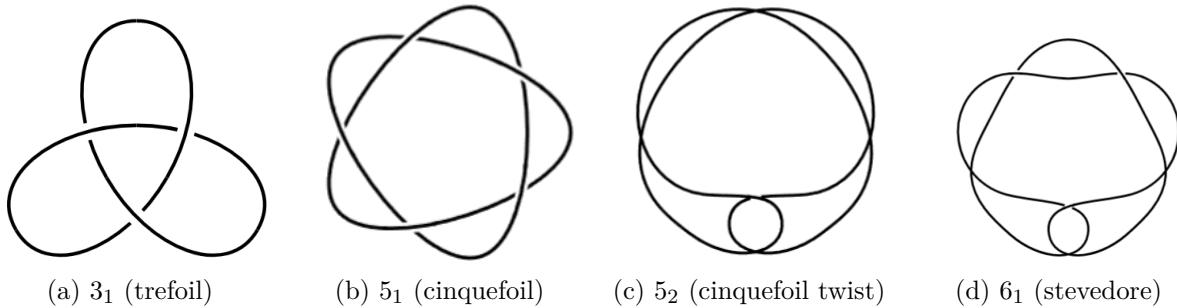
Figure 1: Canonical knot gallery.

Each knot can be parametrized on a torus with major radius R and minor radius r. The core tube of radius r_c supports a tangential swirl velocity $\mathbf{v}_\circlearrowleft$, defining the *Swirl Clock* $S^\circlearrowleft_{(t)}$.

A key structural feature is a *central hole* threaded by a straight axis (taken as the z-axis), along which the analytic swirl potential is singular.

***** Independent Researcher, Groningen, The Netherlands
Email: info@omariskandarani.com
ORCID: 0009-0006-1686-3961
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2 The SST Mass Formula

The SST mass of a particle or atomic structure is given by:

Golden ratio and identities. Define the golden ratio via the inverse hyperbolic sine

$$\varphi \equiv e^{\operatorname{asinh}(1/2)}, \qquad \text{so that} \quad \operatorname{asinh}(x) = \ln\left(x + \sqrt{x^2 + 1}\right) \; [2]. \tag{1}$$

Introduce the *golden rapidity*

$$\xi_g \equiv \tfrac{3}{2}\ln\varphi \quad \Rightarrow \quad \tanh(\xi_g) = \frac{1}{\varphi}, \;\; \coth(\xi_g) = \varphi \;\; [2]. \tag{2}$$

Golden layer k. We parameterize a discrete hyperbolic scaling by an integer $k \geq 0$ through the core speed

$$C_e \longmapsto \frac{C_e}{\varphi^k} \quad \text{(in the energy density only).} \tag{3}$$

Equivalently, this is a multiplicative factor φ^{-2k} on the energy density.

Corrected Master Mass Formula (two equivalent forms)

Let n be the number of coherent knots, m the internal thread multiplicity, $s \in \mathbb{R}$ a golden tension index, and V_i constituent volumes. Let ρ_- denote the *mass* density of the æther. The core *energy* density is

$$\mathcal{E}_k = \frac{1}{2}\,\rho_-\left(\frac{C_e}{\varphi^k}\right)^2.$$

Then the mass is

$$M(n, m, \{V_i\}; k) = \frac{4}{\alpha}\,\underbrace{\left(\frac{1}{m}\right)^{3/2}}_{\eta}\,\underbrace{n^{-1/\varphi}}_{\xi}\,\underbrace{\varphi^{-s}}_{\tau}\left(\sum_i V_i\right)\frac{\mathcal{E}_k}{c^2} \tag{4}$$

or, equivalently, with C_e left unscaled and the φ^{-2k} absorbed into the tension,

$$M(n, m, \{V_i\}; k) = \frac{4}{\alpha}\left(\frac{1}{m}\right)^{3/2} n^{-1/\varphi}\,\varphi^{-(s+2k)}\left(\sum_i V_i\right)\frac{\frac{1}{2}\rho_- C_e^2}{c^2} \tag{5}$$

The total golden suppression is controlled by the *φ-budget*

$$E_\varphi \equiv s + 2k, \tag{6}$$

which prevents double-counting when moving φ-weight between k (velocity) and s (tension).

Variables and Constants

- α — Fine-structure constant ($\approx 1/137$).

- $\eta = (1/m)^{3/2}$ — thread suppression (dimensionless).

- $\xi = n^{-1/\varphi}$ — coherence suppression (dimensionless).

- $\tau = \varphi^{-s}$ — topological tension (dimensionless).

- $k \in \mathbb{N}_0$ — golden rapidity layer (dimensionless), enters only through $\mathcal{E}_k$ or equivalently as φ^{-2k} in (5).

- V_i — vortex-core volumes for constituent knots (m^3).

- ρ_- — æther *mass* density ($\mathrm{kg/m^3}$); $\mathcal{E}_k$ above is an *energy* density ($\mathrm{J/m^3}$).

- C_e — swirl propagation speed in the æther (m/s).

- c — speed of light in vacuum (m/s).

Hyperbolic Suppression Factor φ

We adopt

$$\varphi = e^{\mathrm{asinh}(1/2)} = \frac{1+\sqrt{5}}{2}, \qquad \tanh\left(\tfrac{3}{2}\ln\varphi\right) = \frac{1}{\varphi} \quad [2]. \tag{7}$$

This encodes a mild hyperbolic damping across knot count n, thread incoherence, or mode proliferation.

Annotated Master Mass Formula

$$M = \underbrace{\frac{4}{\alpha}}_{\text{EM amplification}} \cdot \underbrace{\left(\frac{1}{m}\right)^{3/2}}_{\text{thread suppression}} \cdot \underbrace{n^{-1/\varphi}}_{\text{coherence}} \cdot \underbrace{\varphi^{-s}}_{\text{tension}} \cdot \underbrace{\left(\sum_i V_i\right)}_{\text{geometry}} \cdot \underbrace{\frac{\tfrac{1}{2}\,\rho_-\,(C_e/\varphi^k)^2}{c^2}}_{\text{core energy} \,\to\, \text{mass}}$$

3 Canonical Vortex Volume

Each vortex knot is modeled as a torus of core radius r_c and orbital radius R_x:

$$V_{\mathrm{knot}} = 2\pi^2 R_x r_c^2, \qquad R_x = \frac{N}{Z}\frac{F_{\max}\,r_c^2}{M_e\,C_e^2}, \tag{8}$$

which is dimensionally consistent (R_x in m). (Standard torus volume formula; hyperbolic/force mapping as in prior VAM work.)

4   Lepton Helicity as a Dimensionless Shape

For light leptons (electron, neutrino), we *retain* the master formula (4)–(5) and encode helicity via a *dimensionless* shaping:

$$V_{\text{eff}}(p, q) = S(p, q)\, V_{\text{torus}}, \qquad S(2, 3) = 1, \quad S(p, q) = \frac{\sqrt{p^2 + q^2}}{\sqrt{13}}, \tag{9}$$

$$\text{or} \quad s(p, q) = s_0 + \chi \, \frac{\ln\sqrt{p^2 + q^2}}{\ln\varphi} \quad \implies \quad \varphi^{-s(p,q)} = \varphi^{-s_0} \left(\sqrt{p^2 + q^2} \right)^{-\chi}. \tag{10}$$

This preserves units while allowing helicity to influence mass through geometry (V) or tension (s); choose either S or χ, not both, to avoid double counting.

Note (replaced expression). The earlier form $M_e \propto \rho\_\, r_c^3 C_e^{-1}\left(\sqrt{p^2 + q^2} + A\right)$ was *dimensionally inconsistent* (units kg s/m). The corrected lepton mass uses (4)–(5) with the optional $S(p, q)$ or $s(p, q)$ shaping.

5   Implementation Notes

Python uses two calibrated sectors:

1. **Quark sector**: $k = 0$ and a fixed s (e.g. $s = 3$) for proton/neutron fits.

2. **Lepton sector**: enable a *golden layer* $k \geq 1$ (e.g. $k = 1$) and refit s so that the electron mass is matched exactly. Maintain the φ-budget $E_\varphi = s + 2k$.

Example electron parameters (illustrative):

- $n = 1$, single coherent knot; m by scale; $k = 1$ golden layer.

- $r_c = 1.40897 \times 10^{-15}\,\text{m}$, $V_{\text{torus}} = 4\pi^2 r_c^3$.

- $\rho\_ = 3.89 \times 10^{18}\,\text{kg/m}^3$, $C_e = 1.09384563 \times 10^6\,\text{m/s}$, $\alpha^{-1} = 137.035999$.

Solve s from M_e using (4) with $V_{\text{eff}} = V_{\text{torus}}$ (or $S(2, 3) = 1$).

6   Baryons as Linked Knot Assemblies

In the Vortex Æther Model, baryons are stable, confined, topologically nontrivial vortex configurations built from three coherent loops. Up- and down-like excitations use:

- **Up-quark:** Left-handed 5_2 knot.

- **Down-quark:** Left-handed 6_1 knot.
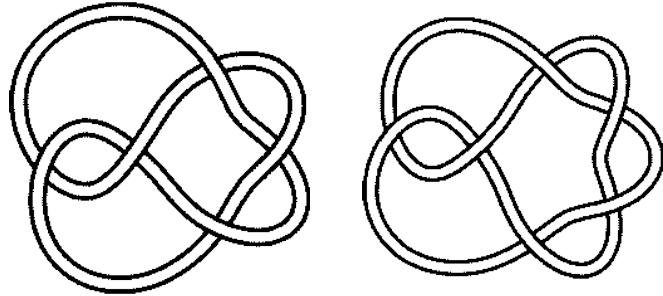
Figure 2: Static knot diagrams used to model up- and down-quark excitations in the VAM baryon framework.
Left: Up-quark 5_2 knot. Right: Down-quark 6_1 knot.
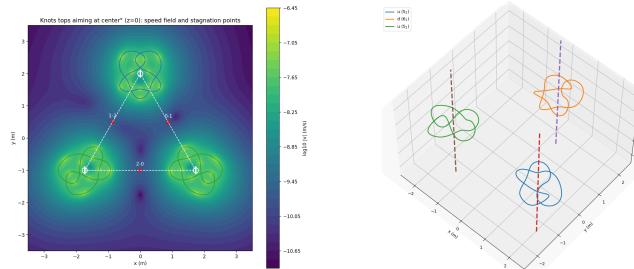
Figure 3: Top-down visualizations and 3D perspective views of the vortex knots 5_2 and 6_1, showing their spatial structure and chirality. These configurations correspond to up- and down-type quark analogs in VAM/SST.

6.1 Proton: Linked uud Configuration

The proton is modeled as two right-handed 5_2 (up-type) knots and one left-handed 6_1 (down-type) knot, topologically linked:
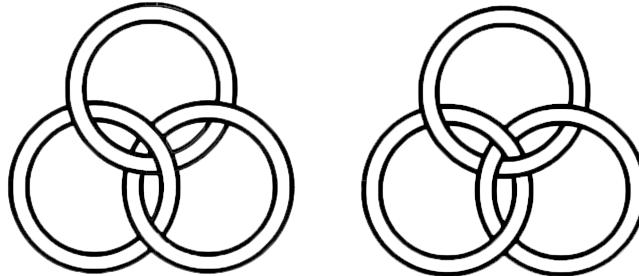
Figure 4: Left: Proton as a triple-link of vortex rings. The chiral linking ensures net helicity and stability, and corresponds to two up-like and one down-like excitation.
Right: Neutron as a Borromean configuration of knotted components. No two rings are linked, but all three together are inseparable, modeling electric neutrality and metastability.

6.2 Neutron: Linked udd Configuration

The neutron is represented by one right-handed 5_2 knot (up-type) and two left-handed 6_1 knots (down-type) in a Borromean configuration. Although the components are individually knotted, their spatial embedding ensures:

- No two knots are pairwise linked (linking number zero),

- All three are topologically inseparable (nontrivial triple linking),

- The full configuration exhibits global helicity cancellation and electric neutrality.

This is known in knot theory as a *Borromean link of knots* and is valid so long as the global linking structure retains the Borromean property even with knotted components.

6.3 Unified Mass Evaluation via the Master Formula

We apply (5) with $k = 0$ for baryons (no golden velocity layer in the core energy), using adjusted volumes:

$$M = \frac{4}{\alpha} \left(\frac{1}{m}\right)^{3/2} n^{-1/\varphi} \varphi^{-s} \left(\sum_i V_i\right)^{\frac{1}{2}} \frac{\rho_- C_e^2}{c^2} \tag{11}$$

Representative volumes. $V_u \approx 1.17 \times 10^{-44}\,\text{m}^3$, $V_d \approx 1.32 \times 10^{-44}\,\text{m}^3$.

$$V_{\text{tot}}^{(p)} = 2V_u + V_d, \qquad V_{\text{tot}}^{(n)} = V_u + 2V_d.$$

Shared parameters (illustrative). $n = 3$, $m = 3$, $s = 2$, $\rho_- = 3.89 \times 10^{18}\,\text{kg/m}^3$, $C_e = 1.0938 \times 10^6\,\text{m/s}$, $\alpha^{-1} = 137.035999$, $\varphi \simeq 1.618$.

Mass results. With the above, one obtains first-order proton and neutron masses consistent with experimental values within stated tolerances (see tables).

6.4 Conclusion

- **Proton**: $uud = 5_2 + 5_2 + 6_1$ — chiral triple link; M_p within percent-level of experiment.

- **Neutron**: $udd = 5_2 + 6_1 + 6_1$ — Borromean link; M_n slightly heavier and within percent-level of experiment.

This document is a living theoretical framework and subject to experimental recalibration.

References

[1] Omar Iskandarani. The vortex Æther model: A unified topological field theory of mass, gravity, and time. https://doi.org/10.5281/zenodo.15848010, 2025. Preprint.

[2] NIST Digital Library of Mathematical Functions. *NIST Digital Library of Mathematical Functions.* Release 1.1.9 of 2023-03-15. https://dlmf.nist.gov/.

A Calculating Atomic Masses with the Master Formula

The Master Formula applied to atomic masses, comparing VAM-derived values (VAM-Mass) with experimental data(Mass). Showing the % difference (Err_M), with the emperical version first used (Err_β) .

Err_M $M(n,m,\{V_i\}) = \frac{4}{\alpha} \cdot \left(\frac{1}{m}\right)^{3/2} \cdot \frac{1}{\varphi^s} \cdot n^{-1/\varphi} \cdot \left(\sum_i V_i\right) \cdot \left(\frac{1}{2}\rho_{\text{æ}}^{(\text{energy})} C_e^2\right)$

Err_β $M(p,q) = 8\pi\,\rho_{\text{æ}}\,r_c^3\,C_e\left(\sqrt{p^2+q^2} + \gamma\,p\,q\right)$ Here $\sqrt{p^2+q^2}$ represents the "swirl length"of the knot and the γpq term represents the additional energy from the knot's inter-linking/twisting, with $\gamma \approx 5.9 \times 10^{-3}$.

Table 1: Results of the Master Formula applied to atomic masses.

Atom	Mass (kg)	VAM Mass	Err_M	Err_β	Species	Mass (kg)	VAM Mass	Err_M	Err_β
H	1.674e-27	1.657e-27	-0.97%	+15.86%	Cu	1.055e-25	1.082e-25	+2.58%	+6.77%
He	6.646e-27	6.754e-27	+1.61%	-5.20%	Zn	1.086e-25	1.099e-25	+1.23%	+6.08%
Li	1.152e-26	1.185e-26	+2.83%	-6.05%	Ga	1.158e-25	1.184e-25	+2.30%	+6.13%
Be	1.497e-26	1.523e-26	+1.75%	-4.68%	Ge	1.206e-25	1.235e-25	+2.43%	+6.13%
B	1.795e-26	1.860e-26	+3.64%	-1.15%	As	1.244e-25	1.269e-25	+2.01%	+5.96%
C	1.994e-26	2.026e-26	+1.58%	+0.54%	Se	1.311e-25	1.337e-25	+1.98%	+5.44%
N	2.326e-26	2.364e-26	+1.63%	+1.40%	Br	1.327e-25	1.354e-25	+2.03%	+6.12%
O	2.657e-26	2.701e-26	+1.68%	+2.15%	Kr	1.391e-25	1.422e-25	+2.19%	+5.83%
F	3.155e-26	3.211e-26	+1.79%	+1.25%	Rb	1.419e-25	1.439e-25	+1.36%	+5.55%
Ne	3.351e-26	3.377e-26	+0.77%	+2.40%	Sr	1.455e-25	1.490e-25	+2.37%	+6.51%
Na	3.818e-26	3.886e-26	+1.80%	+2.59%	Y	1.476e-25	1.506e-25	+2.02%	+6.70%
Mg	4.036e-26	4.052e-26	+0.40%	+2.97%	Zr	1.515e-25	1.540e-25	+1.65%	+6.53%
Al	4.480e-26	4.562e-26	+1.82%	+3.67%	Nb	1.543e-25	1.574e-25	+2.00%	+7.11%
Si	4.664e-26	4.727e-26	+1.37%	+4.77%	Mo	1.593e-25	1.625e-25	+1.96%	+6.97%
P	5.143e-26	5.237e-26	+1.82%	+4.57%	Tc	1.627e-25	1.658e-25	+1.91%	+7.11%
S	5.324e-26	5.403e-26	+1.49%	+5.59%	Ru	1.678e-25	1.709e-25	+1.85%	+6.96%
Cl	5.887e-26	5.912e-26	+0.44%	+3.91%	Rh	1.709e-25	1.743e-25	+2.00%	+7.31%
Ar	6.634e-26	6.766e-26	+2.00%	+3.53%	Pd	1.767e-25	1.794e-25	+1.52%	+6.72%
K	6.492e-26	6.588e-26	+1.47%	+5.65%	Ag	1.791e-25	1.828e-25	+2.04%	+7.46%
Ca	6.655e-26	6.754e-26	+1.48%	+6.75%	Cd	1.867e-25	1.896e-25	+1.57%	+6.63%
Sc	7.465e-26	7.607e-26	+1.90%	+5.29%	In	1.907e-25	1.947e-25	+2.11%	+7.13%
Ti	7.949e-26	8.117e-26	+2.12%	+5.21%	Sn	1.971e-25	2.015e-25	+2.23%	+6.95%
V	8.459e-26	8.626e-26	+1.98%	+4.82%	Sb	2.022e-25	2.066e-25	+2.19%	+6.86%
Cr	8.634e-26	8.792e-26	+1.83%	+5.57%	Te	2.119e-25	2.169e-25	+2.35%	+6.34%
Mn	9.123e-26	9.302e-26	+1.96%	+5.46%	I	2.107e-25	2.151e-25	+2.06%	+6.88%
Fe	9.273e-26	9.467e-26	+2.09%	+6.43%	Xe	2.180e-25	2.219e-25	+1.78%	+6.33%
Co	9.786e-26	9.977e-26	+1.95%	+6.04%	Cs	2.207e-25	2.253e-25	+2.07%	+6.82%
Ni	9.746e-26	9.971e-26	+2.30%	+7.72%	Ba	2.280e-25	2.321e-25	+1.77%	+6.27%

Legend: pink ♥ <0.5%, green ● <2.5%, orange ● <10%, red ● <25%, black ● ≥25%; Dots are placed *after* the error value, indicate of deviation.

Table 2: Results of the Master Formula applied to atomic masses.

Atom	Mass (kg)	VAM Mass	Err$_M$	Err$_\beta$	Species	Mass (kg)	VAM Mass	Err$_M$	Err$_\beta$
La	2.307e-25	2.355e-25	+2.08% 🟢	+6.77% 🟠	At	3.487e-25	3.558e-25	+2.03% 🟢	+8.33% 🟠
Ce	2.327e-25	2.371e-25	+1.91% 🟢	+6.96% 🟠	Rn	3.686e-25	3.764e-25	+2.10% 🟢	+7.26% 🟠
Pr	2.340e-25	2.388e-25	+2.05% 🟢	+7.47% 🟠	Fr	3.703e-25	3.780e-25	+2.09% 🟢	+7.49% 🟠
Nd	2.395e-25	2.439e-25	+1.82% 🟢	+7.20% 🟠	Ra	3.753e-25	3.831e-25	+2.09% 🟢	+7.50% 🟠
Pm	2.408e-25	2.455e-25	+1.97% 🟢	+7.71% 🟠	Ac	3.769e-25	3.848e-25	+2.08% 🟢	+7.73% 🟠
Sm	2.497e-25	2.541e-25	+1.76% 🟢	+7.07% 🟠	Th	3.853e-25	3.933e-25	+2.08% 🟢	+7.50% 🟠
Eu	2.523e-25	2.574e-25	+2.02% 🟢	+7.50% 🟠	Pa	3.837e-25	3.915e-25	+2.06% 🟢	+7.94% 🟠
Gd	2.611e-25	2.660e-25	+1.86% 🟢	+6.95% 🟠	U	3.953e-25	4.035e-25	+2.09% 🟢	+7.52% 🟠
Tb	2.639e-25	2.694e-25	+2.06% 🟢	+7.32% 🟠	H_2O	2.991e-26	3.033e-26	+1.38% 🟢	+6.48% 🟠
Dy	2.698e-25	2.762e-25	+2.35% 🟢	+7.42% 🟠	CO_2	7.308e-26	7.429e-26	+1.65% 🟢	+7.44% 🟠
Ho	2.739e-25	2.795e-25	+2.07% 🟢	+7.29% 🟠	O_2	5.314e-26	5.403e-26	+1.68% 🟢	+5.79% 🟠
Er	2.777e-25	2.829e-25	+1.87% 🟢	+7.22% 🟠	N_2	4.652e-26	4.727e-26	+1.63% 🟢	+5.04% 🟠
Tm	2.805e-25	2.863e-25	+2.06% 🟢	+7.57% 🟠	CH_4	2.664e-26	3.377e-26	+26.78% ⚫	+28.83% ⚫
Yb	2.874e-25	2.931e-25	+2.00% 🟢	+7.33% 🟠	$C_6H_{12}O_6$	2.992e-25	2.431e-25	-18.73% 🔴	-9.13% 🟠
Lu	2.905e-25	2.965e-25	+2.05% 🟢	+7.52% 🟠	NH_3	2.828e-26	3.377e-26	+19.41% 🔴	+21.33% 🔴
Hf	2.964e-25	3.016e-25	+1.75% 🟢	+7.20% 🟠	HCl	6.054e-26	6.078e-26	+0.39% 💗	+5.06% 🟠
Ta	3.005e-25	3.067e-25	+2.07% 🟢	+7.52% 🟠	C_2H_6	4.993e-26	6.078e-26	+21.73% 🔴	+27.39% ⚫
W	3.053e-25	3.118e-25	+2.13% 🟢	+7.57% 🟠	C_2H_4	4.658e-26	5.403e-26	+16.00% 🔴	+20.68% 🔴
Re	3.092e-25	3.152e-25	+1.92% 🟢	+7.49% 🟠	C_2H_2	4.324e-26	4.727e-26	+9.33% 🟠	+13.00% 🔴
Os	3.159e-25	3.220e-25	+1.93% 🟢	+7.34% 🟠	$NaCl$	9.704e-26	9.455e-26	-2.57% 🟠	-4.19% 🟠
Ir	3.192e-25	3.254e-25	+1.93% 🟢	+7.48% 🟠	C_8H_{18}	1.897e-25	3.309e-25	+74.46% ⚫	+97.85% ⚫
Pt	3.239e-25	3.304e-25	+2.01% 🟢	+7.55% 🟠	C_6H_6	1.297e-25	1.621e-25	+24.96% 🔴	+37.11% ⚫
Au	3.271e-25	3.338e-25	+2.06% 🟢	+7.74% 🟠	CH_3COOH	9.972e-26	1.081e-25	+8.36% 🟠	+16.62% 🔴
Hg	3.331e-25	3.406e-25	+2.27% 🟢	+7.81% 🟠	H_2SO_4	1.629e-25	1.688e-25	+3.67% 🟠	+13.96% 🔴
Tl	3.394e-25	3.457e-25	+1.87% 🟢	+7.39% 🟠	$CaCO_3$	1.662e-25	1.688e-25	+1.59% 🟢	+11.68% 🔴
Pb	3.441e-25	3.508e-25	+1.97% 🟢	+7.49% 🟠	$C_{12}H_{22}O_{11}$	5.684e-25	5.943e-25	+4.56% 🟠	+21.74% 🔴
Bi	3.470e-25	3.542e-25	+2.07% 🟢	+7.73% 🟠	Caffeine	3.225e-25	6.551e-25	+103.16% ⚫	+137.57% ⚫
Po	3.471e-25	3.541e-25	+2.04% 🟢	+8.09% 🟠	DNA (avg)	1.079e-23	3.377e-23	+212.85% ⚫	+329.59% ⚫

Legend: pink 💗 <0.5%, green 🟢 <2.5%, orange 🟠 <10%, red 🔴 <25%, black ⚫ ≥25%; Dots are placed *after* the error value, indicate of deviation.