Technical Memo:
The Mass-to-Light Ratio in CPM-Gravity

Why M/L = φ and Its Connection to the Kernel Constants

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Purpose

This memo documents the correspondence between the stellar mass-to-light ratio (M/L) and the CPM-Gravity kernel constants. This material is **not currently in the CPM-Gravity paper** and may be added to strengthen the zero-parameter claim.

Executive Summary

Key Result: Both the kernel enhancement $w(r)$ and the stellar mass-to-light ratio M/L are locked to the same φ-ladder. Neither is a free parameter—both are derived from the same mathematical structure.

1 The Gap in the Current Paper

The CPM-Gravity paper currently:

- ✓ Derives kernel constants $\alpha = \frac{1}{2}(1 - \varphi^{-1})$ and $C = \varphi^{-3/2}$ from Recognition Geometry
- ✓ Derives coercivity constant $c = 49/162$ from CPM structure
- ✓ States the rotation curve equation $v^2 = w(r) \times v^2_{\text{baryon}}$
- × **Does not mention** that $M/L = \varphi$ is also derived
- × **Does not connect** M/L to the same φ-ladder as the kernel

A reviewer may ask: "You claim zero per-galaxy parameters, but don't you still fit M/L per galaxy?" The answer is **no**—and the paper should say so.

2 The Rotation Curve Equation

In CPM-Gravity (ILG), the model velocity is:

$$v^2_{\text{model}}(r) = w(r) \times v^2_{\text{baryon}}(r) \tag{1}$$

where $w(r) \geq 1$ is the kernel enhancement (replacing dark matter).

The baryonic velocity depends on the mass-to-light ratio:

$$v_{\text{baryon}}^2 = v_{\text{gas}}^2 + \left(\sqrt{M/L} \cdot v_{\text{disk}}\right)^2 + v_{\text{bulge}}^2 \tag{2}$$

In standard analyses (MOND, ΛCDM), M/L is a **free parameter** fitted per galaxy. In CPM-Gravity, it is **derived**.

3 The M/L Derivation

The stellar mass-to-light ratio is derived from J-cost minimization on the recognition ledger. Three independent strategies converge to the same result:

Strategy 1: Stellar Assembly (Recognition Cost Weighting)

Stars form where recognition cost is minimized. The cost differential between photon emission and mass storage determines the equilibrium:

$$M/L = \exp\left(\frac{\Delta\delta}{J_{\text{bit}}}\right) = \varphi^n$$

where $J_{\text{bit}} = \ln\varphi$ is the fundamental information unit.

Strategy 2: φ-Tier Nucleosynthesis

Nuclear densities and photon fluxes occupy discrete φ-tiers:

$$M/L = \frac{\varphi^{n_{\text{nuclear}}}}{\varphi^{n_{\text{photon}}}} = \varphi^{\Delta n}$$

Strategy 3: Geometric Observability Limits

Observability constraints (λ_{rec}, τ_0, E_{coh}) combined with J-minimization force M/L onto the φ-ladder.

Result

All three strategies yield:

$$\boxed{M/L = \varphi \approx 1.618 \text{ solar units (characteristic value)}} \tag{3}$$

Valid range: $M/L \in \{\varphi^n : n \in \{0, 1, 2, 3\}\} = \{1, 1.618, 2.618, 4.236\}$

This matches observed stellar $M/L \in [0.5, 5]$ solar units.

4 The φ-Ladder Correspondence

Quantity	**Value**	**φ-Connection**
Kernel exponent α	$\frac{1}{2}(1 - \varphi^{-1}) \approx 0.191$	Direct from φ
Kernel amplitude C	$\varphi^{-3/2} \approx 0.486$	Power of φ
Mass-to-light M/L	$\varphi \approx 1.618$	Power of φ
Coercivity slack c	$49/162 \approx 0.302$	From 8-tick ($\varepsilon = 1/8$)

Key insight: The kernel constants and M/L are not independent. They emerge from the same underlying structure—the golden ratio φ and its self-similar scaling.

5 Implications for the Paper

Strengthens the Zero-Parameter Claim

The paper currently states "no per-galaxy tuning." Adding the M/L derivation makes this precise: **neither** the kernel **nor** the mass-to-light ratio is fitted per galaxy.

Closes a Potential Objection

Without this material, a reviewer could legitimately ask: "Your rotation curve fits still require choosing M/L—isn't that a free parameter?"

With this material, the answer is clear: $M/L = \varphi$ is derived from the same framework that derives the kernel. Choosing a different M/L per galaxy would violate the coercive projection law.

Shows the Deep Connection

The correspondence reveals that CPM-Gravity is not just a phenomenological modification to gravity. The same φ-structure that controls:

- How gravity is enhanced at large scales (kernel w)
- How much mass stars contain per unit luminosity (M/L)

is a single, unified mathematical architecture.

6 Suggested Text for the Paper

The following could be added as a subsection in Section 2 or Section 6:

> **Mass-to-Light Ratio: Derived, Not Fitted**
>
> The baryonic velocity entering the rotation curve equation depends on the stellar mass-to-light ratio M/L:
>
> $$v_{\text{baryon}}^2 = v_{\text{gas}}^2 + (\sqrt{M/L} \cdot v_{\text{disk}})^2 + v_{\text{bulge}}^2$$
>
> In standard analyses, M/L is a free parameter fitted per galaxy. Under the coercive projection law, M/L is *derived* from the same φ-structure that fixes the kernel constants:
>
> $$M/L = \varphi \approx 1.618 \text{ solar units (characteristic)}$$
>
> This follows from J-cost minimization on the recognition ledger. The valid range $M/L \in \{1, \varphi, \varphi^2, \varphi^3\} \approx \{1, 1.6, 2.6, 4.2\}$ matches observed stellar populations.
>
> **Key point**: Both the kernel enhancement $w(r)$ and the mass-to-light ratio M/L are locked to the φ-ladder. Per-galaxy fitting of either quantity violates the coercive projection law.

7 Lean Verification

The M/L derivation is machine-verified in Lean 4:

File	Key Theorems
`Astrophysics/MassToLight.lean`	`ml_derivation_complete`
`Astrophysics/StellarAssembly.lean`	`ml_from_cost_minimization`
`Astrophysics/NucleosynthesisTiers.lean`	`nucleosynthesis_ml_agrees`
`Astrophysics/ObservabilityLimits.lean`	`geometric_ml_agrees`
`URCGenerators/MassToLightCert.lean`	`MassToLightCert.verified`

All three derivation strategies are proven to agree on $M/L = \varphi$.

8 Falsifiability

The $M/L = \varphi$ prediction is falsifiable:

- If observed stellar M/L values systematically deviate from the φ-ladder $\{1, 1.6, 2.6, 4.2\}$, the theory is falsified.
- If rotation curve fits *require* per-galaxy M/L tuning to achieve acceptable residuals, the coercive projection law is violated.
- The M/L and kernel constants are *locked together*—you cannot adjust one without breaking the other.

Summary

1. The CPM-Gravity paper should state that $M/L = \varphi$ is **derived**, not fitted.
2. This strengthens the zero-parameter claim and closes a potential reviewer objection.
3. The correspondence between M/L and the kernel constants reveals the unified φ-architecture underlying CPM-Gravity.
4. The material is machine-verified in Lean and falsifiable against observations.

This memo prepared for Brett's CPM-Gravity paper. Contact: jon@recognitionphysics.org