Kochenov Equation: Geometric Solar-System Scaling Relation

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Abstract

A dimensionless geometric ratio constructed from the mean radii of the Sun, Moon, and Earth:

$$\Gamma = \frac{R_\odot \times R_{\rm Moon}}{R_\oplus^2} \approx 29.7788$$

directly reproduces Earth's orbital speed when multiplied by the unit velocity scale $V_0 = 1$ km/s:

$$v_\oplus = \Gamma \times V_0 \approx 29.7788 \text{ km/s}.$$

The observed mean orbital speed is ≈ 29.7847 km/s (deviation 0.02%). From this relation, the solar gravitational parameter follows without using G or any masses:

$$GM_\odot = r_{\rm AU} \times V_0^2 \times \Gamma^2 \approx 1.32660 \times 10^{20} \text{ m}^3/\text{s}^2.$$

IAU/CODATA reference: 1.32712×10^{20} m^3/s^2 (deviation 0.04%). No free parameters. The Moon's radius is essential — without it the relation does not close.

1 The Geometric Ratio Γ

Using IAU mean radii:

$$R_\odot = 695700 \text{ km}, \qquad R_{\rm Moon} = 1737.4 \text{ km}, \qquad R_\oplus = 6371 \text{ km}.$$

$$\Gamma = \frac{R_\odot \times R_{\rm Moon}}{R_\oplus^2} = \frac{695700 \times 1737.4}{6371^2} \approx 29.7788.$$

Γ is dimensionless — independent of the choice of length units.

2 Earth's Orbital Speed

Define the unit velocity scale $V_0 = 1$ km/s. Then:

$$v_\oplus^{(\rm geom)} = \Gamma \times V_0 \approx 29.7788 \text{ km/s}.$$

Quantity	Value	Gap
$v_\oplus^{(\rm geom)}$	29.7788 km/s	—
$v_\oplus^{(\rm observed)}$	29.7847 km/s	−0.02%

No gravitational constant G, no masses — only geometry and a unit scale.

3 Solar Gravitational Parameter

From classical mechanics $v_\oplus^2 = GM_\odot/r_{\rm AU}$, with $r_{\rm AU} = 149597870.7$ km. Substituting the geometric $v_\oplus$:

$$GM_\odot^{(\rm geom)} = r_{\rm AU} \times V_0^2 \times \Gamma^2 \approx 1.32660 \times 10^{20}\ \mathrm{m}^3/\mathrm{s}^2.$$

Source	$GM_\odot$ ($\mathrm{m}^3/\mathrm{s}^2$)	Gap
Geometric (this work)	1.32660×10^{20}	—
IAU/CODATA	1.32712×10^{20}	-0.04%

Again, no G and no masses — only geometry, distance, and V_0.

4 G as a Derived Quantity

The Newtonian constant G appears only if one insists on expressing $GM_\odot$ in terms of $M_\odot$:

$$G^{(\rm geom)} = \frac{GM_\odot^{(\rm geom)}}{M_\odot} \approx 6.67144 \times 10^{-11}\ \mathrm{m}^3\mathrm{kg}^{-1}\mathrm{s}^{-2}.$$

CODATA 2022: 6.67430×10^{-11} (deviation -0.043%).

In the primary relations $v_\oplus = \Gamma V_0$ and $GM_\odot = r_{\rm AU} V_0^2 \Gamma^2$, G is **not needed at all**.

5 Key Features

- **No masses** in the primary relations — only radii, distance, and a unit velocity scale.
- **No free parameters** — everything is fixed by the geometry of the Sun–Earth–Moon system.
- **The Moon's radius is essential** — without it the system does not close.
- G **is a derived artifact** — it appears only if one insists on separating $GM_\odot$.

6 Kochenov Equation (Final Form)

$$\boxed{v_\oplus = \Gamma \times V_0}$$

where

$$\Gamma = \frac{R_\odot \times R_{\rm Moon}}{R_\oplus^2}, \qquad V_0 = 1\ \mathrm{km/s}.$$

Or equivalently, in explicit numerical form:

$$\boxed{v_\oplus\ (\mathrm{km/s}) = \frac{R_\odot \times R_{\rm Moon}}{R_\oplus^2}}$$

7 Conclusion

The dimensionless ratio

$$\Gamma = \frac{R_\odot \times R_{\rm Moon}}{R_\oplus^2} \approx 29.7788$$

determines Earth's orbital speed ($v_\oplus = \Gamma \times 1$ km/s, deviation 0.02%) and the solar gravitational parameter ($GM_\odot = r_{\rm AU}\Gamma^2$, deviation 0.04%) without using G or any masses.

The relations are empirical geometric correlations presented as observations. No dynamical model is claimed.

I am almost joking. But the formula works.

— Boris V. Kochenov, May 21, 2026

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