Enchan SPARC Rotation-Curve Prediction Report v0.1

Fixed-parameter prediction of $V_{\mathrm{obs}}(r)$ from public SPARC mass models

Mitsuhiro Kobayashi

Tokyo, Japan

enchan.theory@gmail.com

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Abstract

This report documents a minimal, reproducible "rotation-curve prediction" test using public SPARC Newtonian mass-model files (`Rotmod_LTG`). For each radial point we compute the baryonic acceleration proxy $g_{\mathrm{bar}}(r) = \left(V_{\mathrm{gas}}^2 + \Upsilon_{\mathrm{disk}} V_{\mathrm{disk}}^2 + \Upsilon_{\mathrm{bul}} V_{\mathrm{bul}}^2\right)/r$ and map it to a predicted gravitational response using the one-parameter empirical curve $g_{\mathrm{pred}} = g_{\mathrm{bar}} / \left(1 - e^{-\sqrt{g_{\mathrm{bar}}/a_0}}\right)$. In contrast to a fit, we hold parameters fixed at $(\Upsilon_{\mathrm{disk}}, \Upsilon_{\mathrm{bul}}) = (0.60, 0.70)$ and $a_0 = 1.12 \times 10^{-10}\,\mathrm{m/s^2}$ (a representative value from an independent RAR fit), and compare the implied $V_{\mathrm{pred}}(r) = \sqrt{g_{\mathrm{pred}}(r)\, r}$ against observed $V_{\mathrm{obs}}(r)$. After basic quality cuts ($r > 0$, $V_{\mathrm{obs}} > 0$, finite values), we analyze 3375 radial points from 171 galaxies. The global RMS residual in $\log_{10} g$ is 0.208 dex (velocity fractional RMS 0.358).

Contents

1 Scope and deliverable

This document is intentionally narrow: it records a **single** verification task that can be rerun from public data with short Python code. The goal is to provide an external "handle" on an Enchan-relevant question: *can a direct baryons-to-dynamics mapping predict full rotation curves with fixed parameters?* No claim of definitive model selection is made here; we fix definitions, parameters, and outputs.

2 Data and definitions

Data

We use the SPARC `Rotmod_LTG` files (`[Galaxy]_rotmod.dat`), which provide: radius r (kpc), observed velocity V_{obs} (km/s) with uncertainty, and Newtonian component velocities V_{gas}, V_{disk}, V_{bul} (km/s), plus surface-brightness metadata. We apply basic quality cuts ($r > 0$, $V_{obs} > 0$, finite values).

Accelerations

We compute

$$g_{\rm obs}(r) = \frac{V_{\rm obs}(r)^2}{r}, \tag{1}$$

$$g_{\rm bar}(r) = \frac{V_{\rm gas}(r)^2 + \Upsilon_{\rm disk} V_{\rm disk}(r)^2 + \Upsilon_{\rm bul} V_{\rm bul}(r)^2}{r}, \tag{2}$$

converting $(\mathrm{km/s})^2/\mathrm{kpc}$ to $\mathrm{m/s}^2$.

Fixed mapping and prediction

We use

$$g_{\rm pred}(g_{\rm bar}; a_0) = \frac{g_{\rm bar}}{1 - \exp\left(-\sqrt{g_{\rm bar}/a_0}\right)}. \tag{3}$$

Parameters are fixed for the entire sample:

$$(\Upsilon_{\rm disk}, \Upsilon_{\rm bul}) = (0.60, 0.70), \qquad a_0 = 1.12 \times 10^{-10}\,\mathrm{m/s}^2. \tag{4}$$

Predicted velocity is

$$V_{\rm pred}(r) = \sqrt{g_{\rm pred}(r)\, r}, \tag{5}$$

where $g_{\rm pred}(r) \equiv g_{\rm pred}(g_{\rm bar}(r); a_0)$.

3 Results

Point-level comparison

Figure 1 compares V_{pred} and V_{obs} across all points.

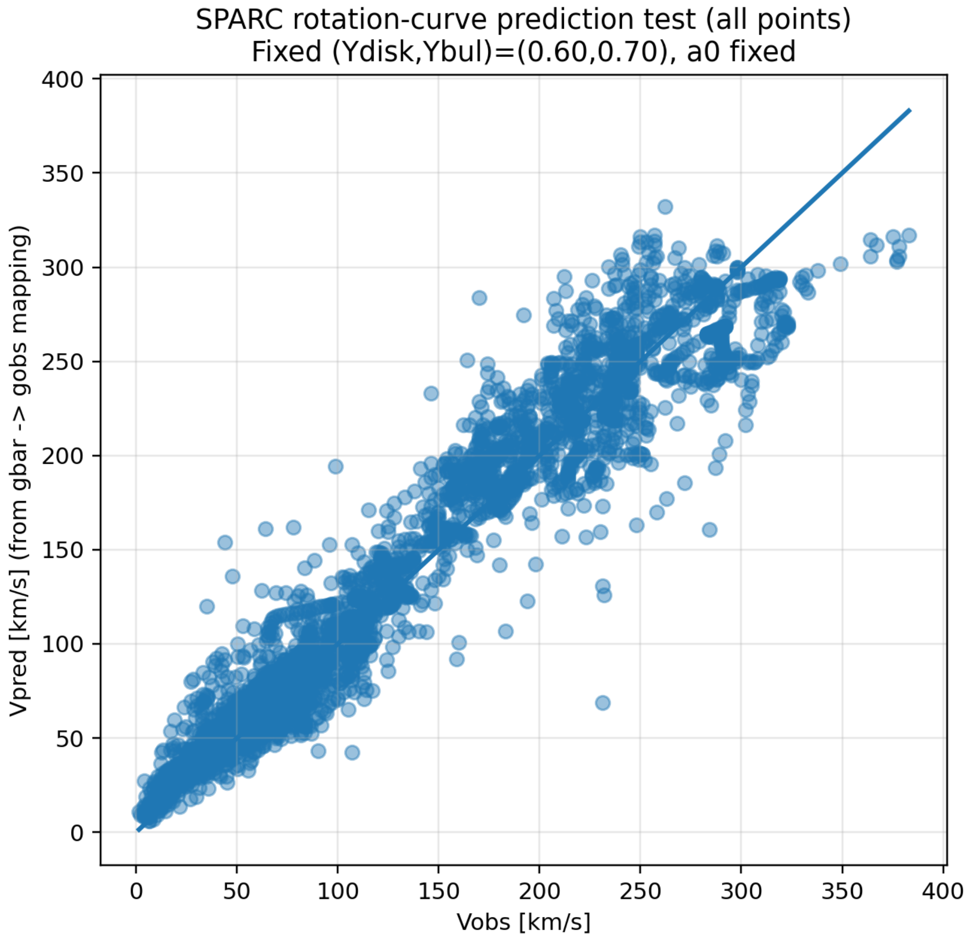

Figure 1: Point-level comparison of predicted vs observed rotation speed (all galaxies, all radii).

Residual distributions

We report residuals in $\log_{10} g$:

$$\Delta = \log_{10}(g_{\text{obs}}) - \log_{10}(g_{\text{pred}}). \tag{6}$$

Figure 2 shows the residual distribution, and Figure 3 shows the distribution of per-galaxy RMS residuals.

Quick numerical summary

Table 1 summarizes global and per-galaxy metrics. Note: the per-galaxy reduced χ^2 values use an approximate uncertainty $\sigma_{\log g} \approx (2\sigma_V/V)/\ln(10)$ and ignore radius uncertainty.

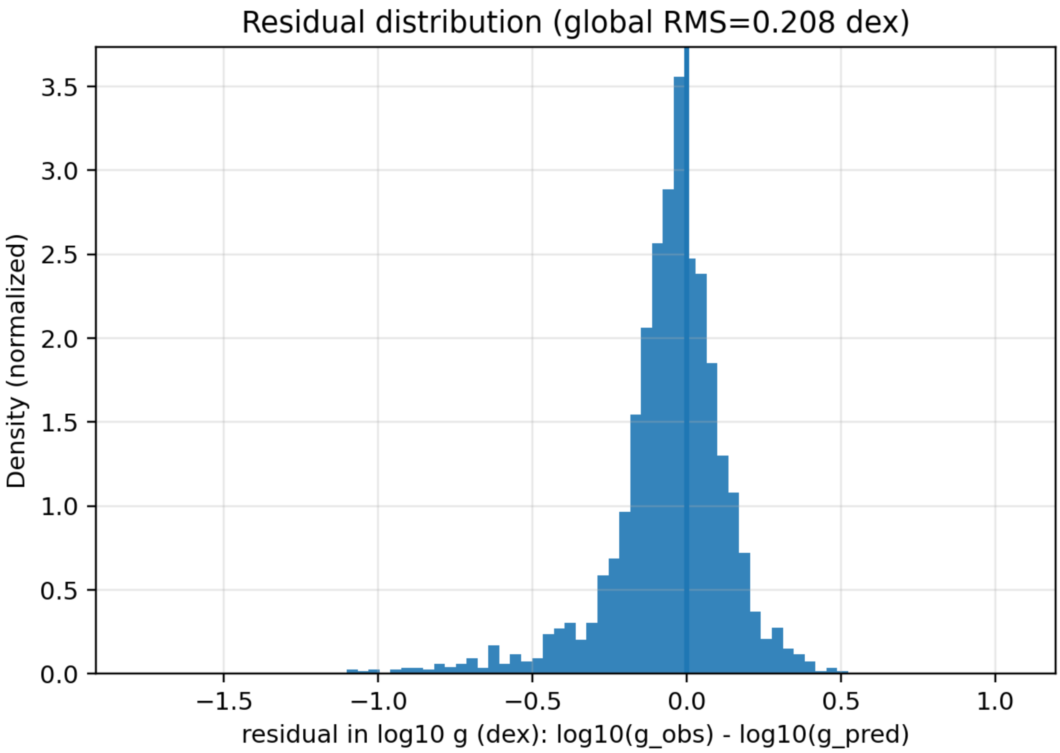

Figure 2: Residual distribution in $\log_{10} g$ (global RMS = 0.208 dex).

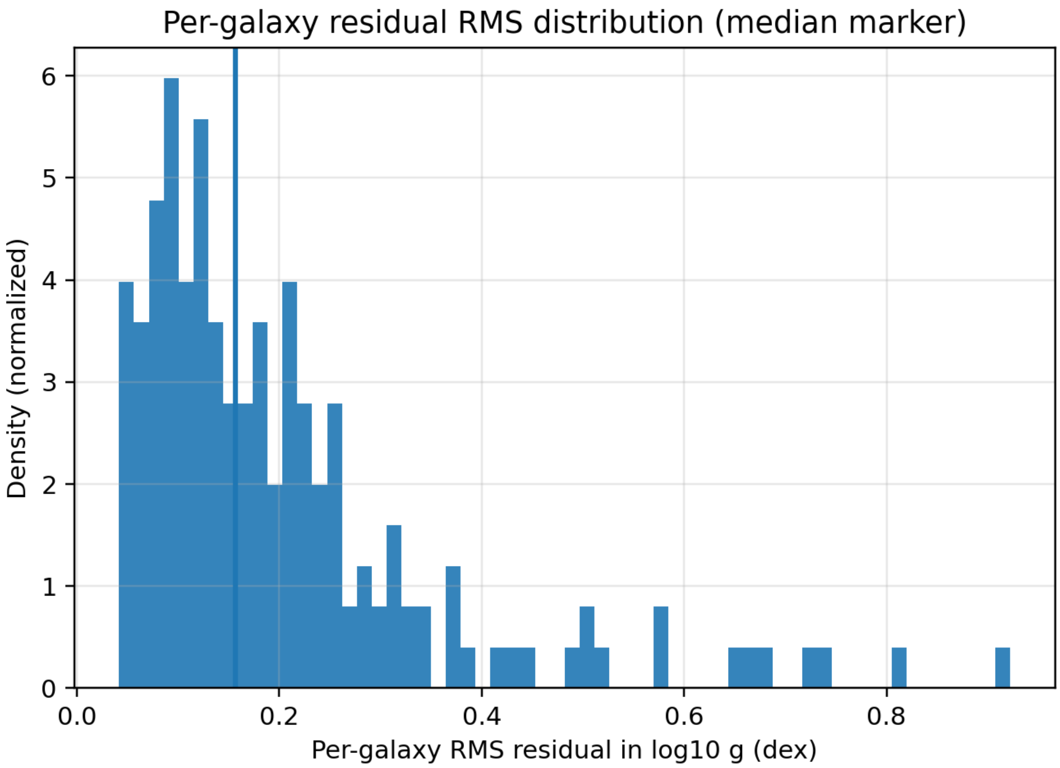

Figure 3: Distribution of per-galaxy RMS residuals in $\log_{10} g$ (median marker).

Metric	Value	Notes
Galaxies	171	after cuts
Radial points	3375	after cuts
Global RMS in $\log_{10} g$	0.208 dex	all points
Global RMS in fractional V	0.358	$(V_{\rm obs} - V_{\rm pred})/V_{\rm obs}$
Median per-galaxy reduced χ^2	10.37	approximate $\sigma_{\log g}$
Fraction with reduced $\chi^2 < 2$	0.129	
Fraction with reduced $\chi^2 < 5$	0.327	

Table 1: Summary of the fixed-parameter rotation-curve prediction test.

4 Interpretation: geometry vs particles (minimal statement)

This report establishes one empirical fact from public SPARC mass models: **a single fixed mapping $g_{\rm bar} \mapsto g_{\rm pred}$ produces a nontrivial, sample-wide prediction for full rotation curves without tuning parameters per galaxy.**

What this does and does not show

This test does *not* falsify particle dark matter, and it does *not* validate any specific geometric theory by itself. It does provide a reproducible target: any successful explanation must account for why a tight baryons-to-dynamics mapping works as well as it does, and where it fails. The residuals and reduced χ^2 indicate substantial scatter and/or unmodeled systematics, so this should be read as a baseline fixed-parameter benchmark.

5 Reproducibility artifacts

This report is accompanied by:

- `sparc_vpred_points_Yd0p60_Yb0p70_a0fixed.csv`: point-level predictions and residuals
- `sparc_vpred_galaxy_summary_Yd0p60_Yb0p70_a0fixed.csv`: per-galaxy summary
- figures: `fig_vpred_vs_vobs.png`, `fig_resid_logg_hist.png`, `fig_galaxy_rms_hist.png`

6 References

- SPARC database (downloads): https://astroweb.case.edu/SPARC/