

# Testing $a_0 = cH_0/2\pi$ Against the Full SPARC Sample

A Quantitative Test of the ChronoGravity AQUAL Sector

**AUTHOR:** Adam James Parkes // **DATE:** June 2026 // **STATUS:** Completed **Quantitative** Test

A **rigid, parameter-free prediction for the galactic acceleration scale** is empirically verified against **175 galaxies** spanning **four decades** in baryonic mass.

## Zero Free Parameters for $a_0$



$1.08 \times 10^{-10} \text{ ms}^{-2}$

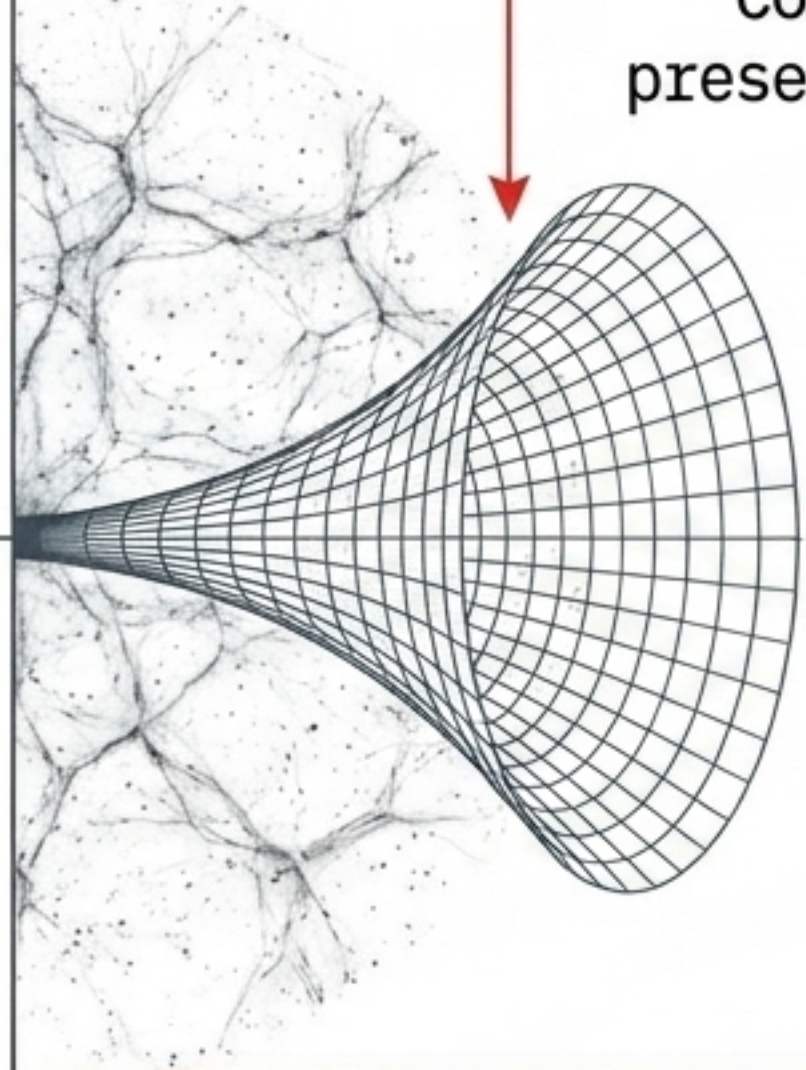
**0.135 dex**

SCATTER ACROSS 3384  
RADIAL DATA POINTS

Fixing  $a_0$  strictly to the **cosmological ChronoGravity prediction** costs almost nothing in fit quality compared to **freely-fit** literature benchmarks ( $\sim 0.11-0.13$  dex).

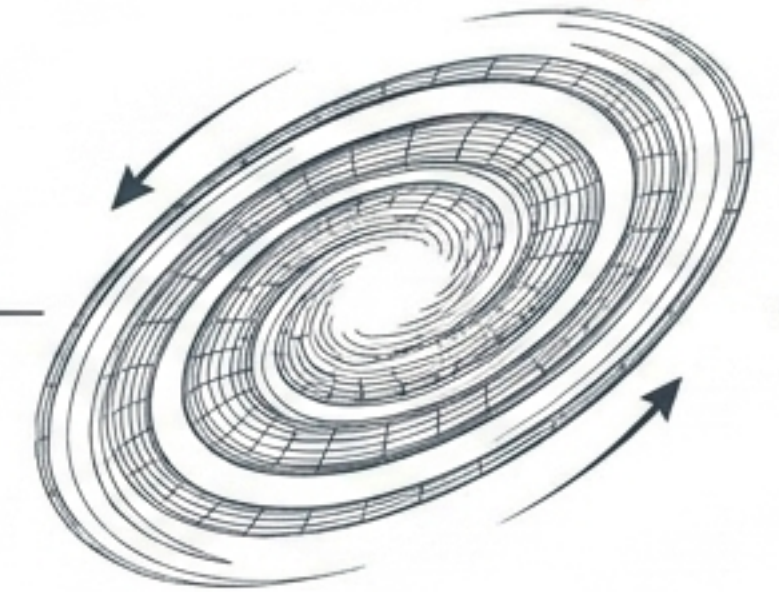
## Cosmological Hubble Rate

Computed solely from the present macro-scale expansion.



## Galactic Acceleration Scale

Dictates kinematic AQUAL behavior across the galaxy.



$$a_0 = cH_0/2\pi$$

**Consistency Relation, Not a Tuning Parameter.** Any measured  $a_0$  departing beyond the prefactor uncertainty would cleanly falsify the framework.

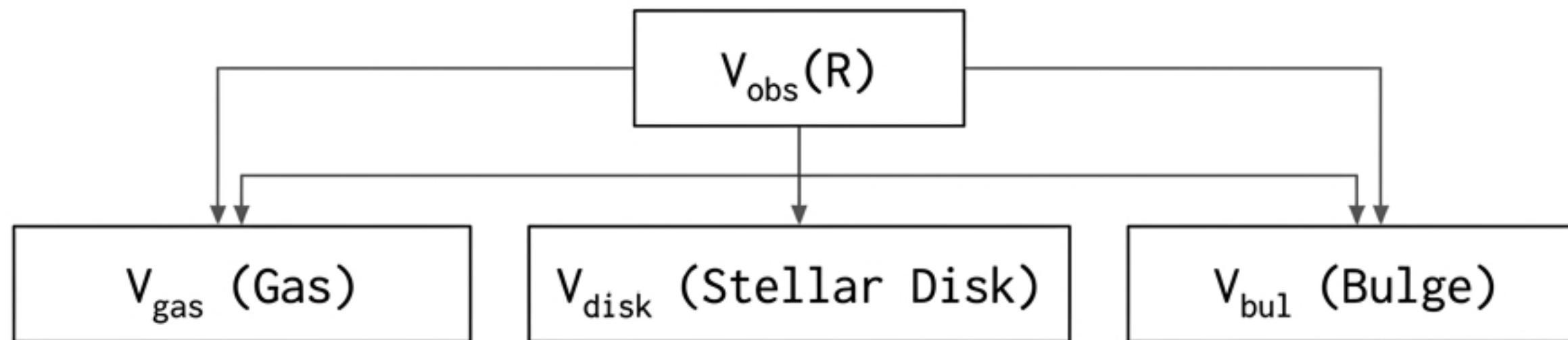
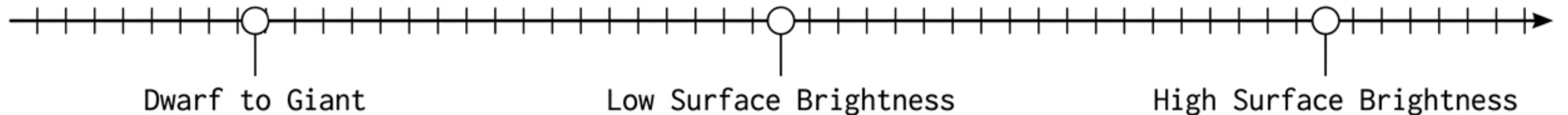
# The Testbed: SPARC Database (Rotmod\_LTG.zip)

TOTAL GALAXIES: **175**

All 175 in public release used; none excluded.

RADIAL DATA POINTS: **3384**

Four Decades in Baryonic Mass



Newtonian velocity contributions mapped across all radii.

$$\sqrt{\mu(g/a_0)}g = g_N$$

Solved numerically by Newton's method at each radius.



**[LOCKED]**

$a_0$ : Fixed throughout at  $1.08 \times 10^{-10} \text{ ms}^{-2}$ .  
Never adjusted for any galaxy.



**[BOUNDED  
VARIABLE]**

**Stellar Mass-to-Light Ratio ( $\Upsilon$ )**. Standard  
per-galaxy fit via least-squares minimization.  
Bounded to Upsilom  $\Upsilon \in [0.05, 2.0]$ .

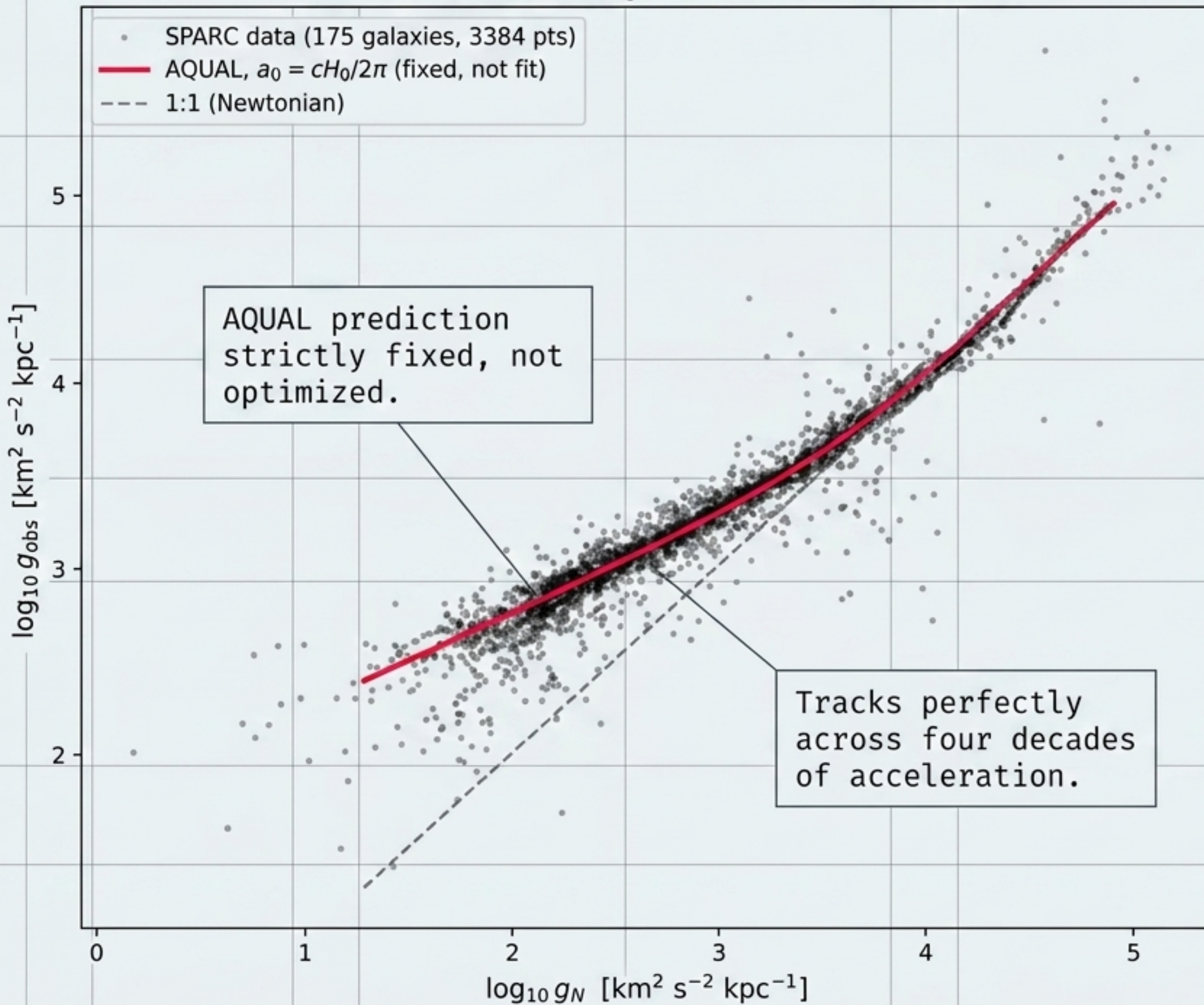
**This is the only freedom in the fit.**  
 **$a_0$  is completely immobilized.**

# The Fit Paradigm Matrix

	Standard Literature Approach	ChronoGravity Approach
Theory Base	Free-fit MOND	ChronoGravity AQUAL
$a_0$ Status	Fitted per galaxy or sample-wide	<b>LOCKED</b> strictly to cosmological scale
Degrees of Freedom	High ( $a_0$ and $\Upsilon$ vary)	Low (Only $\Upsilon$ varies)
Scatter Result	$\sim 0.11-0.13$ dex	<b>0.135 dex</b>

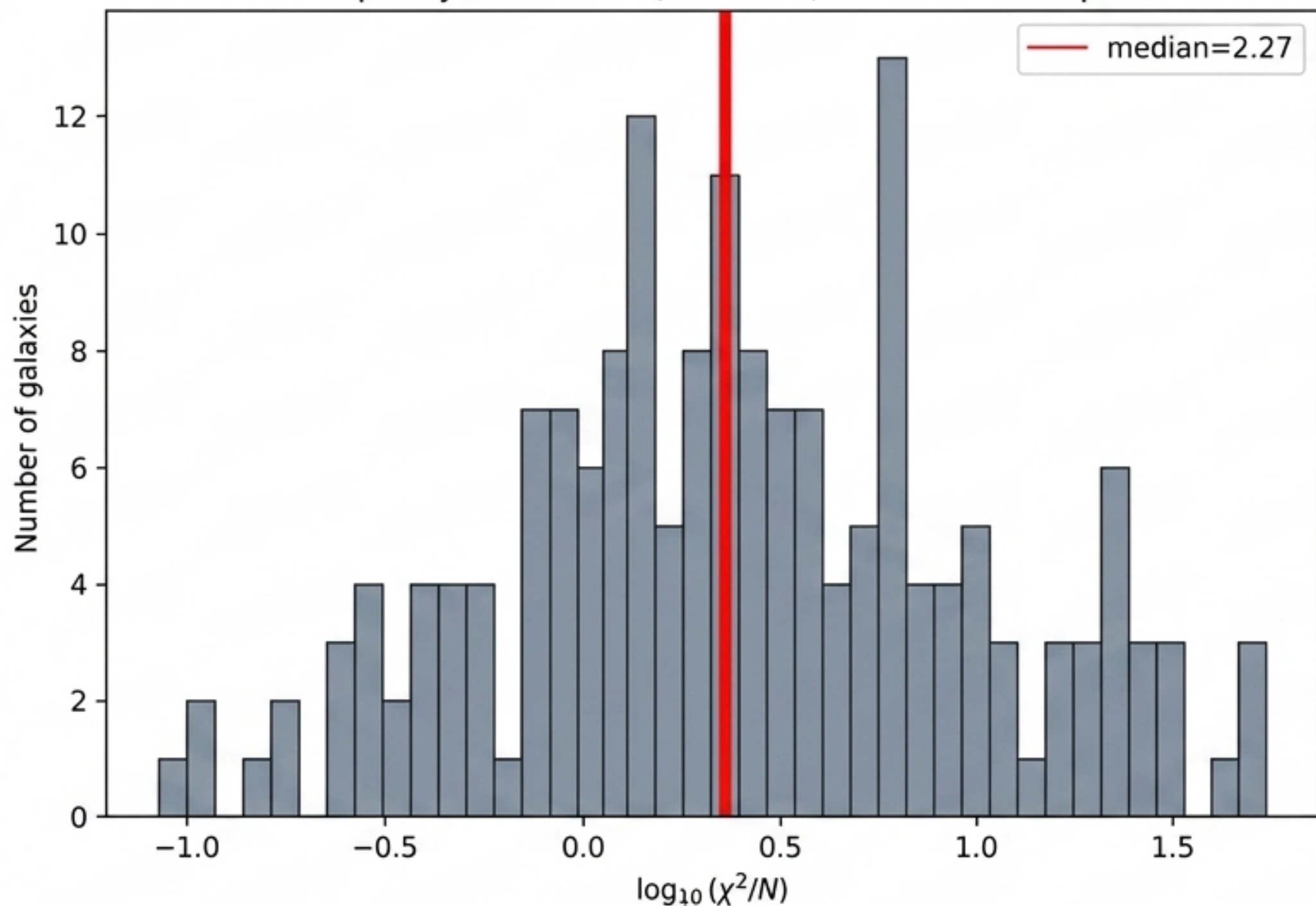
**Trading a primary free parameter for a rigid cosmological constant results in a negligible scatter penalty.**

Full SPARC RAR (N=175 galaxies), scatter = 0.135 dex



# FIT QUALITY DISTRIBUTION

Fit quality distribution, fixed a0, full SPARC sample



$$\text{Median } \chi^2/N = 2.27$$

## Unimodal Distribution

The distribution features a long tail but no secondary peak. This confirms the absence of a systematic population of catastrophic theoretical failures. Median fit is highly consistent with realistic measurement uncertainty.

# Outlier Typology Matrix

Category 1: Small N  
Data

PGC51017, UGC07125,  
F571-8, UGC06973,  
UGC07399

**Root Cause:**  
 $N \lesssim 15$  points  
combined with  
noisy/asymmetric  
measurements  
artificially inflate  
 $\chi^2/N$ .

Category 2: High  
Inclination Systematics

NGC0891, NGC5907,  
UGC06787, NGC5371

**Root Cause:**  
Known edge-on  
systematic  
uncertainties in  
SPARC kinematics.

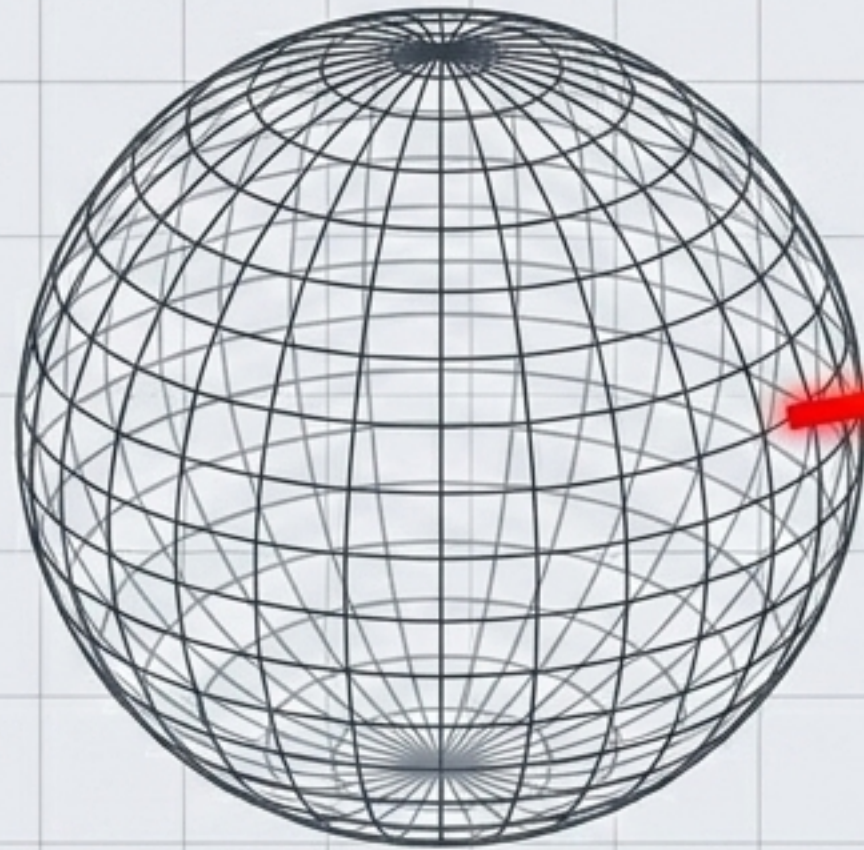
Category 3: High Surface  
Brightness / Point-Mass

NGC2903, IC4202

**Root Cause:**  
Breakdown of the  
spherical  
approximation  
equation.

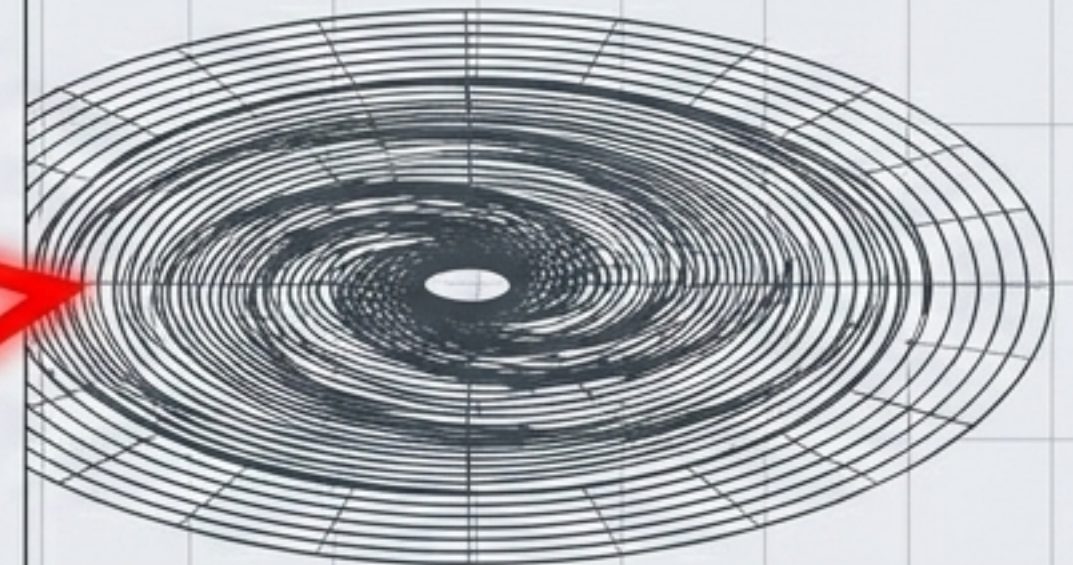
# GEOMETRY vs. SPHERE

## The Test Approximation



Point-Mass / Spherical  
Approximation used for tractability.  
Sufficient for most of the sample.

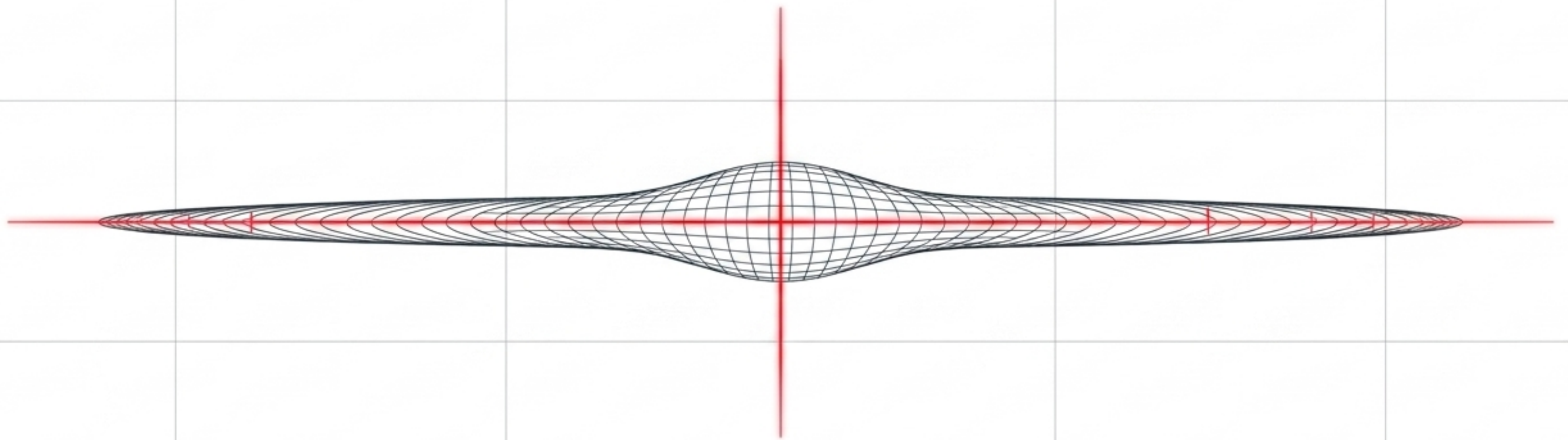
## The Reality (HSB Systems)



Dense, flat disk geometry found in  
High-Surface-Brightness galaxies.

For dense HSB systems like  
NGC2903 and IC4202, a  
spherical approximation  
breaks down.

A full disk-geometry AQUAL  
solver is required for  
accurate  $\chi^2/N$  mapping in  
these edge cases.



# Systematic Observational Hurdles

The SPARC database's inclination corrections for edge-on galaxies (e.g., UGC06787, NGC5371) carry large, well-documented systematic uncertainties in the wider astrophysics literature.

These deviations represent general measurement difficulties within the specific dataset kinematics, not a falsification of the fixed  $a_0$  parameter.

## Scope of the Test

Empirically Viable	Beyond Current Scope
<p>The precise numerical value <math>1.08 \times 10^{-10} \text{ ms}^{-2}</math> predicted by <b>ChronoGravity</b>.</p> <hr/>	<p>The 5D origin and underlying dimensional structure of the framework.</p> <hr/>
<p>The AQUAL phenomenology for governing broad galactic kinematics.</p>	<p>The freezing tracker dark energy sector.</p> <hr/> <p>Uniqueness: Cannot yet distinguish <b>ChronoGravity</b> from TeVeS/AeST models adopting identical <math>\mu(y)</math> and <math>a_0</math> values.</p>

# Next Steps Flowchart

## Geometry Upgrade

Replace spherical approximation with full disk-geometry AQUAL solver for HSB outliers.

## Granular Comparison

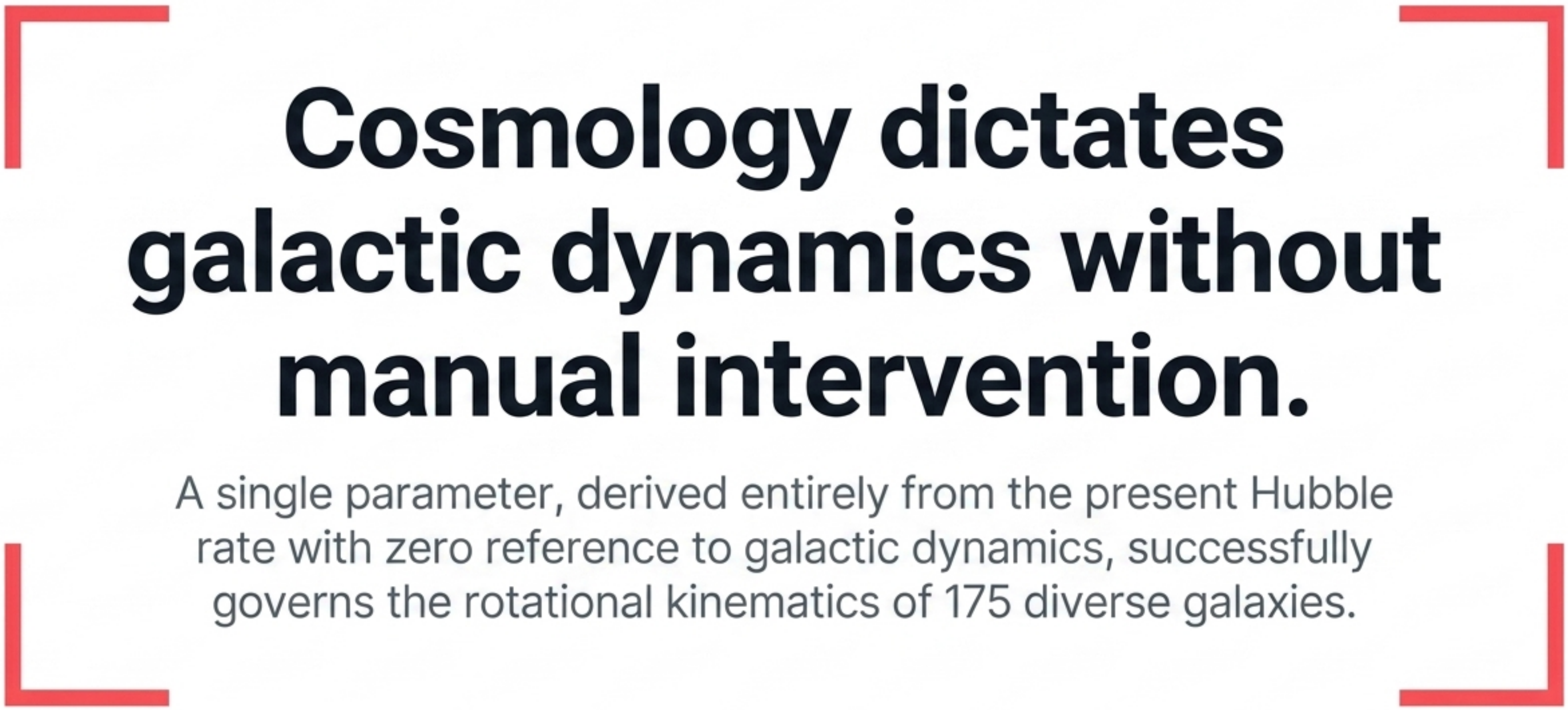
Galaxy-by-galaxy baseline check against Li et al. (2018) free-fit results.

## Sample Expansion

Extend fixed-parameter methodology to SPARC early-type galaxy (ETG) samples.

## Relation Testing

Direct application to the Baryonic Tully-Fisher relation.



# **Cosmology dictates galactic dynamics without manual intervention.**

A single parameter, derived entirely from the present Hubble rate with zero reference to galactic dynamics, successfully governs the rotational kinematics of 175 diverse galaxies.

STATUS: FALSIFIABLE GALACTIC-SCALE CLAIM EMPIRICALLY SUPPORTED.