A Gravitational Sorting Resolution of the Hubble Tension

Mathematical & Statistical Formulations from BFUT Paper P60

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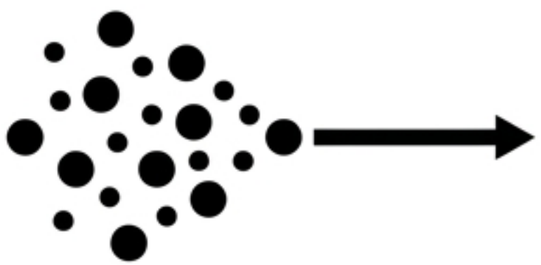


The Axiomatic Discrepancy: A Century of Non-Convergence

$$H_0[\text{CMB}] = 67.4 \pm 0.5 \text{ km/s/Mpc} \quad (z \sim 1100)$$

$$H_0[\text{SH0ES}] = 73.04 \pm 1.04 \text{ km/s/Mpc} \ (z < 0.15)$$

$$H_0[\text{Group}] = 63 \pm 6 \text{ km/s/Mpc} \quad (z < 0.01)$$

$$H_0[\text{Group}] \neq H_0[\text{CMB}] \neq H_0[\text{SH0ES}]$$

Successive independent methodologies have failed to converge despite substantial improvements in measurement precision.

Reframing the Velocity-Distance Relationship

Standard Cosmology

$$v = H_0 \cdot D$$

$H_0 \rightarrow$ Universal Constant

Assumes the relationship is a signature of a single, universal metric expansion rate.

P60 Gravitational Sorting

$$v \propto D \Rightarrow H_{eff} = f(\text{scale, binding degree})$$

$H_{eff} \rightarrow$ Emergent Statistical Property

Assumes the relationship is an emergent outcome of a gravitationally sorted population of galaxies.

The Foundational Substrate Axiom

The Spaticle Field Equilibrium Density.

Provides the physical framework for gravitational

$$\rho_s = 5.9 \times 10^{-27}\,\mathrm{kg/m^3}$$

Provides the physical framework for gravitational sorting dynamics without invoking dark energy or metric expansion.

N-Body Simulation: Boundary Conditions

$N = 200$ galaxies (Randomized initial positions and velocities)

$a(t) = 1$ (No expansion parameter)

$\Lambda = 0$ (No dark energy term)

$\vec{v}_{init} = \text{Random}$ (No tuned initial velocity field)

$\text{Dynamics} \rightarrow \text{Pure Newtonian Gravity}$

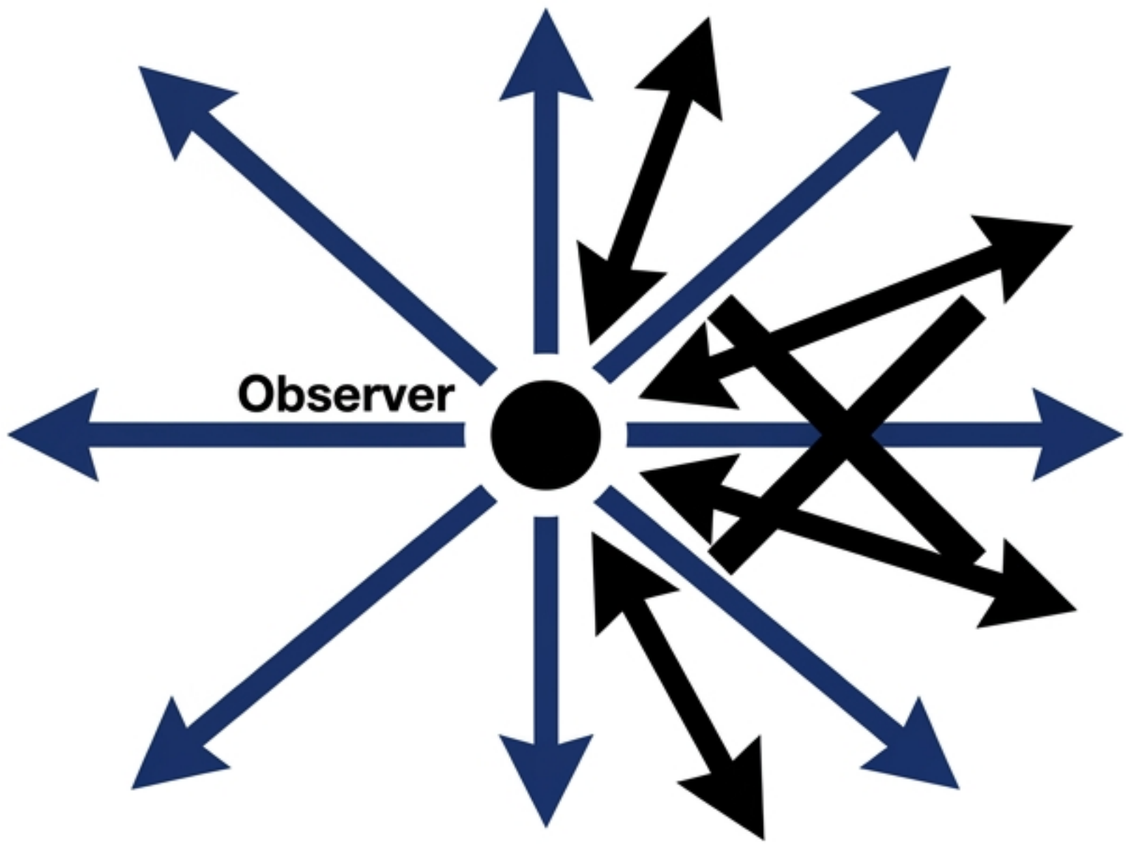
Can a Hubble-like velocity-distance correlation emerge purely from gravitational dynamics with no imposed metric expansion?

Simulation Output I: Velocity-Distance Correlation

Eq 1: r = 0.675

Pearson correlation coefficient achieved after dynamical evolution. A statistically significant velocity-distance correlation emerges purely from gravitational sorting.

Simulation Output II: The Asymmetric Survival Fraction



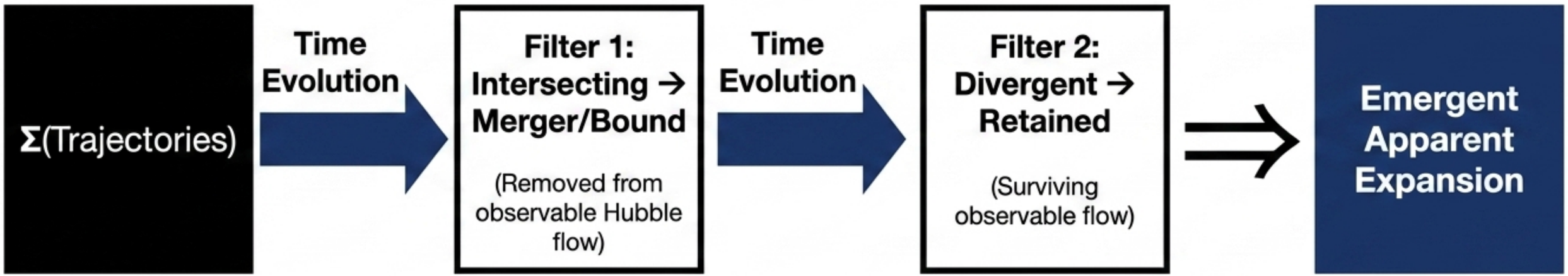
Eq 2:

$$f_{recede} = 84\%$$

Annotation

84 percent of surviving galaxies are receding from an arbitrarily chosen observer. Galaxies on interacting trajectories are preferentially removed via mergers; divergent trajectories are retained.

The Gravitational Sorting Operator



Galaxies subject to ongoing gravitational interaction develop a statistical velocity-distance relationship over long dynamical timescales.

The Scale-Dependent Sorting Formalism

$$H_{eff} \propto 1/\tau_{\text{sort}}(z, E_{\text{bind}})$$

H_{eff}: The effective velocity-distance relationship inferred by any given measurement.

τ_{sort}: Characteristic sorting timescale of the specific galaxy population.

z: Redshift range.

E_{bind}: Degree of gravitational binding.

Measurements probing different spatial scales and degrees of binding are expected to return systematically different effective values of H_0.

Mapping Observables to the Sorting Formalism

63 km/s/Mpc

High binding energy, very small scale ($z < 0.01$). Probes galaxy group infall dynamics.

67.4 km/s/Mpc

Low local binding energy, maximum scale ($z \sim 1100$). CMB-scale average where peculiar velocities average out.

73.04 km/s/Mpc

Intermediate scale ($z < 0.15$). Local distance ladder, susceptible to residual bulk-flow contamination.

Falsifiable Mathematical Predictions

$$\Delta H_0 \not\to 0 \text{ as } \text{precision} \to \infty$$

Measurements will not converge to a single value as precision improves.

$$H_0(z < 0.01, \text{bound}) \leq 63 \text{ km/s/Mpc}$$

Future measurements of bound galaxy groups will continue trending downward.

$$H_0[\text{SH0ES\_corrected}] < 73.04 \text{ km/s/Mpc}$$

Distance ladder values will drop closer to the CMB value when local bulk flow is explicitly removed.

Conclusion

> **The century-long pattern of non-convergence reflects a genuine physical property of the measurement. The Hubble relationship is an emergent statistical property of gravitational dynamics acting on a sorted galaxy population, rather than the signature of a single, universal metric expansion rate.** ■