

# K-Synchronisation: A Correlation-Based Extension of Galactic Dynamics (Corrected)

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**Note:** Computations performed with AI-assisted tools

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## Abstract

We propose a correlation-based framework for galactic dynamics. From the observed light distribution  $I(\mathbf{r})$  we reconstruct a correlation field  $K(\mathbf{r})$  that adds a long-range, nonlocal term to the effective potential  $\Phi_{\text{eff}}$ . Applied to HST data of M51 (after geometric deprojection and companion masking), the model yields flat rotation curves without invoking particle dark matter and remains robust under parameter variation. We further introduce an operational time reparameterisation (*K-synchronisation*) linking time dilation to correlation depth and provide lensing proxies derived from the same  $\Phi_{\text{eff}}$ .

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## 1. Motivation

Conventional dark-matter phenomenology attributes the flattening of galactic rotation curves to invisible mass. We instead interpret it as an interior, correlation-driven modification of the metric's time component: where correlation density increases, operational time appears dilated and dynamics reflect an additional, smooth potential.

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## 2. Method (explicit definitions)

We proceed in three steps.

### (i) Holographic proxy from light

$$\kappa[I](\mathbf{r}) = a I_{\text{norm}}(\mathbf{r}) + b [(-\Delta)^{-1} I_{\text{norm}}](\mathbf{r}) + c \mathcal{F}[I](\mathbf{r}), \quad a, b, c \geq 0.$$

Here  $I_{\text{norm}} \in [0, 1]$  is the masked, normalised intensity map. The **Fisher information density**  $\mathcal{F}[I]$  is built from

$$p(\mathbf{r}) = \frac{I_{\text{norm}}(\mathbf{r}) + \varepsilon}{\int (I_{\text{norm}}(\mathbf{r}') + \varepsilon) d^2 r'}, \quad \mathcal{F}[I](\mathbf{r}) = p(\mathbf{r}) \|\nabla \ln p(\mathbf{r})\|^2.$$

The operator  $(-\Delta)^{-1}$  denotes the 2D Poisson inverse (realised via FFT), i.e. convolution with the logarithmic Green's function (up to an additive constant fixed by zero-mean).

### (ii) Correlation field with finite range (Yukawa)

$$(\nabla^2 - \ell^{-2}) K(\mathbf{r}) = \alpha \kappa[I](\mathbf{r}), \quad \ell > 0, \alpha > 0.$$

In Fourier space:

$$\hat{K}(\mathbf{k}) = \frac{\alpha \hat{\kappa}(\mathbf{k})}{-(|\mathbf{k}|^2 + \ell^{-2})}.$$

This implements a controlled correlation range  $\ell$  and yields a smooth, stable  $K$ .

### (iii) Effective potential and rotation curve

$$\Phi_{\text{eff}}(\mathbf{r}) = \Phi_N(\mathbf{r}) + \beta K(\mathbf{r}), \quad \nabla^2 \Phi_N \propto I_{\text{norm}}.$$

The azimuthally averaged circular velocity (in deprojected rings) is

$$v(r) = \sqrt{r \frac{d\Phi_{\text{eff}}}{dr}}.$$

### Optional: K-synchronisation (operational time)

$$dt^{*}(\mathbf{r}) = \chi(K(\mathbf{r})) dt, \quad \chi(K) = \exp(-\beta_{\text{sync}} K).$$


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## 3. Results (M51, HST)

- **Baseline vs. +K:** Newtonian light-only curves decline;  $\Phi_{\text{eff}} = \Phi_N + \beta K$  exhibits a broad, flat plateau.
  - **Robustness:** The shape remains stable for  $\ell \in [40, 320]$  (pixels) and  $\beta \in [0.4, 1.6]$ ;  $\ell$  mostly sets the plateau radius.
  - **Deprojection & masking:** Using  $i \approx 22^\circ$ ,  $PA \approx 173^\circ$ , masking NGC 5195, the result persists.
  - **K-synchronisation:** Curves in  $t^*$  align with the correlation-augmented dynamics, making the “missing pull” explicit in  $K$ .
  - **Lensing proxies:** From the same  $\Phi_{\text{eff}}$  we compute convergence  $\kappa_L = \frac{1}{2} \nabla^2 \Phi_{\text{eff}}$  and shear amplitude  $|\gamma| = \sqrt{(\frac{1}{2}(\Phi_{xx} - \Phi_{yy}))^2 + \Phi_{xy}^2}$ , yielding plausible central patterns.
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## 4. Discussion

The framework reframes flat rotation curves as an **interior correlation effect**: additional long-range structure in  $\Phi_{\text{eff}}$  emerges from  $K$  reconstructed out of light, rather than from unseen particles. The same construction underwrites both dynamics and lensing proxies and connects time dilation to correlation depth through K-synchronisation.

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## 5. Outlook

- (1) Fixed-parameter tests on a SPARC subset (BTFR, RAR).
  - (2) Prediction of internal gravitational redshifts  $\Delta z(r)$ .
  - (3) Weak-lensing comparisons using  $\Phi_{\text{eff}}$ -derived convergence.
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**Keywords:** galactic dynamics, dark matter alternatives, correlation field, time dilation, M51