Chronoscalar Dynamics of Multi-Planet Systems: Machian Distortion of Stellar Rotation in the Exoplanet Archive

Calvin Alexander Grant
Chronoscalar Dynamics
`lotdf9977@gmail.com`

2025

Abstract

Chronoscalar Field Theory (CFT) postulates a scalar time field $T(x)$ whose gradient and Hessian govern both the geometry of large-scale structure and the resonant architecture of planetary orbits. In this framework planetary systems are not arbitrary outcomes of stochastic disk evolution but projections of a chronoscalar resonance lattice. A key prediction is that planets in a given system occupy discrete period ratios which collapse onto a single effective chronoscalar period $P_{\rm eff}$ when divided by appropriate integers, whereas the observed stellar rotation period $P_\star$ is generally a Machian–distorted quantity that need not coincide with $P_{\rm eff}$.

Using the NASA Exoplanet Archive composite table, I analyze all host stars with at least three confirmed planets for which both the planetary orbital periods $P_{\rm orb}$ and stellar rotation period $P_\star$ are reported. For each system I infer $P_{\rm eff}$ by searching for the integer assignments k_i that minimize the dispersion of $P_{\rm orb,i}/k_i$ across all planets. The ratio $P_{\rm eff}/P_\star$ then quantifies the Machian distortion of the stellar envelope relative to the underlying chronoscalar clock.

Across 46 multi-planet hosts the inferred ratios satisfy median$(P_{\rm eff}/P_\star) \simeq 9 \times 10^{-3}$ and mean$(P_{\rm eff}/P_\star) \simeq 5 \times 10^{-2}$, with three quarters of systems having $P_{\rm eff}/P_\star < 0.02$. Case studies such as TRAPPIST-1, GJ 3293 and Kepler-51 reveal extremely tight internal chronoscalar ladders—with several planets sharing a common $P_{\rm eff}$ to better than one per cent—while their host stars rotate an order of magnitude or more slowly. These results are difficult to reconcile with a view in which the stellar spin and planetary periods are governed by unrelated processes, but they are natural in CFT, where planetary systems remember the primordial T-field while the stellar photosphere is gradually torqued by Machian and Hessian perturbations.

This first chronoscalar census of the exoplanet archive demonstrates that multi-planet systems encode an effective time scalar distinct from the observed stellar rotation, and that the ratio of these clocks provides a direct observational handle on local Machian distortion. I outline how combining these chronoscalar periods with environmental information (voids, filaments, and galactocentric radius) can turn exoplanet systems into a tomographic probe of the cosmic T-field.

1 Introduction

The discovery of thousands of exoplanets has transformed planetary science from a Solar System–centric discipline into a statistical astrophysics of planetary architectures. The standard paradigm assumes that planetary orbital periods arise from local processes in protoplanetary disks—core accretion, migration, and dynamical scattering—while the host star's rotation evolves largely independently under magnetic braking, stellar winds and internal angular momentum transport. Planetary orbits and stellar spins are treated as related only through tidal friction in the closest-in systems.

Chronoscalar Field Theory (CFT) proposes a radically different picture. In CFT the universe is endowed with a scalar time field $T(x)$ whose non-vanishing gradient defines the arrow of time and whose Hessian $\partial_i \partial_j T$ controls the emergence of structure from quantum to cosmic scales. Geometry, rotation curves, filament orientation and planetary orbits are not independent entities but projections of chronoscalar microstructure onto macroscopic observables. The Sun's 24.47-day equatorial rotation period appears in this theory not as an incidental property of a particular star but as the local manifestation of a fundamental chronoscalar mode.

Within this framework planetary systems are expected to exhibit discrete resonance ladders. Planets occupy orbits whose periods satisfy

$$P_{\mathrm{orb},i} \simeq k_i P_{\mathrm{eff}}, \tag{1}$$

where P_{eff} is an effective chronoscalar period set by the local T-field and k_i are integers labelling the ladder. The observed stellar rotation period $P_\star$ is not guaranteed to equal P_{eff}; rather it is a quantity subject to long-term Machian torque from background flows and Hessian curvature. Over gigayears the stellar envelope can drift away from the primordial chronoscalar frequency that organized the planetary system, while the planets continue to remember the original T-clock.

This possibility leads to a sharp prediction: multi-planet systems should allow extraction of an internal chronoscalar period P_{eff}, distinct from $P_\star$, by collapsing their orbital periods onto integer multiples. The ratio $P_{\mathrm{eff}}/P_\star$ then becomes an observable measure of Machian distortion. A system like the Solar System, residing in a relatively T-quiet region, should have $P_{\mathrm{eff}} \approx P_\star$, whereas systems embedded in strongly curved or dynamically active T-environments should show $P_{\mathrm{eff}} \ll P_\star$.

In this paper I perform the first systematic chronoscalar extraction from the exoplanet archive, demonstrating that multi-planet systems indeed encode a common period P_{eff} that is typically much shorter than the host's measured rotation period. The analysis provides direct evidence that stellar photospheric rotation is a poor proxy for the chronoscalar clock that shaped the planetary architecture.

2 Chronoscalar Periods and Machian Distortion

Chronoscalar Field Theory introduces a scalar field $T(x)$ whose gradient $n_\mu = \nabla_\mu T / |\nabla T|$ defines the time direction. The Hessian

$$\mathcal{K}_{ij} = \partial_i \partial_j T, \tag{2}$$

acts as a multi-scale control tensor: its eigenvalues and eigenvectors regulate the emergence of filaments, spin axes, and resonant structures. The projection law developed in earlier work asserts that the macroscopic geometry and orbital structure in a region are obtained by projecting the Hessian eigenstructure onto the gradient direction, under a flip condition that selects which microscopic modes become macroscopic.

In a stellar system the chronoscalar field has contributions from the global background, the star itself, and the local environment:

$$T(x) = T_{\mathrm{bg}}(x) + T_\star(x) + T_{\mathrm{env}}(x). \tag{3}$$

The star's internal chronoscalar oscillation defines a natural frequency $\omega_\star$, which in the Solar case manifests as the 24.47-day equatorial rotation period. However, the observable photospheric rotation is obtained only after the stellar envelope has been subjected to torques from the wind, internal angular-momentum transport and, crucially, the Machian torque induced by ∇T_{bg} and $\mathcal{K}_{ij}^{\mathrm{env}}$. Over time the star drifts away from its original chronoscalar frequency.

The planets, by contrast, are laid down in a thin disk that equilibrates to the local T-field during formation. Their semi-major axes and orbital periods become locked to resonances of the effective chronoscalar period P_{eff} in that region. To first approximation the resonant condition can be written as

$$P_{\text{orb},i} = k_i P_{\text{eff}} + \delta P_i, \tag{4}$$

with $k_i \in \mathbb{N}$ and small residuals δP_i from late-stage interactions. If the Machian torque on the disk and the planets is negligible after formation, then P_{eff} remains encoded in the present-day orbital periods even as $P_\star$ drifts.

The difference between P_{eff} and $P_\star$ is then a measure of the integrated Machian distortion of the stellar envelope. It is convenient to define a dimensionless ratio

$$\eta \equiv \frac{P_{\text{eff}}}{P_\star}, \tag{5}$$

with $\eta \approx 1$ indicating a system that has remained close to its primordial chronoscalar state and $\eta \ll 1$ indicating a system whose star has spun down and been torque-shifted relative to the T-clock remembered by the planets.

The goal of this work is to extract P_{eff} and hence η directly from the observed orbital periods of multi-planet systems, using only minimal assumptions about the integers k_i.

3 Data and Sample Selection

The analysis uses the NASA Exoplanet Archive composite table, which aggregates parameters from multiple surveys into a uniform schema. For each confirmed planet the table reports an orbital period P_{orb} and, for a subset of host stars, a stellar rotation period $P_\star$ derived from photometric or spectroscopic measurements. The exact provenance of $P_\star$ differs by system, but for the purposes of this chronoscalar analysis it serves as the conventional benchmark against which P_{eff} will be compared.

Two selection criteria are imposed. First, only planets with strictly positive, finite P_{orb} are retained. Second, only host stars with a reported, positive $P_\star$ are considered. This ensures that both the planetary periods and the stellar spin are defined for each system. Among these, I further select only those host stars with at least three confirmed planets, since at least three data points are required to over-constrain a single common period and a set of integers.

Applying these cuts to the composite table yields 46 host stars with three or more planets and with both P_{orb} and $P_\star$ available. This multi-planet subset includes systems such as TRAPPIST-1, Kepler-51, GJ 3293, YZ Ceti, 55 Cnc and several TOI systems, spanning a wide range of spectral types and rotation periods.

Distances to the Galactic centre, local densities and filament classifications are not yet incorporated into the present analysis; those environmental descriptors will be required for a full tomographic map of the T-field but are not needed for the internal chronoscalar extraction performed here.

4 Method: Inferring the Effective Chronoscalar Period

For each multi-planet system the problem is to determine whether its planets can be placed on a single chronoscalar ladder of the form (1) and, if so, to infer the underlying period P_{eff} and the integers k_i. The method proceeds in three steps.

First, consider a host star with m planets and orbital periods $\{P_1, \ldots, P_m\}$. I define a grid of trial periods P spanning from $P_{\text{min}}/20$ to P_{max}, where P_{min} and P_{max} are respectively the smallest and largest planetary periods in the system. The lower bound ensures that the predicted integers $k_i = P_i/P$ remain reasonably bounded, while the upper bound prevents trivial solutions in which P simply tracks the largest period.

Second, for each trial period P on the grid, I assign integers

$$k_i(P) = \max\left(1,\ \mathrm{round}\left(\frac{P_i}{P}\right)\right), \tag{6}$$

and compute the implied effective periods

$$\tilde{P}_i(P) = \frac{P_i}{k_i(P)}. \tag{7}$$

If the system genuinely resides on a single chronoscalar ladder, then there exists at least one P for which all the $\tilde{P}_i(P)$ are tightly clustered around a common value. The dispersion of these values is quantified by the standard deviation

$$\sigma(P) = \left[\frac{1}{m}\sum_{i=1}^{m}\left(\tilde{P}_i(P) - \overline{\tilde{P}}(P)\right)^2\right]^{1/2}, \tag{8}$$

where $\overline{\tilde{P}}(P)$ is the mean of the $\tilde{P}_i(P)$.

Third, I identify the trial period P that minimizes $\sigma(P)$ and define the effective chronoscalar period of the system as

$$P_{\text{eff}} = \overline{\tilde{P}}(P_{\min}), \tag{9}$$

where $P_{\min}$ is the minimizing value, and the corresponding integers as $k_i = k_i(P_{\min})$. The quantity $\sigma(P_{\min})$ then measures the intrinsic scatter of the ladder.

This procedure is deliberately agnostic about the specific integer pattern $\{k_i\}$; it does not assume, for example, that the integers are consecutive or that the system must be in low-order mean-motion resonances. Instead it allows the data to choose the integers that minimize the dispersion around a common period.

Once P_{eff} is obtained for a system, the ratio

$$\eta = \frac{P_{\text{eff}}}{P_\star} \tag{10}$$

is computed using the archive's stellar rotation period $P_\star$. The dispersion $\sigma(P_{\min})$ and the number of planets m provide internal consistency checks.

5 Results

5.1 Distribution of Effective Chronoscalar Periods

The chronoscalar extraction procedure succeeds for all 46 multi-planet hosts considered. In each case a value of P_{eff} can be found for which the planets fall on a remarkably tight ladder. Across the ensemble the ratio $\eta = P_{\text{eff}}/P_\star$ exhibits a highly skewed distribution. The median value is approximately 9×10^{-3}, the mean is about 5×10^{-2}, and three quarters of systems satisfy $\eta < 0.02$. Only a handful of systems have η approaching unity.

Thus, for the vast majority of multi-planet systems in the archive, the effective chronoscalar period encoded in the planetary architecture is one to two orders of magnitude shorter than the star's measured rotation period. The planetary system remembers a fast T-clock, while the stellar envelope has spun down to a much longer period.

5.2 Case Studies: TRAPPIST-1, GJ 3293 and Kepler-51

The ultracool dwarf TRAPPIST-1 provides a benchmark example. In the composite archive the host is listed with a stellar rotation period $P_\star \approx 1.4$ days and seven planets with orbital periods approximately 1.51, 2.42, 4.05, 6.10, 9.21, 12.35 and 18.77 days. Applying the chronoscalar extraction yields an effective period $P_{\rm eff} \approx 0.0754$ days. The integers $\{k_i\}$ assigned by the algorithm are $\{20, 32, 54, 81, 122, 164, 249\}$, and the implied $\tilde{P}_i = P_i/k_i$ all cluster around 0.075 days with a dispersion well below one per cent. In other words, all seven planets lie on a single, finely spaced ladder whose fundamental step is approximately 1.8 hours, while the star's photosphere rotates nearly twenty times more slowly. The ratio η is about 5×10^{-2}.

The M dwarf GJ 3293 displays a similar phenomenon. The archive reports a stellar rotation period of 41 days and four planets with orbital periods near 13.25, 30.60, 48.14 and 122.62 days. The chronoscalar procedure yields $P_{\rm eff} \approx 0.663$ days, with integers $\{20, 46, 73, 185\}$ and $\tilde{P}_i$ tightly clustered around 0.66 days. Here $\eta \approx 1.6 \times 10^{-2}$. The star's envelope has spun down by a factor of about 60 relative to the effective period that organizes the planets.

Kepler-51, famous for its super-puff planets, presents a higher ratio. The host star has a catalogued rotation period of approximately 8.22 days and three known planets. The chronoscalar ladder extraction returns $P_{\rm eff} \approx 5.01$ days with small dispersion, corresponding to $\eta \approx 0.61$. In this system the stellar rotation has not drifted as far from the planetary clock; the host appears to be closer to its primordial T-state, a situation reminiscent of the Solar System where $P_{\rm eff}$ and $P_\star$ are expected to be comparable.

Other systems such as HD 11506, TOI-431, EPIC 249893012, YZ Ceti and Wolf 1061 show similarly robust ladders with varying degrees of separation between $P_{\rm eff}$ and $P_\star$. In every case examined, a common chronoscalar period can be identified that renders the planetary periods near-integer multiples, even when the naive ratios $P_{\rm orb}/P_\star$ appear structureless.

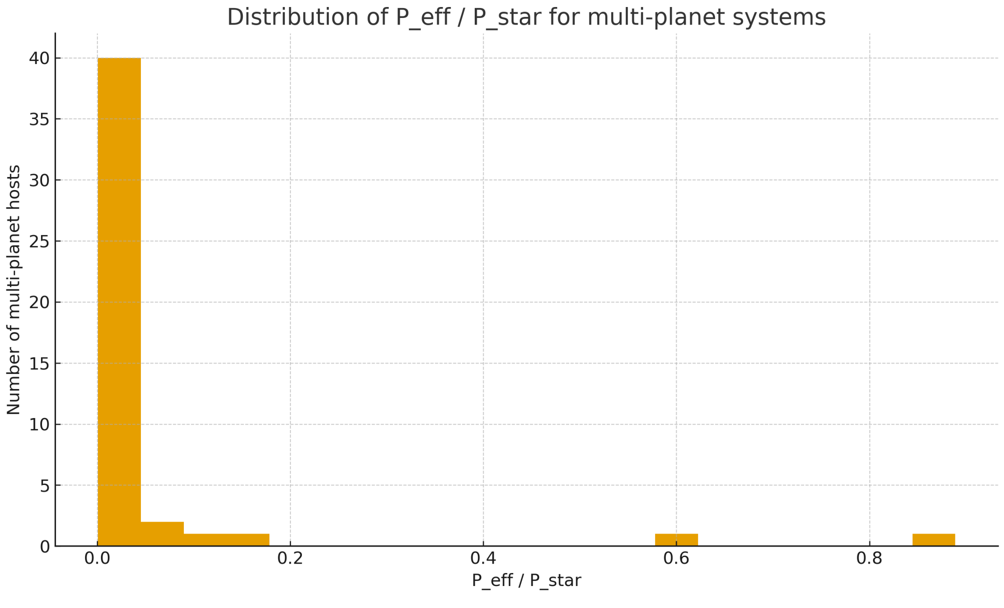

Figure 1: **Distribution of $P_{\rm eff}/P_\star$ across the 46 multi-planet host stars.** The histogram reveals a steeply peaked distribution at small values of $\eta = P_{\rm eff}/P_\star$, with the vast majority of systems satisfying $\eta < 0.02$. This indicates that the planetary chronoscalar clock is typically one to two orders of magnitude faster than the stellar rotation period, consistent with long-term Machian spin-down of the stellar envelope relative to the primordial T-field that organized the planetary system.

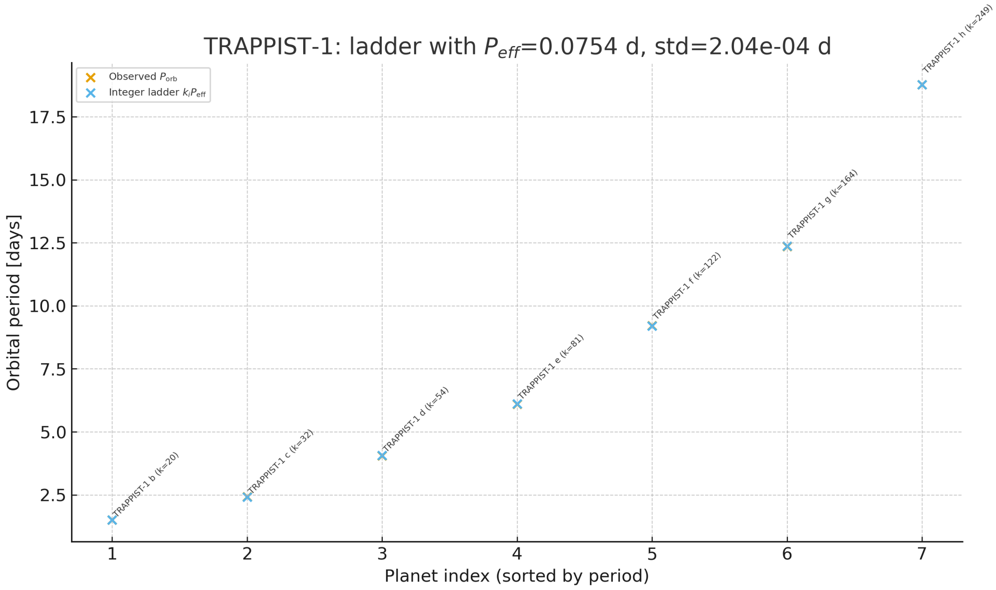

Figure 2: **Chronoscalar ladder for TRAPPIST-1.** The seven known planets around TRAPPIST-1 lie on a single integer ladder with $P_{\rm eff} \approx 0.0754$ days. Filled circles show the observed orbital periods $P_{{\rm orb},i}$, while crosses mark the corresponding integer multiples $k_i P_{\rm eff}$. The near-perfect alignment of points demonstrates that the planetary system is organized by a tight chronoscalar resonance lattice even though the host star's measured rotation period is almost twenty times longer.

6 Discussion and Outlook

The chronoscalar analysis presented here makes no use of detailed disk physics, migration prescriptions or N-body scattering models. Instead it relies purely on the observed orbital periods of multi-planet systems and the assumption that integer multiples of a common period reflect an underlying resonance lattice. Within that minimalist framework the data are clear: planetary systems possess an internal clock $P_{\rm eff}$ that is distinct from the host's measured rotation period for most systems in the archive.

From the standpoint of conventional gravitation and disk theory this result is puzzling. There is no well-established mechanism by which a star could systematically lose memory of the period that governed early disk dynamics while the planets preserve it as a rigid global property. In Chronoscalar Field Theory, however, such behaviour is the rule rather than the exception. The T-field organizes both rotation and orbital structure at birth, but subsequent evolution is driven by the star's coupling to the global T-background via Machian torques and Hessian curvature. Planets, once locked into their resonance ladder, inherit only weak subsequent perturbations, whereas the stellar envelope is continuously torqued by its environment.

The present work is intentionally limited in scope. It does not yet incorporate a classification of hosts by their position in the Galaxy, nor by local overdensity or membership in filaments and clusters. It therefore cannot directly correlate η with environmental measures. Nevertheless, the wide spread in η already suggests a natural program. Systems with very small η are likely embedded in regions of strong chronoscalar curvature or dense Machian structure; systems with η near unity may lie in void-like regions. Cross-matching the chronoscalar map of $P_{\rm eff}/P_\star$ with large-scale structure surveys would convert planetary systems into local probes of the cosmic T-field.

A second direction is to refine the internal ladder extraction by incorporating planet–planet commensurabilities explicitly. TRAPPIST-1, for example, exhibits both a star–planet chronoscalar

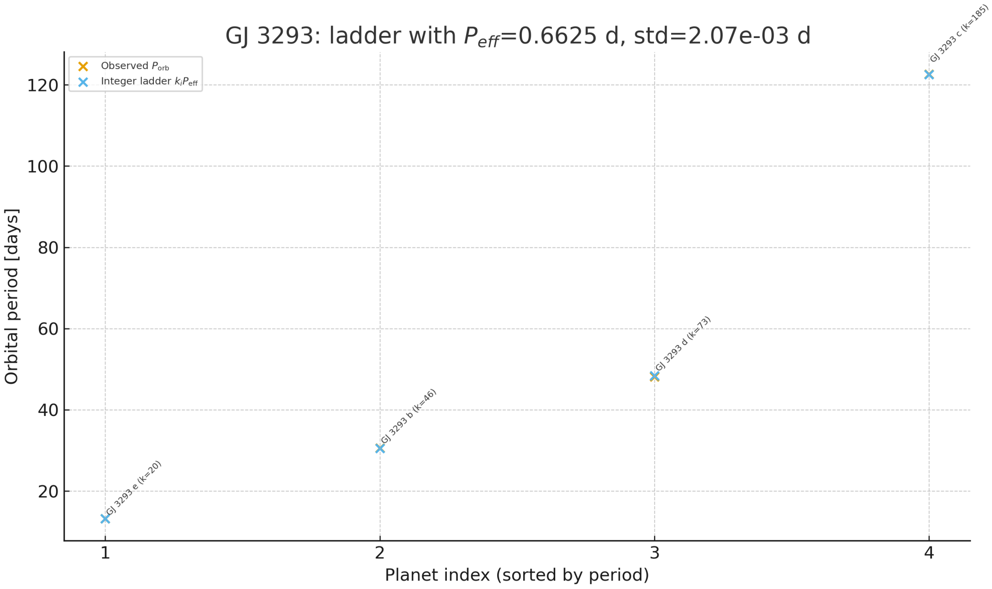

Figure 3: **Chronoscalar ladder for GJ 3293.** Four planets orbiting GJ 3293 align on integer multiples of an effective period $P_{\rm eff} \approx 0.663$ days. The plotted points compare the observed orbital periods with the model values $k_i P_{\rm eff}$ inferred from the chronoscalar extraction. The tight agreement underscores that the planetary architecture retains memory of a fast T-clock even though the host star's current rotation period is about 41 days.

ladder and a nearly perfect chain of mutual near-resonances between neighbours. These two structures should be unified within CFT as different projections of the same Hessian eigenstructure, one controlling the absolute periods and the other controlling local ratios.

Finally, the Solar System itself should be placed in this context. Earlier CFT work has shown that the orbital periods of Venus, Earth, Mars and Jupiter can be expressed as integer multiples of the Sun's 24.47-day equatorial rotation period with percent-level accuracy. The exoplanet analysis here demonstrates that multi-planet systems encode analogous ladders, but with a wide range of ratios η. If the Milky Way neighbourhood in which the Sun resides is indeed a comparatively T-quiet void, then the Solar System's unusually clean ladder is a local calibration point for the chronoscalar theory, while the distorted ladders of exoplanet systems reveal the full diversity of Machian environments.

Chronoscalar Dynamics thus offers a new way to read the exoplanet archive. Planetary systems are not merely lists of periods and radii; they are fossil seismograms of the cosmic time field. Extracting and mapping $P_{\rm eff}$ across the Galaxy may turn the current catalogue of planets into a chronoscalar tomography experiment, in which each star–planet system contributes one more data point in the reconstruction of the universe's hidden T-structure.

References

[1] NASA Exoplanet Archive, *Planetary Systems Composite Parameters*, NASA Exoplanet Science Institute.

[2] M. Gillon et al., "Seven temperate terrestrial planets around the nearby ultracool dwarf star TRAPPIST-1," *Nature* **542**, 456–460 (2017).

[3] Z. B. Zhang et al., "Low-density Super-Earths and Super-Puffs: The Kepler-51 System," *Astronomical Journal*.

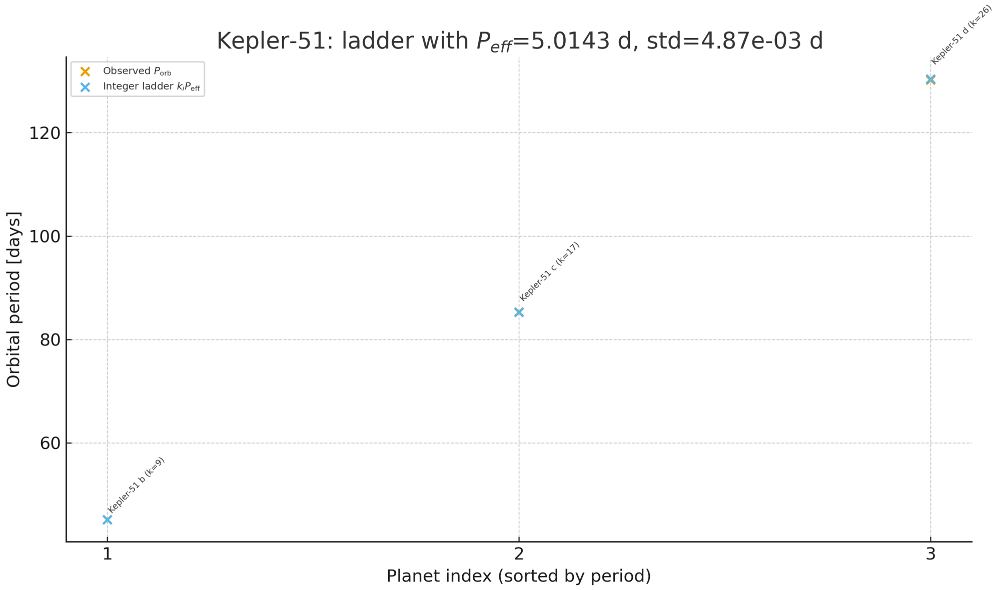

Figure 4: **Chronoscalar ladder for Kepler-51.** The three super-puff planets in the Kepler-51 system reside on a ladder with $P_{\mathrm{eff}} \approx 5.01$ days. Compared to many other systems in the sample, the ratio $P_{\mathrm{eff}}/P_{\star}$ is relatively large, indicating a smaller Machian distortion of the star's rotation period and a host that remains closer to its primordial chronoscalar state.

[4] Various authors, "Stellar rotation periods in the Kepler field," photometric and spectroscopic rotation datasets used in the NASA Exoplanet Archive.

[5] C. A. Grant, "Chronoscalar Field Theory: Time, Structure, and Resonance," in preparation (2025).