The Pivot Universe: A Stationary Kerr-Geometry Interpretation of JWST Observations

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June 2026

Abstract

Recent observations from the James Webb Space Telescope (JWST) reveal massive galaxies, chemically evolved stellar populations, mature disk structures, and compact luminous systems known as Little Red Dots (LRDs) at redshifts exceeding $z \sim 8$. Within the standard ΛCDM cosmological framework, such observations can create tension with hierarchical structure-formation timescales, because massive galaxies and black holes appear to be present when the Universe is conventionally interpreted to be very young. This paper develops the Pivot Universe (PU), a stationary Kerr-geometry interpretation in which observed redshift is treated primarily as a spatial coordinate rather than as a direct measure of cosmic age. The visible Universe is modeled as a thin shell in the exterior Kerr-like spacetime generated by a central rotating mass, the Pivot. Within this framework, we derive a coordinate redshift relation, a Newtonian tidal-shear estimate, a Kerr-modified tidal amplification factor, a relativistic Hill radius, and a disk stability criterion. The theory is then applied to the coexistence of compact LRDs and extended disk galaxies at similar redshift. As a representative example, CANUCS-LRD-z8.6 and CEERS-1019 are compared. Although both systems have nearly the same redshift, their observed radii differ by roughly an order of magnitude. In the PU interpretation, this diversity follows from differences in the Kerr-modified Hill radius and local tidal environment rather than from differences in cosmic age.

1 Introduction

JWST has substantially extended the observational record of galaxies and active nuclei at high redshift. Among the notable findings are massive galaxies, compact red objects, candidate overmassive black holes, and apparently mature stellar systems at redshifts $z > 8$. In the standard cosmological interpretation, redshift is primarily associated with cosmic expansion and look-back time. A galaxy observed at $z \approx 10$ is therefore interpreted as a system existing only a few hundred million years after the Big Bang. Massive or chemically evolved systems at such redshifts then require rapid early assembly, rapid star formation, efficient metal enrichment, and rapid black-hole growth.

The Pivot Universe proposes a different interpretation. Instead of interpreting redshift primarily as a measure of cosmic age, PU treats redshift as a coordinate position within a stationary gravitational structure. The large-scale geometry is modeled as a Kerr-like spacetime generated by a central rotating object called the Pivot. In this framework, high-redshift galaxies are not necessarily younger than low-redshift galaxies. Rather, they occupy deeper positions in the gravitational potential of the Pivot.

The aim of this manuscript is to develop the mathematical structure needed for this interpretation. The central sequence of arguments is

$$\text{Kerr geometry} \rightarrow \text{tidal shear} \rightarrow \text{relativistic Hill radius} \rightarrow \text{observed morphology}. \tag{1}$$

This sequence is then used to interpret why compact LRDs and extended disk galaxies may coexist at nearly the same observed redshift.

2 Fundamental Assumptions of the Pivot Universe

The PU framework is based on four assumptions.

2.1 Stationarity

The large-scale spacetime is assumed to be stationary:

$$\frac{\partial g_{\mu\nu}}{\partial t} = 0. \tag{2}$$

Consequently, redshift is not attributed to time-dependent scale-factor expansion. It is instead interpreted as arising from position within a stationary gravitational field, together with possible kinematic contributions.

2.2 A central rotating Pivot

The spacetime is generated by a central rotating gravitating object with adopted parameters

$$M_P = 7.82 \times 10^{53}\,\text{kg}, \tag{3}$$

$$J_P = 1.06 \times 10^{87}\,\text{J s}. \tag{4}$$

Here M_P is the Pivot mass and J_P is its angular momentum.

2.3 Exterior Kerr-like geometry

Outside the Pivot, spacetime is approximated by a Kerr-like metric. This choice is motivated by the need to include rotation, gravitational redshift, frame dragging, latitude dependence, and horizons in a single stationary geometry.

2.4 Redshift as a radial coordinate

The defining PU assumption is

$$z = z(r), \tag{5}$$

rather than the standard cosmological interpretation in which redshift is primarily a function of cosmic time. Thus, observed redshift becomes a mapping from an astronomical object to its radial position relative to the Pivot.

3 Kerr Geometry of the Pivot

In Boyer-Lindquist coordinates (t, r, θ, ϕ), the Kerr line element can be written schematically as

$$ds^2 = -\left(1 - \frac{R_s r}{\rho^2}\right) c^2 dt^2 - \frac{2R_s a r \sin^2\theta}{\rho^2} c\, dt\, d\phi + \frac{\rho^2}{\Delta} dr^2 \tag{6}$$

$$+ \rho^2 d\theta^2 + \frac{\Sigma \sin^2\theta}{\rho^2} d\phi^2, \tag{7}$$

where

$$\rho^2 = r^2 + a^2 \cos^2\theta, \tag{8}$$

$$\Delta = r^2 - R_s r + a^2, \tag{9}$$

$$\Sigma = (r^2 + a^2)^2 - a^2 \Delta \sin^2\theta. \tag{10}$$

The Schwarzschild radius associated with the Pivot is

$$R_s = \frac{2GM_P}{c^2}. \tag{11}$$

Using the adopted Pivot mass gives

$$R_s \approx 1.16 \times 10^{27}\,\mathrm{m} \approx 122\,\mathrm{Gly}. \tag{12}$$

The Kerr horizons are determined by

$$\Delta = 0. \tag{13}$$

Solving gives

$$r_\pm = \frac{R_s}{2} \pm \sqrt{\frac{R_s^2}{4} - a^2}. \tag{14}$$

The outer horizon r_+ defines the strong-field boundary in the PU model. Most observable matter is assumed to reside in a shell slightly outside this radius.

4 Coordinate Redshift from the Kerr Lapse

The Kerr lapse function is

$$\alpha^2 = \frac{\Delta \rho^2}{\Sigma}. \tag{15}$$

For stationary observers in a stationary spacetime, a first approximation to the gravitational redshift is

$$1 + z_g \simeq \frac{1}{\alpha}. \tag{16}$$

Thus,

$$1 + z_g \simeq \left(\frac{\Sigma}{\Delta\rho^2}\right)^{1/2}. \tag{17}$$

Equation (17) is the Kerr-coordinate redshift relation used in the PU framework.

In the non-rotating limit $a \to 0$, one has

$$\rho^2 \to r^2, \tag{18}$$

$$\Sigma \to r^4, \tag{19}$$

$$\Delta \to r(r - R_s). \tag{20}$$

Therefore Equation (17) reduces to

$$1 + z_g \simeq \left(1 - \frac{R_s}{r}\right)^{-1/2}. \tag{21}$$

This is the Schwarzschild gravitational-redshift expression. In this manuscript, Equation (21) is used as a simple radial mapping, while Equation (17) gives the more general Kerr form.

For example, the Schwarzschild-limit mapping gives

$$r = \frac{R_s}{1 - (1+z)^{-2}}. \tag{22}$$

At $z = 8.6$,

$$r \approx 1.011 R_s. \tag{23}$$

Thus high-redshift systems occupy positions close to the Pivot horizon in the PU interpretation.

5 Tidal Shear in the Pivot Universe

The gravitational acceleration produced by the Pivot is approximated by

$$g(r) = \frac{GM_P}{r^2}. \tag{24}$$

Consider a galaxy of diameter D at coordinate radius r. The near side and far side of the galaxy experience slightly different accelerations. For $D \ll r$, the tidal acceleration difference is

$$\Psi = \left|\frac{dg}{dr}\right| D. \tag{25}$$

Since

$$\frac{dg}{dr} = -\frac{2GM_P}{r^3}, \tag{26}$$

the tidal shear is

$$\boxed{\Psi \approx \frac{2GM_P D}{r^3}.} \tag{27}$$

This expression has units of acceleration and measures the differential gravitational field across the galaxy.

Because

$$\Psi \propto r^{-3}, \tag{28}$$

small radial displacements near the Pivot horizon can significantly change the tidal environment. A smaller r implies stronger tidal confinement, while a larger r permits larger bound structures.

6 Kerr Modification of the Tidal Field

Equation (27) is Newtonian. Near the Pivot horizon, relativistic effects cannot be neglected. The Kerr geometry modifies local distances, local energies, and the relation between angular momentum and inertial frames. We therefore write the effective tidal field as

$$\Psi_{\text{Kerr}} = \Psi\, \Xi(r, a, \theta), \tag{29}$$

where Ξ is a phenomenological Kerr amplification factor.

The dominant geometrical factor is the lapse:

$$\alpha^2 = \frac{\Delta \rho^2}{\Sigma}. \tag{30}$$

As the outer horizon is approached, $\Delta \to 0$, so $\alpha \to 0$. The local redshift and effective tidal distortion therefore increase.

The second contribution comes from frame dragging. In Kerr spacetime, local inertial frames rotate with angular velocity $\omega(r, \theta)$. Matter with conserved energy E and angular momentum L has local effective energy

$$E_{\text{local}} = E - \omega L. \tag{31}$$

Thus

$$\frac{E_{\text{local}}}{E} = 1 - \frac{\omega L}{E}. \tag{32}$$

Combining lapse suppression and frame dragging gives

$$\boxed{\Xi(r, a, \theta) = \left[\frac{\Delta \rho^2}{\Sigma} \left(1 - \frac{\omega L}{E} \right)^2 \right]^{-1/2}.} \tag{33}$$

This expression should be interpreted as a compact phenomenological representation of the dominant Kerr corrections to the local tidal environment. A full calculation would use the electric part of the Kerr curvature tensor in a tetrad frame; Equation (33) is the working approximation adopted here.

7 Newtonian Hill Radius

The Hill radius is the radius at which the self-gravity of a galaxy balances the external tidal field. Let M_{gal} denote the galaxy mass. The self-gravity at radius R_H is

$$g_{\text{gal}} = \frac{G M_{\text{gal}}}{R_H^2}. \tag{34}$$

The standard tidal acceleration across R_H is approximated by

$$g_{\text{tidal}} = \frac{3 G M_P R_H}{r^3}. \tag{35}$$

Equating the two gives

$$\frac{G M_{\text{gal}}}{R_H^2} = \frac{3 G M_P R_H}{r^3}. \tag{36}$$

Solving,

$$GM_{\text{gal}} = \frac{3GM_P R_H^3}{r^3}, \tag{37}$$

$$R_H^3 = r^3 \left(\frac{M_{\text{gal}}}{3M_P}\right), \tag{38}$$

$$\boxed{R_H = r \left(\frac{M_{\text{gal}}}{3M_P}\right)^{1/3}.} \tag{39}$$

8 Relativistic Hill Radius

Since the Hill radius scales inversely as the cube root of the external tidal field,

$$R_H \propto \Psi^{-1/3}, \tag{40}$$

the Kerr amplification factor enters as

$$R_H \propto \Xi^{-1/3}. \tag{41}$$

Define

$$\Phi = \Xi^{-1/3}. \tag{42}$$

Using Equation (33) gives

$$\boxed{\Phi(a, \theta) = \left[\frac{\Delta \rho^2}{\Sigma} \left(1 - \frac{\omega L}{E}\right)^2\right]^{1/6}.} \tag{43}$$

The relativistic Hill radius is therefore

$$\boxed{R_H = r \left(\frac{M_{\text{gal}}}{3M_P}\right)^{1/3} \Phi(a, \theta).} \tag{44}$$

Equation (44) is the central morphological equation of the PU framework. It shows that galaxy size depends not only on mass and radial coordinate, but also on the local Kerr correction factor.

9 Stability Criterion

A stable disk of radius R_{disk} requires

$$R_H \geq R_{\text{disk}}. \tag{45}$$

The critical mass is obtained by setting $R_H = R_{\text{disk}}$ in Equation (44):

$$R_{\text{disk}} = r \left(\frac{M_{\text{crit}}}{3M_P}\right)^{1/3} \Phi. \tag{46}$$

Thus,

$$\frac{R_{\text{disk}}}{r\Phi} = \left(\frac{M_{\text{crit}}}{3M_P}\right)^{1/3}, \tag{47}$$

and

$$\boxed{M_{\rm crit} = 3M_P \left(\frac{R_{\rm disk}}{r\Phi}\right)^3.} \tag{48}$$

This mass is the minimum galaxy mass required to maintain a disk of radius $R_{\rm disk}$ against the Pivot tidal field.

For $z \approx 8.6$, the radial coordinate is

$$r \approx 1.173 \times 10^{27}\,\text{m}. \tag{49}$$

Using

$$R_{\rm disk} = 10\,\text{kpc} = 3.086 \times 10^{20}\,\text{m}, \tag{50}$$

and representative value

$$\Phi \approx 0.93, \tag{51}$$

one obtains

$$M_{\rm crit} \approx 2.7 \times 10^4 M_\odot. \tag{52}$$

Thus, observed galaxies with masses far above this value are not near the threshold for complete tidal disruption.

10 Application to JWST Objects

10.1 CANUCS-LRD-z8.6

CANUCS-LRD-z8.6 is treated here as a compact Little Red Dot at $z \approx 8.6$. Representative values used in this manuscript are

$$M_{\rm BH} \sim 10^8 M_\odot, \tag{53}$$

$$M_{\rm gal} \sim 10^{10} M_\odot, \tag{54}$$

$$R_{\rm out} \sim 0.5\,\text{kpc}. \tag{55}$$

Its compact morphology and large central black-hole fraction make it a useful example of strong tidal confinement in the PU framework.

10.2 CEERS-1019

CEERS-1019 is an extended galaxy with an active nucleus at redshift

$$z = 8.679. \tag{56}$$

Representative values are

$$M_{\rm BH} \sim 9 \times 10^6 M_\odot, \tag{57}$$

$$M_{\rm gal} \sim 3 \times 10^9 M_\odot, \tag{58}$$

$$R_{\rm out} \sim 5\,\text{kpc}. \tag{59}$$

Although its redshift is nearly the same as CANUCS-LRD-z8.6, its morphology is substantially more extended.

10.3 Direct comparison

Table 1: Comparison of CANUCS-LRD-z8.6 and CEERS-1019. Values are representative order-of-magnitude quantities used for the PU worked example.

Parameter	CANUCS-LRD-z8.6	CEERS-1019
Redshift z	≈ 8.6	8.679
$M_{\rm BH}$	$\sim 10^8 M_\odot$	$\sim 9 \times 10^6 M_\odot$
$M_{\rm gal}$	$\sim 10^{10} M_\odot$	$\sim 3 \times 10^9 M_\odot$
$M_{\rm BH}/M_{\rm gal}$	$\sim 10^{-2}$	$\sim 3 \times 10^{-3}$
Observed outer radius	$\sim 0.5\,{\rm kpc}$	$\sim 5\,{\rm kpc}$
Morphology	Compact LRD	Extended disk galaxy

Both systems have approximately the same redshift. In PU, this implies approximately the same radial coordinate relative to the Pivot. However, their observed sizes differ by approximately an order of magnitude.

10.4 Comparison with the stability threshold

For CANUCS-LRD-z8.6,

$$\frac{M_{\rm gal}}{M_{\rm crit}} = \frac{10^{10}}{2.7 \times 10^4} \approx 3.7 \times 10^5. \tag{60}$$

For CEERS-1019,

$$\frac{M_{\rm gal}}{M_{\rm crit}} = \frac{3 \times 10^9}{2.7 \times 10^4} \approx 1.1 \times 10^5. \tag{61}$$

Table 2: Comparison with the stability threshold at $z \approx 8.6$ for $R_{\rm disk} = 10\,{\rm kpc}$.

Quantity	CANUCS-LRD-z8.6	CEERS-1019
$M_{\rm gal}$	$10^{10} M_\odot$	$3 \times 10^9 M_\odot$
$M_{\rm crit}$	$2.7 \times 10^4 M_\odot$	$2.7 \times 10^4 M_\odot$
$M_{\rm gal}/M_{\rm crit}$	3.7×10^5	1.1×10^5

Both systems exceed the stability threshold by many orders of magnitude. Therefore, their morphological difference is not explained by one being stable and the other unstable. Rather, the distinction is attributed to the relativistic Hill radius,

$$R_H \propto M_{\rm gal}^{1/3} \Phi(a, \theta), \tag{62}$$

with compact LRDs corresponding to smaller effective Φ and extended galaxies corresponding to larger effective Φ.

11 Predictions and Potential Tests

The PU framework generates several testable predictions.

1. Galaxies at the same redshift should show substantial dispersion in observed radius.
2. Compact LRDs should generally exhibit smaller inferred relativistic Hill radii than extended galaxies at the same redshift.
3. LRDs should show larger effective $M_{\mathrm{BH}}/M_{\mathrm{gal}}$ ratios than extended disk galaxies at comparable redshift.
4. Morphology should correlate more strongly with inferred tidal environment and Hill-radius scaling than with redshift alone.
5. At fixed redshift, systems with stronger angular-momentum support should preferentially appear extended, while centrally concentrated systems should appear compact.

A possible falsification would occur if compactness at high redshift shows no correlation with black-hole dominance, angular-momentum support, inferred tidal environment, or Hill-radius scaling.

12 Comparison with ΛCDM

The central difference between PU and standard cosmology is the meaning assigned to redshift.

In ΛCDM,

$$z \to \text{look-back time.} \tag{63}$$

High-redshift galaxies are interpreted as young systems. Massive galaxies, disks, and black holes at $z > 8$ therefore require rapid formation.

In PU,

$$z \to \text{radial coordinate.} \tag{64}$$

High-redshift galaxies are interpreted as systems located deeper in the gravitational potential of the Pivot. Their maturity is not surprising, because redshift is not a direct age indicator.

Table 3: Conceptual comparison of ΛCDM and the Pivot Universe.

Property	ΛCDM	Pivot Universe
Meaning of redshift	Cosmic expansion and time	Radial coordinate
High-z galaxies	Young systems	Deep in potential well
Origin of morphology	Evolutionary history	Tidal environment
LRD compactness	Rapid early growth	Reduced Hill radius
Mature galaxies at high z	Tension	Expected
Dark energy	Required	Not required in PU picture

13 Discussion

The PU framework connects observable morphology to the local tidal environment. The central mathematical chain is

$$\text{Kerr geometry} \to \text{tidal shear} \to \text{relativistic Hill radius} \to \text{galaxy morphology.} \tag{65}$$

The comparison between CANUCS-LRD-z8.6 and CEERS-1019 illustrates this chain. Both objects have nearly identical redshifts, so they occupy nearly the same radial coordinate in PU. Both exceed the stability threshold by many orders of magnitude. Their different observed sizes are therefore attributed to different values of the Kerr-modified correction factor Φ and hence to different effective Hill radii.

The model is phenomenological in its present form. In particular, the Kerr amplification factor Ξ should ultimately be replaced by a calculation based on the Kerr tidal tensor in a local orthonormal tetrad. Nevertheless, the current formulation provides a mathematically explicit and observationally testable mechanism for morphology at high redshift.

14 Conclusions

This manuscript developed a stationary Kerr-geometry interpretation of JWST observations. The principal results are:

1. Redshift is interpreted as a radial coordinate rather than a direct measure of cosmic age.
2. The Pivot tidal shear is approximated by
$$\Psi \approx \frac{2GM_P D}{r^3}. \tag{66}$$
3. Kerr geometry modifies the effective tidal field through the amplification factor $\Xi(r, a, \theta)$.
4. The corresponding relativistic Hill radius is
$$R_H = r\left(\frac{M_{\text{gal}}}{3M_P}\right)^{1/3}\Phi(a, \theta). \tag{67}$$
5. The critical mass for disk stability is
$$M_{\text{crit}} = 3M_P\left(\frac{R_{\text{disk}}}{r\Phi}\right)^3. \tag{68}$$
6. CANUCS-LRD-z8.6 and CEERS-1019 have nearly the same redshift but very different sizes. In PU this difference follows from different Kerr-modified Hill radii rather than different cosmic ages.

The PU framework therefore offers an alternative interpretation of compact LRDs, extended disk galaxies, and mature systems observed by JWST at high redshift. Its central observational prediction is that morphology should correlate with relativistic Hill-radius scaling and inferred tidal environment more strongly than with redshift alone.

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