Galaxy Formation: Z-Pinch Compression and Early Massive Galaxies

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Abstract

JWST observations have revealed highly mature, massive galaxies at redshifts $z > 7$, forming much faster than allowed by gravity-only hierarchical collapse in the standard ΛCDM model. We present the CPT framework model of galaxy formation: we show that gas collapse along cosmic Birkeland filaments is driven by the electromagnetic Z-pinch force ($F_p \propto 1/r$) and accelerated by the shifted primordial gravitational coupling ($G_{\text{eff}} \approx 0.993 G_0$). This combination compresses gas into stars and galaxies orders of magnitude faster than gravity-only hierarchical collapse, explaining the JWST observations without dark matter halos.

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1. The JWST Challenge

In standard ΛCDM cosmology, galaxy formation is a slow, hierarchical process. Small dark matter halos merge over time to form larger halos, which gradually pull gas in to form stars. This model predicts that at $z > 7$ (less than 700 Myr after the Big Bang), galaxies should be small, irregular, and low-mass.

JWST discoveries of massive ($10^{11} M_{\odot}$), well-structured spiral and disk galaxies at $z \approx 7-10$ challenge this paradigm. To form such mature structures so early requires a gas collapse mechanism that operates much faster than gravity alone.

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2. Electromagnetic Z-Pinch Compression

In the CPT framework, galaxies form along the filaments of the cosmic Birkeland current network. The current flowing along these filaments generates a toroidal magnetic field that wraps around the current channel.

This magnetic field exerts a radial inward force on the plasma—the **Z-pinch effect**. The Z-pinch magnetic pressure compresses the plasma toward the filament axis. Unlike gravity, which decays as $1/r^2$, the Z-pinch force scales as: $$F_p \propto \frac{I^2}{r}$$ where I is the current flowing along the filament.

This $1/r$ force profile compresses gas along the filaments orders of magnitude faster than gravity-only collapse, speeding up galaxy assembly and star formation timescales.

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3. Shifted Primordial Gravitational Strength

During the early universe’s gas collapse phase, the early vacuum eversion phase state of the torus-knot lattice globally shifts the effective gravitational coupling to $G_{\text{eff}} \approx 0.993 G_0$.

This slight reduction in gravity alters the Jeans mass and collapse thresholds for the primordial gas, preventing premature fragmentation and allowing large, coherent gas clouds compressed by Z-pinch forces to form massive stellar disks.