

STOCHASTIC GRAVITATIONAL-DYNAMIC MULTIVERSE MODEL (SGDM)

A Unified Paradigm for the Dark Sector, Cyclic Gravitational Evolution, and the Origin of Cosmological Expansion

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ABSTRACT

A self-consistent relativistic cosmological paradigm free from hypothetical scalar "dark energy" fields and unobserved weakly interacting massive particles (WIMPs) is formulated. The dark sector (~95% of cosmic mass) is unified into a stochastic ensemble of stable non-rotating black holes with finite core density $\rho_0 = \text{const}$. Observed cosmic acceleration and large-scale coherent velocity flows ("Dark Flow") are derived from the tidal gravitational field of an open, infinite Multiverse populated by domains at non-equilibrium evolutionary epochs. A physical mechanism for the Big Bang ($t=0$) is proposed as the centrifugal disruption of the ultra-dense core of a maximally rotating Kerr Mega-Black Hole ($a^* \rightarrow 1$).

Keywords: Multiverse, Dark Matter, Primordial Black Holes, Kerr Limit, Big Bang, Tidal Gravitation, Dark Flow, SGDM.

1. INTRODUCTION & Λ CDM CRISIS

The standard cosmological model (Λ CDM) divides the universe's mass-energy into baryons ($\Omega_b \approx 4.9\%$), cold dark matter ($\Omega_{DM} \approx 26.8\%$), and dark energy ($\Omega_\Lambda \approx 68.3\%$). However, it faces severe fundamental challenges:

1. *The Vacuum Catastrophe:* The quantum field theoretical vacuum energy density $\rho_{vac} \sim 10^{96} \text{ kg/m}^3$ differs from the observed critical density $\rho_{crit} \approx 9 \times 10^{-27} \text{ kg/m}^3$ by **120 orders of magnitude (10^{120})**.

2. *Absence of WIMP particles:* Four decades of direct searches at colliders (LHC) and cryogenic detectors (XENONnT, LUX-ZEPLIN) have yielded zero evidence for supersymmetric particles or dark matter candidates.

The SGDM model applies Occam's razor: unifying the 95% dark sector into a single physical category — **gravitating compact objects (black holes)** governed by classical General Relativity (GR) in an infinite dynamic Multiverse.

2. GALACTIC KINEMATICS

In spiral galaxies (Milky Way), circular orbital velocities at radius R are governed by the enclosed mass $M(R)$:

$$v(R) = \sqrt{\frac{GM(R)}{R}}$$

The total baryonic mass of the Milky Way is $M_{\bar{b}} \approx 5.5 \times 10^{10} M_\odot$. At the optical radius $R = 20 \text{ kpc}$, the observed rotational velocity remains flat at $v \approx 220 \text{ km/s}$, requiring an enclosed dynamic mass $M(20 \text{ kpc}) \approx 2.25 \times 10^{11} M_\odot$, and with the virial halo ($R \sim 200 \text{ kpc}$) $M_{tot} \approx 1.2 \times 10^{12} M_\odot$.

In SGDM, 95% of galactic mass is provided by a stochastic halo of stable primordial black holes (PBHs) with an isothermal density profile $\rho(r) = \rho_0 / (1 + (r/r_c)^2)$, which naturally yields $M(r) \propto r$ and a flat rotation curve $v(r) \approx 220 \text{ km/s} = \text{const}$.

3. PHYSICAL CORE OF BLACK HOLES

The model replaces the non-physical infinite mathematical singularity with a real physical core of finite maximum density $\rho_0 = \text{const}$ (nuclear matter scale $\rho_{nuc} \approx 3 \times 10^{17} \text{ kg/m}^3$).

The physical core radius and Schwarzschild event horizon radius scale as:

$$R_{core}(M) = \left(\frac{3M}{4\pi\rho_0} \right)^{1/3} \propto M^{1/3}, \quad R_s(M) = \frac{2GM}{c^2} \propto M$$

The critical mass for event horizon formation ($R_s \geq R_{core}$) is:

$$M_{crit} = c^3 \sqrt{\frac{3}{32\pi G^3 \rho_0}} \approx 7.8 M_\odot$$

For a cluster-scale Mega-Black Hole ($M = 10^{20} M_\odot$), the event horizon is $R_s \approx 31 \text{ million light-years}$, while the physical core radius is merely $R_{core} \approx 0.36 \text{ AU}$ (less than the Sun-Venus distance). Over **99.9999999999999999% of the interior volume is pure vacuum spacetime**.

4. MECHANISM OF THE BIG BANG

Local domain evolution follows an invariant supercycle ($10^0 \dots 10^{18} \text{ years}$):

1. *Baryonic Spring* ($10^0 \dots 10^{11} \text{ yr}$): stellar evolution and PBH halos.

2. *Gravitational Coalescence* ($10^{12} \dots 10^{15} \text{ yr}$): baryonic depletion and black hole mergers.

3. *Mega-Consolidation* ($10^{16} \dots 10^{18} \text{ yr}$): collapse into a single Domain Mega-BH and spin-up toward the Kerr limit $a^* = \frac{Jc}{GM^2} \rightarrow 1$.

4. *The Big Bang Act* ($t=0$): As $a^* \rightarrow 1$, the core's equatorial velocity approaches c , and centrifugal acceleration exceeds gravitational binding:

$$a_{\text{cent}} = \frac{v_{\text{eq}}^2}{R_{\text{core}}} \geq g_{\text{grav}} = \frac{GM}{R_{\text{core}}^2}$$

The incompressible core ρ_0 centrifugally ruptures the event horizon from within, explosively ejecting quark-gluon plasma (~5%) and micro-black hole fragments (~95%), initiating a new expanding daughter universe.

5. TIDAL MULTIVERSE & EXPANSION

In an infinite Multiverse, the external gravitational potential from surrounding domains expanded in a Taylor series is:

$$\Phi_{\text{ext}}(\vec{r}) \approx \Phi_0 + (\nabla\Phi)_0 \cdot \vec{r} + \frac{1}{2} r_i r_j \left(\frac{\partial^2 \Phi}{\partial x_i \partial x_j} \right)_0$$

1. *Dipole gradient* $(\nabla\Phi)_0$: drives coherent bulk velocity across our entire universe — "**Dark Flow**" ($v \approx 1000 \text{ km/s}$ toward Centaurus) induced by a massive Ancient Domain Mega-BH ($M_1 \sim 10^{53} \text{ kg}$).

2. *Quadrupole tidal tensor* T_{ij} : generates isotropic radial acceleration:

$$a_{\text{tidal}}(r) = + \frac{2GM_{\text{ext}}}{R_{\text{ext}}^3} \cdot r \equiv \frac{\Lambda_{\text{eff}} c^2}{3} \cdot r$$

This exactly reproduces cosmological acceleration, eliminating the necessity for scalar dark energy.

6. OBSERVATIONAL VERIFICATION

Observation	Λ_{CDM} Conflict	SGDM Resolution
Early Supermassive BHs (JWST, $z > 10$)	Insufficient growth time from gas ($< 400 \text{ Myr}$).	Capture of relict massive BHs from older neighboring domains.
NANOGrav GWB Background (2023)	Unrealistic binary population required.	Integrated stochastic noise of mergers across the Multiverse.
Cosmic Dark Flow	Anisotropy anomaly.	Dipole gravitational gradient from Ancient Mega-BH.

7. CONCLUSION

The SGDM paradigm unites cosmic dark mass into classical relativistic black holes, removes unphysical singularities, and eliminates the "Heat Death" of the universe by establishing a self-renewing, eternal cyclic Multiverse.

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