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Could Black Holes Drive the Acceleration of the Universe? An Idealized Approach

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Abstract: Motivated by quantum-gravity scenarios involving possible black-hole to white-hole-like transitions, we introduce a minimal phenomenological model in which black-hole evolution is associated with a creation pressure that may contribute to cosmic acceleration without a fundamental cosmological constant. Within the standard FLRW framework, black holes are represented by their averaged energy density, while local strong-gravity effects are neglected. The proposed mechanism links the cumulative effects of black-hole growth to an effective negative-pressure contribution. The model is exploratory and does not claim observational confirmation. In particular, the creation-pressure law remains an assumption whose microscopic origin in black-hole physics and associated energy budget require further investigation.

Keywords: *Black Holes; Dark Energy; Cosmic Acceleration; White Hole Transitions.*

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I. INTRODUCTION

Black holes mark the endpoints of gravitational collapse and are usually viewed as regions of spacetime that trap matter and radiation. In the standard picture, their role in the Universe is essentially passive. However, several approaches to quantum gravity suggest that the internal evolution of black holes may be more complex, potentially involving transitions to white hole-like states or other non-trivial dynamics over long timescales [1-5]. These scenarios indicate that black holes may not be purely absorptive objects, but could undergo dynamical phases in which energy is released.

Recent work has also suggested possible connections between black hole evolution and cosmological dynamics (see [4]). A natural question therefore arises: could black holes act as sources of a dark energy-like component that influences the large-scale evolution of the Universe? In this brief report we develop a minimal model to investigate whether the cumulative effect of such processes can contribute to the observed acceleration. Within this framework we examine a possible negative-pressure contribution associated with black-hole evolution over cosmic time.

The possibility that dark energy may be connected to black hole growth (as stars die) has recently been discussed in the literature and is still viewed as controversial [2,9-11] . The idea, most prominently advanced by [4], proposes that the mass of black holes couples directly to the cosmic scale factor, thereby sourcing the observed increase in dark energy density. While this mechanism offers an elegant astrophysical origin for cosmic acceleration, it requires a non-standard extension of general relativity and lies outside the minimal ΛCDM paradigm. In contrast, the present model is constructed entirely within the standard Friedmann cosmology equations. We introduce no modification to the metric or the gravitational sector. We introduce a phenomenological creation pressure motivated by black-hole evolution. Its mathematical form resembles a source term in interacting-fluid models [3], but here it must enter the physical stress-energy tensor.

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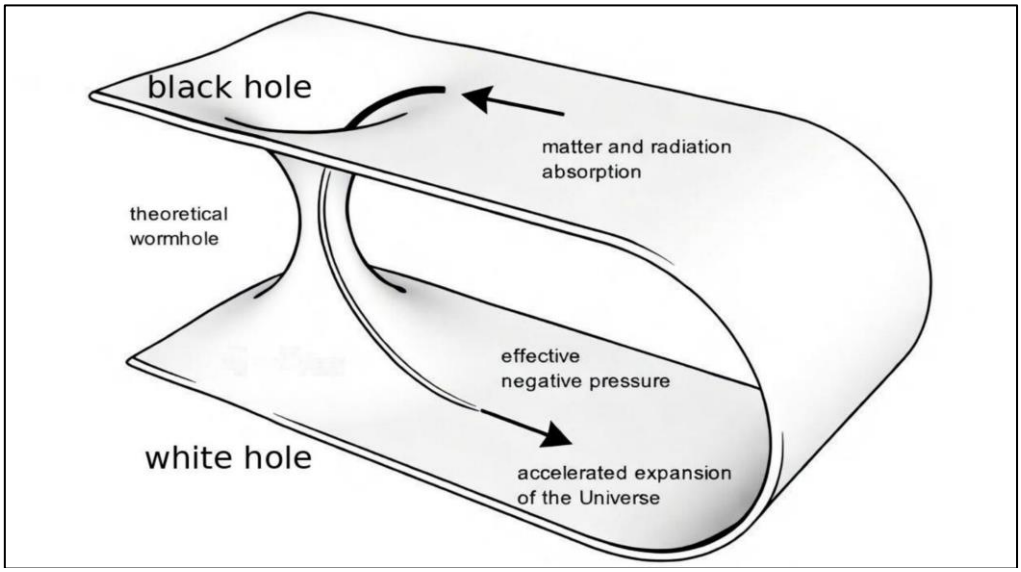

Fig 1 Schematic representation of the proposed mechanism. In essence, while absorbing matter and radiation, black holes may effectively re-inject energy into a hidden component of the Universe through transient emission phases. The assumed creation pressure is $P_c = -\Gamma\rho_{BH}/(3H)$. Whether this mechanism occurs in nature remains open.

II. MINIMAL FRAMEWORK

A schematic illustration of the proposed minimal model is shown in Fig. 1. We work within standard homogeneous and isotropic, spatially flat FLRW cosmology and omit the cosmological constant. The Hubble expansion is governed by the first Friedmann equation in terms of density parameters

$$H^2(z)=\left(\frac{\dot{a}}{a}\right)^2=\frac{8\pi G}{3}\rho_{tot}. \quad (1)$$

This equation describes how expansion changes over time with redshift (z). It is the usual first Friedmann equation for a spatially flat homogeneous and isotropic universe and it is not an additional assumption beyond standard cosmology. The phenomenological element enters through the hidden component ρ_X and its assumed physical creation pressure. In our model the total content consists of ordinary matter (pressureless dust, P_m=0) plus the hidden component sourced by black holes $\rho_{tot}=\rho_m+\rho_X$. Here, ρ_m includes the averaged black-hole population and ρ_X denotes an additional effective component. The black-hole density ρ_{BH} is a subset of ρ_m and is not counted again in ρ_{tot}. We use relativistic units with c=1, while keeping Newton's constant G explicit for standard cosmological normalization, particularly in the Friedmann equations and in the later definition of the density parameters $\Omega_i \equiv \frac{8\pi G\rho_i}{3H^2}$. We assume a flat universe (k=0).

The total energy density satisfies the usual conservation law described by the Friedmann equations , while in a mixture of non-interacting cosmic fluids each component evolves according to its own continuity equation

$$\dot{\rho}_f+3H(1+w_f)\rho_f=0, \quad (2)$$

With Equation-of-state parameter

$$P_f=w_f\cdot\rho_f. \quad (3)$$

We now assume that the effective component has a physical creation pressure P_c in addition to its equilibrium pressure $P_X=w_0\rho_X$. Its contribution to the FLRW stress-energy tensor is P_X+P_c. Conservation of this effective component gives

$$\dot{\rho}_X+3H(\rho_X+P_X+P_c)=0. \quad (4)$$

This is a constitutive assumption, not a consequence of rewriting an ordinary interaction equation. We assume a physical creation pressure of the form $P_c=-\Gamma\rho_{BH}/(3H)$, where Γ is a phenomenological parameter. For convenience, we define $Q\equiv\Gamma\rho_{BH}$, which parametrizes the strength of the assumed creation pressure rather than an independently imposed energy-transfer term. The black-hole density acts here as an astrophysical proxy for the strength of the proposed nonequilibrium process. We do not claim to derive P_c from microscopic black-hole physics or to describe a separately conserved transfer from the black-hole reservoir. Ordinary matter is taken to satisfy $\dot{\rho}_m+3H\rho_m=0$ at this idealized background level. Thus the total stress-energy tensor is conserved, with $\rho_{tot}=\rho_m+\rho_X$ and $P_{tot}=P_X+P_c$.

The equation-of-state parameter of the effective component, including its *physical* creation pressure, is:

$$w_{eff}=\frac{P_X+P_c}{\rho_X}=w_0-\frac{Q}{3H\rho_X}. \quad (5)$$

Unlike the effective parameter obtained by merely rewriting a sourced continuity equation, this w_{eff} is defined here from the physical pressure assumed in the stress-energy tensor. For the simple illustrative choice w_0=0,

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$$w_{eff} = -\frac{Q}{3H\rho_X} = -\frac{\Gamma}{3H}\left(\frac{\rho_{BH}}{\rho_X}\right). \quad (6)$$

The corresponding physical pressure is:

$$P_X + P_c = w_{eff}\rho_X = -\frac{Q}{3H} = -\frac{\Gamma\rho_{BH}}{3H} \leq 0. \quad (7)$$

The parameter Γ/H controls the assumed creation-pressure strength relative to expansion. A sufficiently negative total pressure can produce accelerated expansion. This requires the physical creation-pressure assumption above; positive energy injection alone would not suffice.

➢ *Cosmological Constraint on* $\boldsymbol{\Gamma/H}$

A conditional bound on the model follows from the requirement that the Universe undergoes accelerated expansion today. This condition is equivalent to:

$$\rho_m + \rho_X + 3(P_X + P_c) < 0. \quad (8)$$

Which follows directly from the second Friedmann (acceleration) equation [6]:

$$\frac{\ddot{a}}{a} = -\frac{4\pi G}{3}(\rho_{tot} + 3P_{tot}) > 0, \quad (9)$$

With $P_{tot} = P_X + P_c$.

For the illustrative choice $w_0 = 0$, substituting the physical pressure from Eq. (7) gives

$$\rho_m + \rho_X - \frac{\Gamma\cdot\rho_{BH}}{H} < 0. \quad (10)$$

Expressing everything in terms of the standard density parameters $\Omega_i \equiv 8\pi G\rho_i/3H^2$ yields

$$\frac{\Gamma}{H} > \frac{\Omega_m + \Omega_X}{\Omega_{BH}}. \quad (11)$$

This conditional bound shows that the required parameter is inversely proportional to the black-hole density proxy. It holds only if the proposed creation pressure is a physical contribution to the stress-energy tensor. Evaluating at the present epoch ($z=0$) with $\Omega_{m0} \approx 0.315 \pm 0.007$, $\Omega_\Lambda \sim \Omega_{X0} \approx 0.685 \pm 0.007$ [8], and the realistic stellar-remnant black hole density $\Omega_{BH,0} \approx 3.5 - 5 \times 10^{-4}$ ([4] and references therein) gives an illustrative lower bound of order $\Gamma/H_0 \gtrsim 2.5 \times 10^3$ (approximately $2–3 \times 10^3$ across the adopted $\Omega_{BH,0}$ range). A separate illustrative estimate follows by requiring that the effective component reproduces the observed dark-energy density. In the quasi-stationary regime (late-time behaviour where the sourced component has already reached a nearly constant density) $\dot{\rho}_X \approx 0$, and taking $w_0 \approx 0$, Eq. (4) gives $\Omega_X \approx \frac{\Gamma}{3H}\Omega_{BH}$. Evaluating this relation at the present epoch ($z=0$) and requiring the above value for Ω_{X0} yields $\frac{\Gamma}{H_0} \approx 3\frac{\Omega_{X0}}{\Omega_{BH,0}} \approx 5 \times 10^3$.

These estimates suggest that the phenomenological parameter is of order $\Gamma/H_0 \sim 10^3–10^4$ under the stated assumptions; they are not independent observational measurements of a black-hole production rate. Cosmological consistency further requires that both Γ and Ω_{BH} evolve with redshift, with significant energy injection turning on after the onset of structure formation (e.g., $z \sim 10$ to 20). This parameterization provides a possible link between compact-object populations and cosmic acceleration, and can in principle be tested through observational probes of the expansion history.

III. DISCUSSION

We have introduced one additional component sourced by compact objects into the standard Friedmann equation. Black holes are assumed to undergo transient emission phases that inject energy into a hidden sector which does not couple directly to radiation yet contributes to the expansion. The key idea is that black holes form and accumulate over cosmic time, intermittently acting as sources whose cumulative effect influences large-scale dynamics. At the background level, energy-momentum conservation is enforced through the assumed creation pressure. The microscopic origin of that pressure remains to be established.

The continuously injected component behaves differently from ordinary matter. Instead of contributing only to gravitational attraction, we assume a physical creation pressure proportional to the black-hole density proxy. This is a phenomenological constitutive choice rather than a derived consequence of an interaction term. Importantly, the model does not require long-lived or directly observable white holes –these are expected to be highly unstable. Hypothetical short-lived, microscopic white hole-like phases could motivate such a process, but are not established. Their detailed structure is not essential for the present model. What matters is their integrated contribution across cosmic history.

Our model is speculative and the sign and magnitude of the creation pressure are crucial assumptions. It follows the intriguing possibility that cosmologically coupled black holes whose mass grows with the scale factor can source the observed increase in dark energy density as by [4]. Here, the same sign convention is implicitly used in the cosmologically-coupled black hole scenario of Croker et al., where black hole mass growth acts as a positive source for the dark energy density.

The model contains ordinary matter, including black holes, and an effective component with physical creation pressure. The quantity $Q = \Gamma\rho_{BH}$ is a convenient parametrization of this pressure, not a separately imposed transfer between two fluids. This avoids identifying a density-evolution EOS with the pressure in Einstein's equations. The detailed microscopic origin remains open. Transient white hole-like phases are mentioned only as a possible motivation [1,5].

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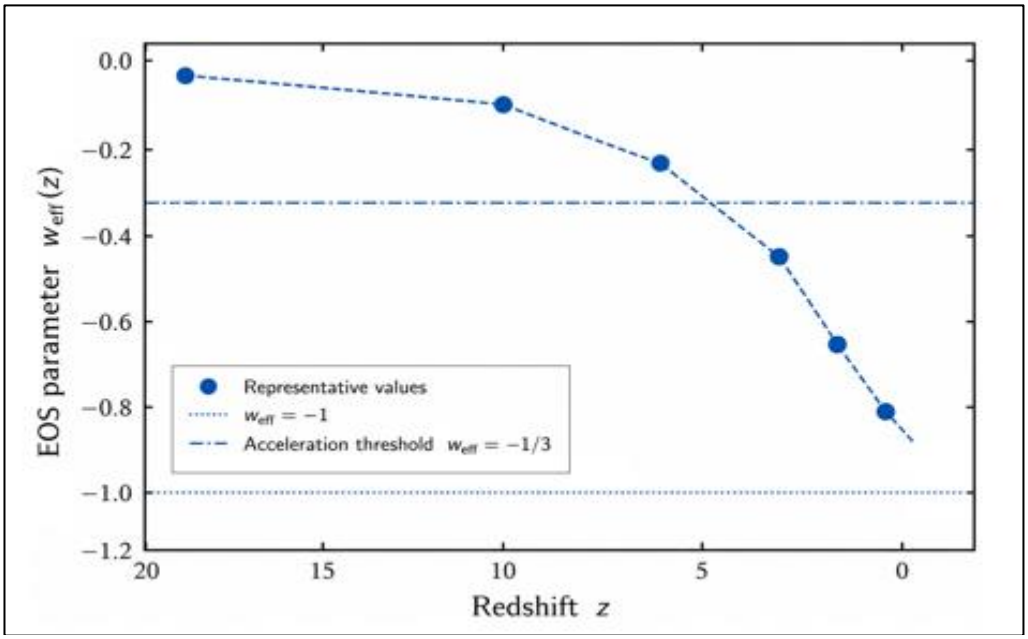

Fig 2 Illustrative values of the effective-component EOS $w_{eff}(z)$, including the assumed physical creation pressure. The curve is schematic, not a numerical solution. The dashed-dotted line at $-1/3$ is a reference for a single dominant fluid. Acceleration in the model is determined by the total physical EOS, not by this crossing alone.

Black holes do not constitute a fixed, isolated reservoir that can be depleted. New stellar-remnant black holes are continuously formed throughout cosmic history from the deaths of massive stars. The cosmic star-formation rate peaks around $z \approx 1.9$ –see [7] (approximately 3.5 Gyr after the Big Bang) and remains non-zero even at low redshifts. Consequently, both the production rate Γ and the black hole density parameter Ω_{BH} evolve with redshift, potentially sustaining the phenomenological scale Q at late times. The connection with cosmologically coupled black-hole scenarios remains qualitative rather than a demonstrated equivalence.

Let us next attempt to motivate the physical consistency and the phenomenological nature of the present proposal. Quantitative implications can be explored through conditional bounds on Γ/H, representative values of Ω_{BH}, and the evolution of the EOS parameter w_{eff} with redshift z. In Fig. 2 we show representative illustrative values of $w_{eff}(z)$, motivated by Eq. (6) with w_0=0. The points are not the result of integrating a specified redshift-dependent Γ and black-hole formation history. For constant Γ/H and a constant black-hole density proxy normalized by H_0^2, the effective continuity equation can be written as $d\Omega_X/dlna = -3\Omega_X + (\Gamma/H)\Omega_{BH}$, where $\Omega_i = 8\pi G\rho_i/(3H_0^2)$. This illustrates the balance between dilution and the assumed creation-pressure term, but does not produce the gradual curve shown in Fig. 2. For representative values $\Gamma/H \sim 5 \times 10^3$ and $\Omega_{BH,0} = 4 \times 10^{-4}$, the model approaches $\Omega_X \approx \frac{\Gamma}{3H}\Omega_{BH,0} \sim 0.7$, giving $w_{eff} \simeq -1$ in that quasi-stationary limit. A gradual redshift evolution requires an additional history for Γ and ρ_{BH}.

The plot illustrates a possible evolution from a weakly negative EOS at high redshift toward $w_{eff} \simeq -1$ today. This shape is not predicted by the constant-parameter example. It is an illustrative history requiring a suitable time dependence of the creation pressure. The condition for accelerated expansion is $w_{tot} = P_{tot}/\rho_{tot} < -1/3$. Therefore, the crossing of $w_{eff} = -1/3$ in Fig. 2 does not by itself identify the onset of acceleration. The relevant condition is instead Eq. (11) under the assumptions of Sec. III.

The model is constructed entirely within the standard Friedmann framework with Newton's constant G, as in standard general relativity. The purpose of keeping G explicit follows the conventional normalization used in cosmology, particularly in the Friedmann equations and in the definition of the density parameters. The phenomenological assumptions are the additional component ρ_X and its physical creation pressure, parametrized using the black-hole density. Thus, the model does not modify the gravitational sector or assume a new background geometry. It keeps the standard Friedmann framework and simply decomposes the total density as $\rho_{tot} = \rho_m + \rho_X$, where ρ_X represents a component with a creation-pressure contribution to its stress-energy tensor. The proposed novelty is the parametrization $P_c = -\Gamma\rho_{BH}/(3H)$, whose physical origin remains an open question.

An important conceptual point regarding the background cosmology must be emphasized. Our model is constructed as an idealized approach on cosmological (homogeneous and isotropic) scales. On these large scales, the standard Friedmann–Lemaître–Robertson–Walker (FLRW) metric and the associated Friedmann equations remain an excellent approximation, as is standard practice in cosmology when incorporating the averaged contribution of compact objects (such as stars, galaxies, or black holes) into the cosmic energy budget. Local strong-field effects around

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individual black holes are averaged out in the homogeneous background, exactly as is done when including ordinary matter or radiation in the standard ΛCDM model.

The Schwarzschild–de Sitter solution would be appropriate for describing the spacetime around a single isolated black hole embedded in a de Sitter background, but it is not the relevant global description for the statistical ensemble of black holes distributed throughout the Universe. Our approach follows the conventional treatment used in interacting dark-energy models and in studies of the backreaction of compact objects on cosmic expansion (e.g., [4] and references therein). We explicitly state in the Minimal Framework section that we work within the standard homogeneous and isotropic FLRW cosmology and that the new ingredient is the phenomenological physical creation pressure of the effective component.

The mathematical structure of our continuity equation is similar to that of recent interacting holographic dark energy (IHDE) models [12]. However, the physical motivation and interpretation differ. In our case the scale $Q=\Gamma\rho_{BH}$ is motivated by black-hole populations and hypothetical transient emission phases, rather than by a specified dark-sector interaction. This provides a possible phenomenological link between compact objects and cosmic acceleration, subject to a microscopic justification of the creation pressure.

IV. CONCLUSION

The purpose of the present work was to introduce a minimal framework with a physical creation-pressure assumption and derive conditional cosmological bounds on Γ/H. The model is speculative and phenomenological in nature. The detailed structure of the hypothetical transient phases is not essential for the cosmological framework developed here. The black hole to white hole-like transitions remain speculative since the latter are not established astrophysical phenomena. The role of the white hole-like scenarios in the manuscript is only motivational. The actual model is formulated phenomenologically through the creation pressure $P_c=-Q/(3H)$, with $Q=\Gamma\rho_{BH}$ as a proxy for its strength. The formalism itself does not depend on the detailed microscopic mechanism responsible for this transfer.

This framework should be regarded as a minimal parametrization of a possible nonequilibrium creation pressure. It captures the essential idea that the cumulative action of many compact objects may be associated with cosmic acceleration and thereby provides a concrete link between local astrophysical objects and the large-scale evolution of the Universe. The negative-pressure component is an explicit physical assumption of the model, not a consequence of rewriting a sourced continuity equation. No modification to the Friedmann equations or the background metric was introduced. The model remains a minimal extension within standard cosmology. The present model does not yet provide a microscopic derivation of the assumed creation pressure from black-hole evolution. Its connection to black-hole physics remains hypothetical, and a more complete treatment will require a physical justification of the pressure law and a consistent description of the associated energy budget.

REFERENCES

[1]. Ashtekar A., Olmedo J., 2021, Int. J. Mod. Phys. D, 30, 2143006
[2]. Cadoni M., 2026, arXiv:2601.03296 (gr-qc)
[3]. Cataldo M. et al., 2008, Phys. Lett. B, 662, 314
[4]. Croker S. et al., 2024, JCAP, 10, 094
[5]. Haggard H.M., Rovelli C., 2015, Phys. Rev. D, 92, 104020
[6]. Kolb E.W., Turner M.S., *The Early Universe* (Addison-Wesley, Redwood City, CA, 1990)
[7]. Madau P., Dickinson M., 2014, Annual Review of Astronomy and Astrophysics, 52, 415
[8]. Navas S. et al., 2024, Phys. Rev. D, 110, 030001
[9]. Parnovsky S., 2024, Particles, 7, 297
[10]. Sadeghi J., 2023, arXiv:2305.12545 (gr-qc)
[11]. Wu Chou-Hao et al., 2026, Eur. Phys. J. C, 86, 288
[12]. [Landim R.G., 2026, Phys. Rev. D, 106, 043527