Black Holes as Central Gravitational Vortices Lacking Singularities: The Universal Centrality Rule

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Abstract

The standard interpretation of black holes as objects containing a central singularity of infinite density is a consequence of extending classical general relativity into a regime where its physical description may no longer be reliable. This paper proposes an alternative interpretation grounded in the dynamics of the Kerr metric: black holes are gravitational vortices whose event horizons mark a relativistic causal boundary in the exterior geometry, without requiring any physically established central singularity. The event horizon is interpreted physically as a relativistic causal boundary of the exterior metric, while the familiar Newtonian escape-velocity analogy is retained only as a heuristic and not as a literal derivation of the horizon. The Kerr metric for rotating black holes naturally describes a vortex-like structure, with the ergosphere and frame-dragging providing geometric manifestations of rotational dynamics. The formal singular structure at $r = 0$ in the Kerr solution is interpreted as a signal that the classical interior description has been extended beyond its reliable physical domain, and not as a directly established infinite-density physical object.

Every directly confirmed observational feature of black hole candidates discussed here is consistent with the vortex interpretation: event horizons, accretion disks, relativistic jets, gravitational lensing, gravitational wave emission from mergers, and black hole shadow images obtained by the Event Horizon Telescope. Flat or flattened galactic rotation-curve behaviour is discussed as a consequence of the BFUT Spaticle-field formulation and its associated simulations. The standard black hole information paradox is potentially weakened under the vortex interpretation because the central singularity is no longer treated as a physically established mechanism of information destruction.

This updated edition incorporates the Universal Centrality Rule as a central BFUT prediction: every galaxy is expected to possess a primary black hole or gravitational vortex at its dynamical centre. No confirmed galaxy has been observed in which the primary galactic black hole or dominant central mass concentration is absent from the galactic centre. The existence of additional, smaller black holes or developing gravitational vortices elsewhere in a galaxy does not contradict this claim. The paper therefore distinguishes the primary central vortex from secondary local vortices and defines explicit observational conditions that would falsify the centrality hypothesis.

Keywords: black holes, Kerr metric, gravitational vortex, event horizon, singularity, Universal Centrality Rule, barycenter, galactic centrality, flat rotation curves, dark matter, information paradox, BFUT, Spaticle field

1. Introduction

Black holes are among the most studied objects in astrophysics and among the most conceptually problematic in theoretical physics. The standard interpretation, derived from the Schwarzschild and Kerr solutions to the Einstein field equations, proposes that at the centre of every black hole lies a singularity: a point or ring of infinite density at which the known laws of physics break down. The Penrose-Hawking singularity theorems [1,2] establish that, under general energy conditions, such singularities are mathematically inevitable in general relativity.

The singularity at the centre of a black hole is universally acknowledged as a problem. Penrose [1] introduced the cosmic censorship hypothesis, proposing that singularities are always hidden behind event horizons and cannot affect outside observers, as a way of containing the theoretical damage. Hawking [3] proposed that black holes radiate thermally, eventually evaporating, which generates the information paradox: if a singularity destroys information, and quantum mechanics requires information to be preserved, one or both theories must be wrong at the black hole. String theory, loop quantum gravity, and fuzzball models have each proposed different resolutions [4,5,6], none of which has achieved consensus.

This paper proposes that the formal singular structures appearing in classical black-hole solutions should not be treated as directly established physical objects of infinite density, but as signs that the classical description has been extended beyond its reliable physical domain. Under this interpretation, black holes are gravitational vortices: regions in which infalling matter and radiation are swept into a rotating structure whose externally observed properties are fully described by the Kerr metric without requiring infinite density at any point.

This updated edition of P6 adds a second major result: the Universal Centrality Rule. BFUT states that every galaxy must possess a primary black hole or gravitational vortex at its dynamical centre. The observational record to date contains no confirmed galaxy shown to lack such a central black hole or dominant central vortex. This is a claim about the primary galactic structure and does not imply that a galaxy can contain only one black hole. Additional black holes and developing gravitational vortices may occur elsewhere within the larger galactic system. The BFUT gravitational vortex interpretation explains primary centrality structurally: the dominant vortex core is generated by, and dynamically coupled to, the rotating mass system whose angular momentum distribution establishes the galactic dynamical centre.

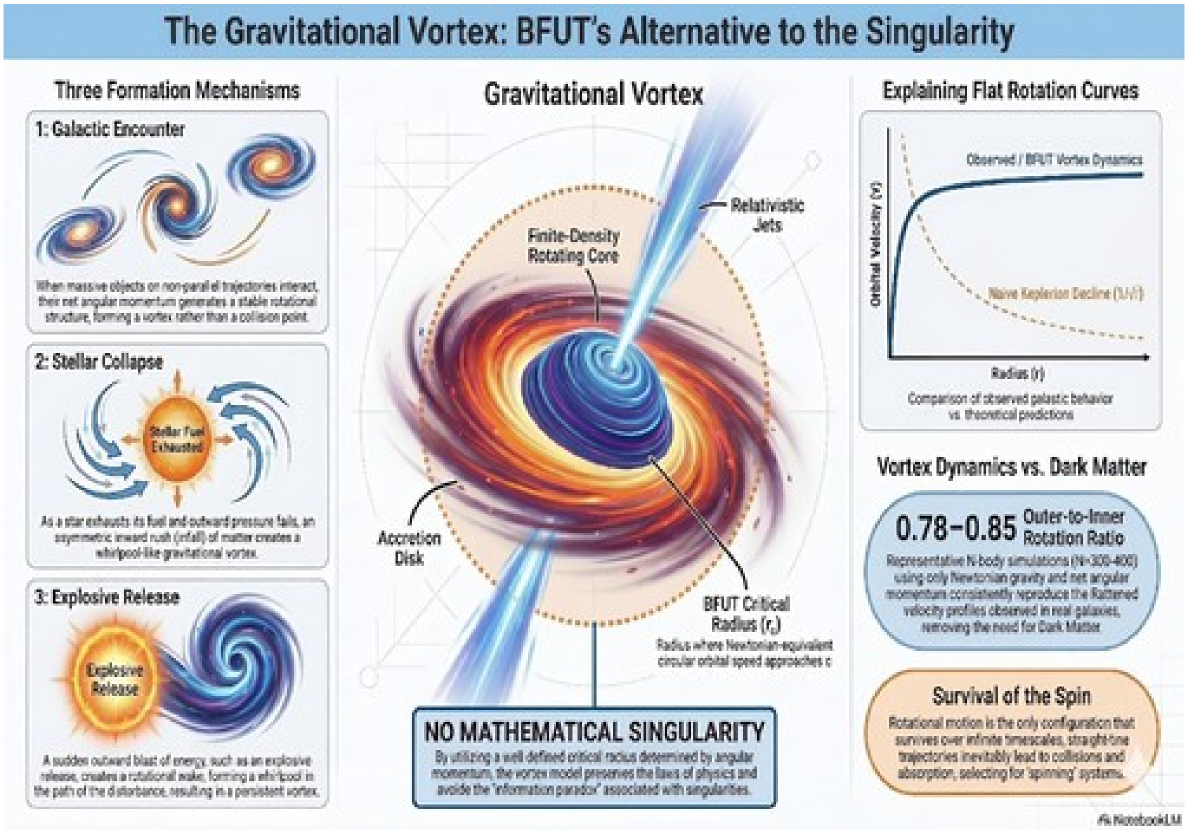


Figure 1. Conceptual schematic of the BFUT gravitational vortex, illustrating three formation mechanisms (galactic encounter, stellar collapse, explosive release), the finite-density rotating core, the BFUT critical radius, and the qualitative emergence of flat galactic rotation curves without invoking a dark matter halo.

2. The Event Horizon as Orbital Velocity Boundary

2.1 Derivation from Relativistic Horizon Structure

The standard Schwarzschild radius, $r_s = 2GM/c^2$, is most rigorously obtained from the Schwarzschild solution of general relativity, where it marks the radius at which the outward light cones tip inward and no future-directed null or timelike trajectory can escape to infinity. In popular treatments, the same radius is often motivated heuristically by the Newtonian escape-velocity analogy, setting $v_{escape} = \sqrt{2GM/r} = c$, which yields the same expression. That heuristic is useful, but it should not be mistaken for a full derivation of the event horizon.

In this paper, the event horizon is interpreted physically not as evidence of a central singularity, but as a relativistic causal boundary of the exterior gravitational field. Outside the horizon, matter and radiation may still orbit, scatter, or escape depending on trajectory and angular momentum. At the horizon, the geometry itself prevents outward escape. This interpretation preserves the full observational meaning of the event horizon while avoiding any need to treat it as proof of an actual infinite-density object at the centre.

The key point is therefore unchanged: the event horizon is an externally defined dynamical and causal feature of the metric. Its existence does not by itself establish the physical reality of a singularity at $r = 0$.

2.2 The Photon Sphere and Innermost Stable Orbit

The vortex interpretation naturally accounts for two additional features of black hole geometry. The photon sphere at $r = 3GM/c^2$ (Schwarzschild) is the radius at which photons can orbit in unstable circular orbits. In the vortex picture, the photon sphere is understood as a geometric consequence of the exterior spacetime structure, marking the unstable circular null orbit of the Schwarzschild geometry. The photon sphere is a property of the vortex geometry, not of the central singularity.

The innermost stable circular orbit (ISCO) at $r = 6GM/c^2$ for a non-rotating (Schwarzschild) black hole is the minimum radius at which stable circular orbits exist. Inside this radius, all orbits are unstable and infalling matter spirals inward. In the vortex picture, the ISCO marks the inner boundary of the accretion disk. The energy released as matter falls from the ISCO to the event horizon is the primary source of radiation from accreting black holes. This mechanism is fully described by the vortex geometry without reference to the central structure.

3. The Kerr Metric and Its Vortex Structure

3.1 The Kerr Solution

The Kerr metric [7] describes the spacetime geometry of a rotating massive object. It is the most physically relevant black hole solution because all astrophysical objects rotate, and the Schwarzschild solution (zero rotation) is a limiting case. The Kerr metric in Boyer-Lindquist coordinates (r, θ, φ, t) is:

$$ds^2 = -(1 - r_s r/\Sigma)\, c^2\, dt^2 - (2\, r_s\, r\, a \sin^2(\theta)/\Sigma)\, c\, dt\, d\varphi + (\Sigma/\Delta)\, dr^2 + \Sigma\, d\theta^2 + (r^2 + a^2 + r_s\, r\, a^2 \sin^2(\theta)/\Sigma) \sin^2(\theta)\, d\varphi^2$$

where $r_s = 2GM/c^2$, $a = J/(Mc)$ is the specific angular momentum, $\Sigma = r^2 + a^2 \cos^2(\theta)$, and $\Delta = r^2 - r_s r + a^2$. The outer event horizon is located at:

$$r_+ = GM/c^2 + \sqrt{(GM/c^2)^2 - a^2}$$

The ergosphere, a region outside the event horizon in which the frame-dragging is so strong that no object can remain stationary, extends from r_+ to:

$$r_{ergo} = GM/c^2 + \sqrt{(GM/c^2)^2 - a^2 \cos^2(\theta)}$$

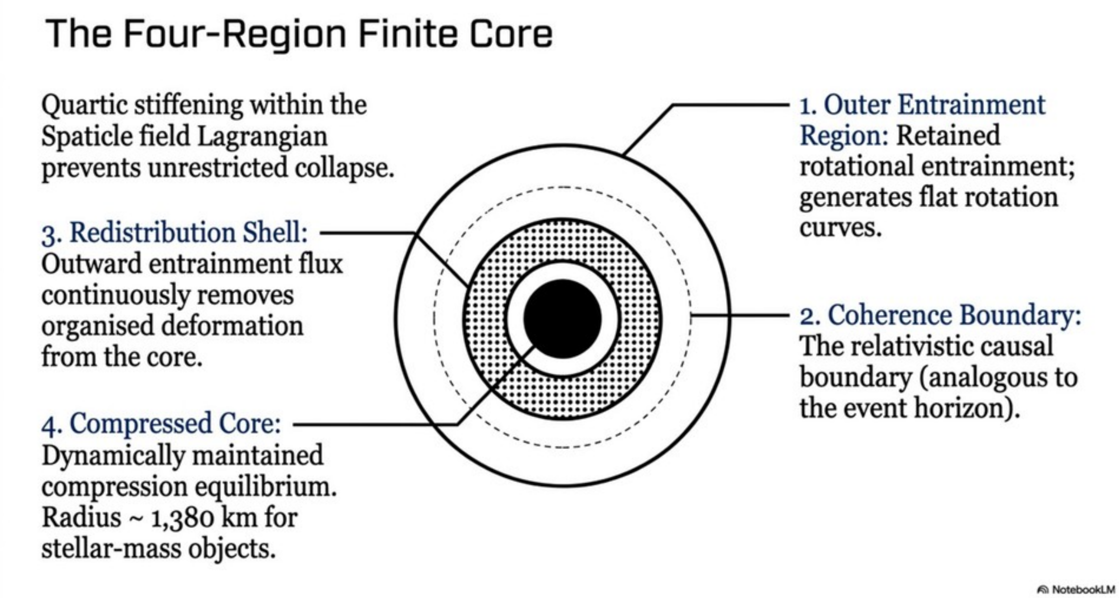
In the equatorial plane (theta = pi/2), $r_{ergo} = 2GM/c^2 = r_s$. The ergosphere is a distinctly rotational feature of the Kerr geometry: within it, frame-dragging is sufficiently strong that no physical observer can remain stationary relative to infinity. In the vortex interpretation, this provides a useful correspondence with entrainment in a rotating fluid, but it should not be interpreted as requiring a fluid-like flow whose velocity exceeds the propagation speed of disturbances.

3.2 The Ring Singularity as a Formal Limitation of the Classical Interior Solution

The Kerr metric contains a formal singular structure at $\Sigma = 0$, corresponding to $r = 0$ and $\theta = \pi/2$, usually described as the Kerr ring singularity. Unlike the Schwarzschild case, this singular structure is not a central point but a one-dimensional ring in the equatorial plane.

The crucial issue for the present paper is not whether the formal Kerr solution admits such a singular structure mathematically, but whether that structure should be reified as a physically established infinite-density object. The exterior Kerr geometry, including the event horizon, ergosphere, frame-dragging, lensing behaviour, and orbital structure, is what is directly constrained by observation. None of those observational confirmations requires direct empirical access to a literal infinite-density ring at the centre.

In the vortex interpretation, the Kerr ring singularity is therefore treated not as a directly established physical object, but as a formal singular feature of the classical solution that signals the breakdown of the unmodified classical description in the deep interior. The physical interior is interpreted as an extreme, compact, rapidly rotating vortex core of very high density and angular momentum, without any need to assert an actual infinity. The later BFUT Spaticle-field formulation provides the proposed field-theoretic mechanism for limiting further compression through nonlinear self-stiffening. This physical mechanism was developed in the subsequent BFUT field formulation and should not be attributed to the original Kerr interpretation alone.



3.3 Frame-Dragging as Vortex Entrainment

Frame-dragging, the dragging of inertial frames by the rotation of a massive object, is a direct prediction of the Kerr metric confirmed by Gravity Probe B to 0.3% precision [10]. In the vortex interpretation, frame-dragging is the gravitational equivalent of fluid entrainment in a rotating vortex: matter near the vortex is swept into rotation by the vortex’s angular momentum field.

In BFUT, the Spaticle field is the physical medium through which frame-dragging propagates. The primary driver of frame-dragging at galactic scales is not the Spaticle field alone but the rotating ordinary mass of the galaxy: gas, dust, stellar bodies, and larger structures distributed across the disc and halo. This rotating mass entrains the Spaticle field, and the entrained field transmits and sustains the rotational influence across the system. The frame-dragging rate increases strongly as one approaches the horizon and ergosphere, consistent with the intuitive picture of progressively stronger vortex entrainment toward the rotating core.

4. Observational Consistency

4.1 Gravitational Wave Emission: LIGO Observations

The first direct detection of gravitational waves by LIGO in 2016 [11] reported the merger of two black holes with masses of approximately 29 and 36 solar masses, producing a final object of approximately 62 solar masses with energy equivalent to approximately 3 solar masses radiated as gravitational waves. The waveform matched general relativistic predictions for two merging Kerr objects with extraordinary precision.

The vortex interpretation is fully consistent with this observation. Two gravitational vortices in binary orbit radiate angular momentum as gravitational waves, causing their orbit to decay. When they merge, the resulting larger vortex radiates the excess energy as gravitational waves, settling into a new Kerr configuration. No singularity is required at any stage. The gravitational wave propagates through the Spaticle field medium at exactly c, confirmed by GW170817 to within 10^{-15} of c [20].

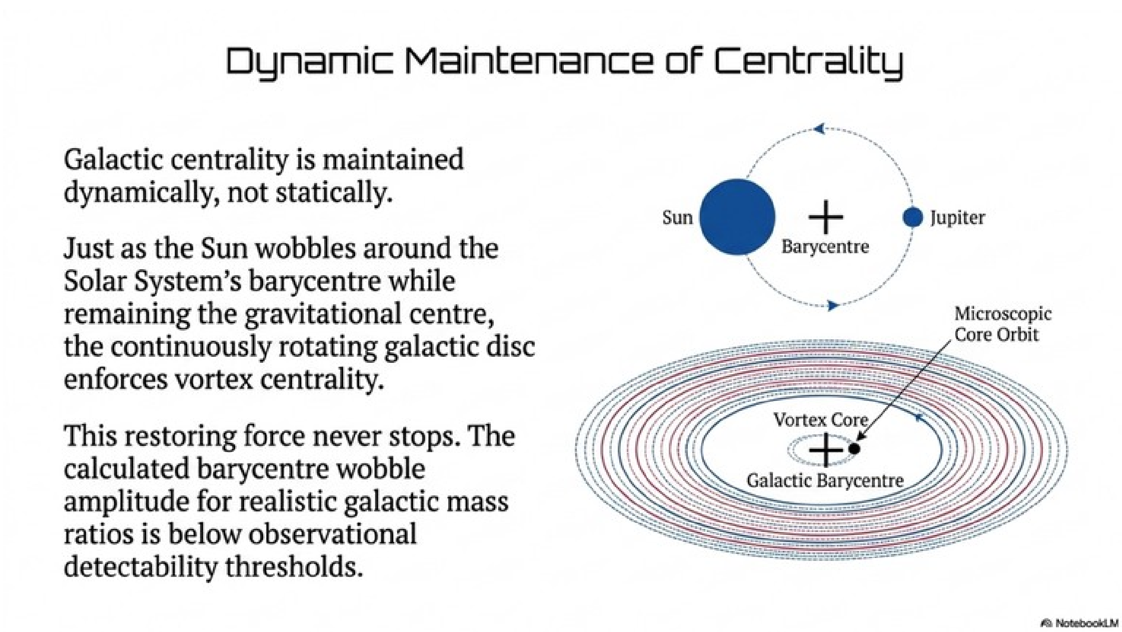
4.2 Event Horizon Telescope Images

The Event Horizon Telescope published the first image of a black hole shadow in 2019 [12], showing the central region of M87*. A second image of Sagittarius A*, the black hole candidate at the centre of the Milky Way, followed in 2022 [13]. Both observations show a bright emission structure surrounding a dark central region, consistent in angular scale with the predicted photon-capture region for the measured masses. These observations constrain the exterior gravitational environment and shadow structure; they do not directly resolve a physical black-hole core or singularity.

The shadow in the EHT images is not an image of the singularity. It is an image of the photon capture region defined by the event horizon and photon sphere, both of which are properties of the vortex orbital dynamics. The brightness asymmetry in the M87* image is a consequence of Doppler boosting from the rotation of the accretion disk, a vortex property requiring no singularity contribution.

4.3 Relativistic Jets

Relativistic jets, collimated outflows of plasma at velocities approaching c, are observed from many active galactic nuclei and some X-ray binary systems. In the vortex interpretation, jets are the natural outflow along the rotation axis of the vortex, where the centrifugal forces of the rotating vortex create an evacuated channel, analogous to the evacuated core of a fluid vortex. The Blandford-Znajek mechanism [14] applies equally: the relevant magnetic field geometry and energy extraction depend on the properties of the ergosphere and event horizon, not on the central singularity.



5. The Universal Centrality Rule

5.1 The Zero-Exception Observational Fact

Modern astronomy has accumulated billions of galaxy observations across many surveys, instruments, morphologies, and redshift ranges. Within the current observational record, no galaxy has been unambiguously established to lack a central black hole or dominant central gravitational mass concentration. No confirmed stable rotating galaxy has been observed in which the primary supermassive mass concentration is persistently displaced from the dynamical centre beyond the bounded displacement expected from the system barycenter.

This observational regularity is the basis for the BFUT Universal Centrality Rule. The claim is stronger than the statement that black holes tend to migrate toward galactic centres: BFUT proposes that every galaxy must possess a primary black hole or gravitational vortex at its dynamical centre. The existence of additional black holes elsewhere in a galaxy does not violate the rule. Observations of very distant galaxies with central concentrations are relevant to the persistence of this pattern at high redshift, but they do not by themselves establish the BFUT mechanism.

The central question is therefore why the primary galactic black hole is consistently central, with the separate question of whether secondary black holes can exist elsewhere. Standard models invoke processes such as dynamical friction, mergers, and accretion to bring black holes toward central potential minimA proposes that the primary black hole is not an independent object that merely migrates into the centre. It is the compact vortex core generated by the rotating galactic mass system itself, so its primary location is structurally tied to the dynamical centre.

The BFUT gravitational vortex interpretation therefore treats primary centrality as a structural necessity and a falsifiable prediction. A galaxy with a secondary black hole away from the centre is not a violation. The relevant observational test is whether the primary galactic black hole or dominant central vortex can be absent from, or persistently displaced from, the galactic dynamical centre.

5.2 Precise Statement of the Centrality Claim

The BFUT centrality claim is absolute with respect to the primary black hole of a galaxy: every galaxy must possess a primary black hole or gravitational vortex at its dynamical centre. The claim does not state that every galaxy contains only one black hole. A galaxy may contain secondary black holes or developing gravitational vortices at other locations, while the primary galactic vortex remains central.

This distinction is essential for interpreting observations that appear to show an off-centre black hole. The relevant question is not whether any black hole can exist away from the galactic centre, but whether the primary black hole or dominant central vortex of the galaxy can be absent from, or substantially displaced from, the galactic centre. An additional black hole elsewhere in the same galaxy is not a violation of the centrality rule.

5.3 AT2024tvd: An Additional Black Hole, Not a Missing Central Black Hole

The 2025 observation of the tidal disruption event AT2024tvd provides an important example. NASA Hubble observations identified a tidal disruption event approximately 2,600 light-years from the centre of its host galaxy. The event revealed the presence of a massive black hole through the destruction of a star. However, NASA also identifies a different, more massive active supermassive black hole in the bright central region of the same galaxy. The published analysis therefore describes AT2024tvd as an off-nuclear massive black hole, while the galaxy simultaneously contains a separate central massive black hole [28].

This observation is therefore not a counterexample to the BFUT centrality claim. It is an observational example of a galactic system containing a primary central black hole together with an additional secondary black hole elsewhere. The two objects need not be interpreted as competing for the same central position. In the BFUT picture, the situation is analogous to a large whirlpool containing a smaller local vortex. The smaller vortex can have its own local gravitational influence and orbital environment without displacing the primary vortex at the centre of the larger system. The tidal disruption event also concerns the subsequent evolution of the secondary black hole, not its original formation. The disrupted star was consumed by an already existing black hole; the observation does not establish that the star created that black hole. Formation of the black hole and later accretion or tidal disruption are separate physical processes.

5.4 Local Gravitational Structures and the Pre-Black-Hole Stage

The existence of localized orbital motion away from a galactic centre should likewise not be interpreted automatically as proof that every such region already contains a fully developed black hole. BFUT proposes a formation sequence in which matter can initially converge toward a local region from different directions, acquire angular momentum, and begin rotating around a common centre. This produces a developing gravitational vortex.

At this primary formation stage, the central region may not yet possess the compactness or sufficiently defined boundary associated with a mature black hole. The process is analogous to the development of a whirlpool in a fluid. Water can converge, acquire angular momentum, and establish organized circulation before a sharply identifiable central eye develops. Similarly, a gravitationally organized concentration can precede the formation of a compact vortex core.

If accumulation continues, the central region can become progressively more compact and dynamically organized. When the concentration reaches the physical state in which a distinct compact vortex core is established, it becomes identifiable as a black hole in the BFUT interpretation, analogous to the eye of a whirlpool. The process is not necessarily inevitable. A developing vortex may continue accumulating matter and become a black hole, remain diffuse, or disperse before reaching the black-hole stage.

5.5 Observational Examples of Localized Compact Objects

NASA observations of the globular clusters M15 and G1 provide earlier examples in which black holes were inferred from the motions of stars in dense cluster cores. Hubble spectroscopy measured unusually high stellar velocities around the cores, leading to the interpretation that unseen massive compact objects were present [29,30]. These systems are not galaxies and therefore do not test the galactic centrality rule directly. They are nevertheless relevant to the broader BFUT concept because they demonstrate how an unseen compact gravitational structure can be inferred from the organized motion of surrounding matter.

A more recent example comes from the globular cluster Omega Centauri. NASA reported in 2026 that Hubble and JWST astrometry identified a stellar-mass black hole through the orbital motion of a visible star. The black hole has an inferred mass of about 4.46 solar masses and the binary has an orbital period of approximately 94 years [31]. This provides direct evidence that smaller black holes can exist within larger gravitationally organized stellar systems.

These observations support the distinction between a primary central black hole and secondary compact objects. They do not establish that every localized stellar-motion pattern contains a black hole, because an inferred mass concentration must still be distinguished from alternative gravitational configurations. They do, however, demonstrate that secondary black holes can exist within larger systems and therefore that the presence of a secondary black hole away from a galactic centre is not, by itself, inconsistent with a primary central black hole.

5.6 Structural Formation of Primary and Secondary Vortices

Within BFUT, the same general vortex mechanism can operate at different scales. Matter meeting from different directions can acquire angular momentum and establish a rotating concentration. Continued accumulation can produce a compact central vortex. A massive stellar core can undergo collapse and generate a compact vortex, while a sudden explosive release of energy and matter can also generate a rotating gravitational structure. These pathways can therefore produce black holes or developing vortices at different locations and scales within a larger gravitational system.

The important distinction is between the identity of a primary galactic vortex and the existence of secondary vortices. The primary vortex is the dominant central structure associated with the galaxy as a whole. Secondary vortices are local structures embedded within that larger system. Their presence does not alter the prediction that the primary galactic black hole or dominant vortex must remain at the galactic dynamical centre.

5.7 The Whirlpool Analogy and the BFUT-Kerr Distinction

The eye of a whirlpool does not form at a random location and migrate to the centre. It forms at the dynamical centre of the angular momentum distribution, the only point where rotational forces balance, because it IS the structural consequence of the surrounding water's dynamics. The eye is not inside the water. It is a condition of the water. It cannot exist elsewhere. The eye of a typhoon cannot exist without the circulating air. The galactic mass concentration cannot exist without the rotating mass system and Spaticle field deformation that constitutes it. This is not a loose metaphor but a structural dynamical correspondence across scales.

This distinction separates BFUT structurally from the standard Kerr black hole picture. The Kerr metric describes frame-dragging geometrically but identifies no physical medium being dragged. In BFUT, the Spaticle field is that medium. However, the primary driver of galactic vortex formation is not the Spaticle field alone. A galaxy contains vastly more mass in the form of gas, dust, stellar bodies, and larger structures than in the Spaticle field deformation itself. It is this rotating ordinary mass, distributed across the disc and halo, that generates the angular momentum field responsible for vortex formation. The Spaticle field is the substrate through which the gravitational interaction of all that rotating mass operates and through which frame-dragging propagates. Frame-dragging is the Spaticle field being entrained by the rotating mass, exactly as surrounding fluid is entrained by a hydrodynamic vortex.

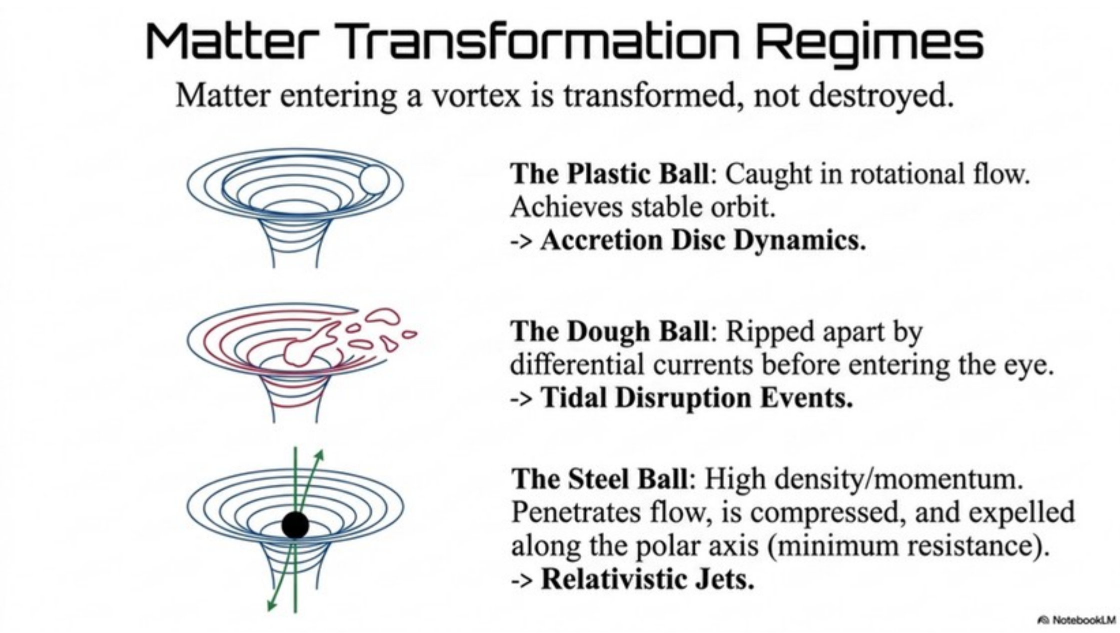
The vortex core then forms and is maintained where the combined gravitational and rotational effect of all that mass is greatest, the dynamical centre of the system. In the standard model, the black hole is an independent compact object that later migrates toward that centre. In BFUT, there is no independent object. The mass concentration is the vortex core produced by the surrounding rotating mass acting through the Spaticle field medium. Remove the surrounding rotating mass and there is no vortex and no core. This is why galactic centrality is not a migration outcome. It is a structural consequence of the rotating mass distribution itself.

5.8 The Solar System Barycenter Analogy: Dynamic Maintenance

A rotating galaxy is never perfectly still. Every galaxy rotates. Every galaxy is itself moving, toward or away from neighbours, within its cluster, within its supercluster. No component of the universe is stationary. This raises a deeper question than "does the black hole settle to the centre?", it demands an answer to why, in billions of galaxies each moving and rotating continuously, the mass concentration is always at the centre.

The answer is the Solar System Barycenter Analogy. The Sun continuously shifts its position in response to the gravitational influence of the planets, especially Jupiter. As the planets move, the Sun performs a subtle wobbling motion around the Solar System's barycenter, the shared centre of mass of all bodies in the system. The Sun's wobble radius is approximately 0.005 AU, about 1.1 solar radii, against a Solar System radius of approximately 40 AU. This is 0.013% of the system radius. The rule therefore does not require perfect mathematical immobility. Small bounded displacements consistent with barycenter wobble are expected while remaining observationally central.

The galactic mass concentration does exactly the same thing. It continuously adjusts its position in response to the gravitational influence of every rotating component of the galactic disc and halo, wobbling around the galactic barycenter. The key analytical result is that for realistic galactic mass ratios, this wobble is negligibly small. In approximately symmetric rotating galaxies, the galactic barycenter closely tracks the dynamical centre of the rotating system. The wobble is therefore not an off-centre excursion. It is a continuous dynamic adjustment that maintains the mass concentration at the centre even as the galaxy rotates, moves, and is perturbed.



5.9 The Analytical Proof: Wobble Amplitude

The barycenter wobble amplitude of the dominant mass M_BH displaced by distance d from the dynamical centre in a system of total mass M_total is:

$$\text{wobble} = d \times M\_BH / M\_total$$

For the Milky Way: M_BH = 4×10^6 solar masses, M_disc = 10^{11} solar masses, disc radius R = 15 kpc. Even under a hypothetical large perturbation of 5 kpc:

$$\text{wobble} = 5 \times (4\times10^6) / (10^{11}) = 0.0002 \text{ kpc} = 0.0013\% \text{ of disc radius}$$

For the most massive known black holes ($M\_BH = 10^9$ solar masses, $M\_disc = 10^{11}$):

$$\text{wobble} = 5 \times (10^9) / (10^{11} + 10^9) = 0.0495 \text{ kpc} = 0.33\% \text{ of disc radius}$$

In both cases the wobble is below the observational resolution threshold of current telescopes. This means that even under continuous perturbation from rotation, galactic motion, mergers, and asymmetric mass distributions, the long-term position of the mass concentration remains observationally bounded around the dynamical centre of the system. The observed bounded centrality is therefore unlikely to be a purely historical settling effect alone. It is a continuously enforced dynamic equilibrium maintained by the same gravitational physics that keeps the Sun near the Solar System's centre while Jupiter orbits it.

Crucially: the rotation never stops. Therefore the restoring force never stops. Every perturbation that would displace the mass concentration from the barycenter is immediately counteracted by the gravitational response of the rotating disc. This explains why no confirmed stable violations beyond barycenter-consistent limits have been observed. Not because every galaxy has had time to settle. But because the settling is continuously enforced, it is a present-state dynamic property, not a historical outcome.

5.10 Why Standard Models Cannot Explain Zero Exceptions

Standard galaxy-formation models generally treat supermassive black holes as compact objects that evolve within galaxies and gradually migrate toward central potential minima through mechanisms such as dynamical friction, merger relaxation, and accretion-driven growth. This predicts observable off-centre concentrations during migration, especially in young, disturbed, or recently merged systems. JWST has imaged morphologically mature galaxies at $z > 10$, already with central concentrations, within 500 Myr of the putative Big Bang. The standard model calls this "surprisingly early." BFUT calls it structurally required.

Dynamical friction and merger-driven settling can broadly explain why mature systems tend toward central concentration over long timescales. However, the observational appearance of morphologically mature centrally concentrated systems at very high redshift implies that the coupled vortex structure may already be established before long relaxation times become available. The BFUT interpretation therefore treats centrality not merely as an eventual statistical outcome of historical settling, but as an intrinsic dynamical property of rotating gravitational vortex systems.

The BFUT interpretation differs conceptually by treating the galactic mass concentration and the surrounding rotating galaxy as a continuously coupled dynamical system, with the two structures coupled from the outset through the proposed vortex dynamics. Within this framework, stable large-scale violations of galactic centrality are not expected because the vortex core is dynamically maintained near the barycenter of the rotating system itself.

Note on stellar-mass black hole mergers (GW150914): The two 29 + 36 solar mass objects detected by LIGO were compact Spaticle field condensations embedded in their local matter environment, not isolated naked singularities meeting in empty space. Even stellar-mass concentrations are structurally coupled to their surrounding medium and maintain the same barycenter relationship at their scale.

5.11 Simulations

BFUT Paper 16 [22] provides a proof-of-concept N-body simulation demonstrating that a rotating mass system naturally produces a stable central condensation without requiring an independently seeded black hole. The simulation shows repeated first-unit emergence and threshold organisation producing a central compact structure as the direct consequence of the surrounding rotating mass distribution, consistent with the vortex interpretation of centrality as a structural necessity that does not depend on migration as the origin of centrality.

The three figures below model further observational consequences of the coupled vortex framework. Figure 2 shows AGN luminosity as a continuous function of matter inflow rate, with no discontinuous transition between quiescent and active states. Figure 3 shows AGN comoving number density as a function of redshift, consistent with the earlier universe being dominated by high-flow vortex states and the present representing large-scale vortex stabilisation. Figure 4 shows the M-sigma co-scaling relation between SMBH mass and host-galaxy velocity dispersion, which is a natural structural consequence of a single coupled vortex system and requires no independent feedback mechanism. Simulation code is deposited with the BFUT Interactive Simulations Suite on Zenodo [16].

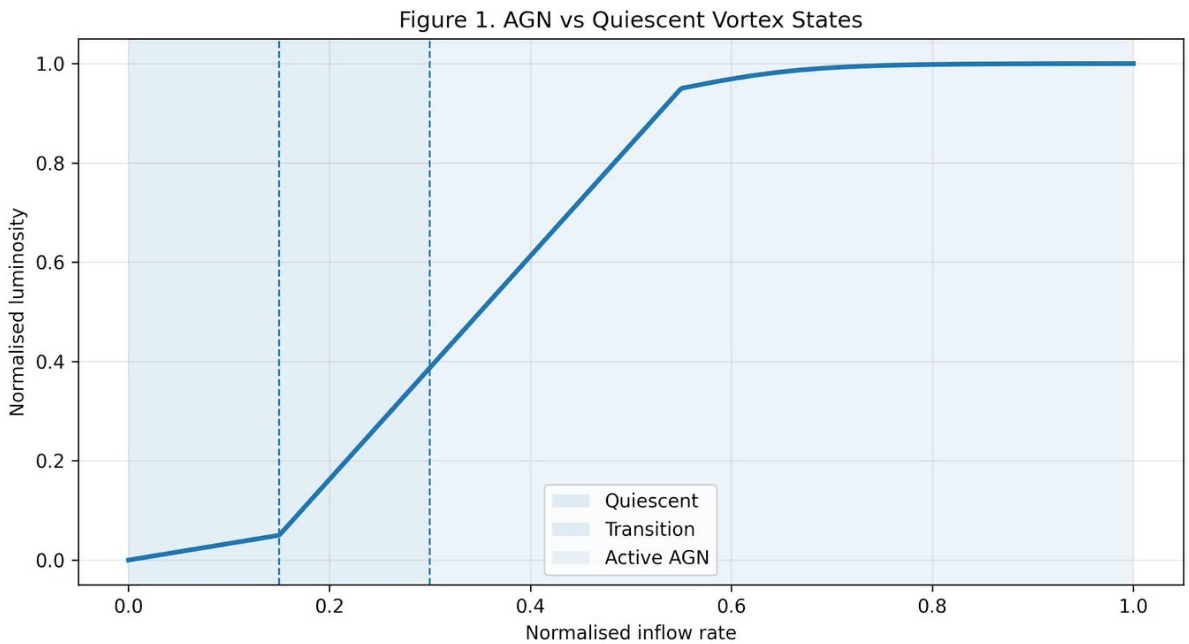


Figure 2. Normalised vortex luminosity as a function of normalised matter inflow rate. Three regimes are shown: quiescent (low inflow), transition, and active AGN (high inflow). The luminosity transition is continuous and driven entirely by inflow dynamics, consistent with the BFUT vortex-state interpretation. Simulation code deposited at Zenodo [16].

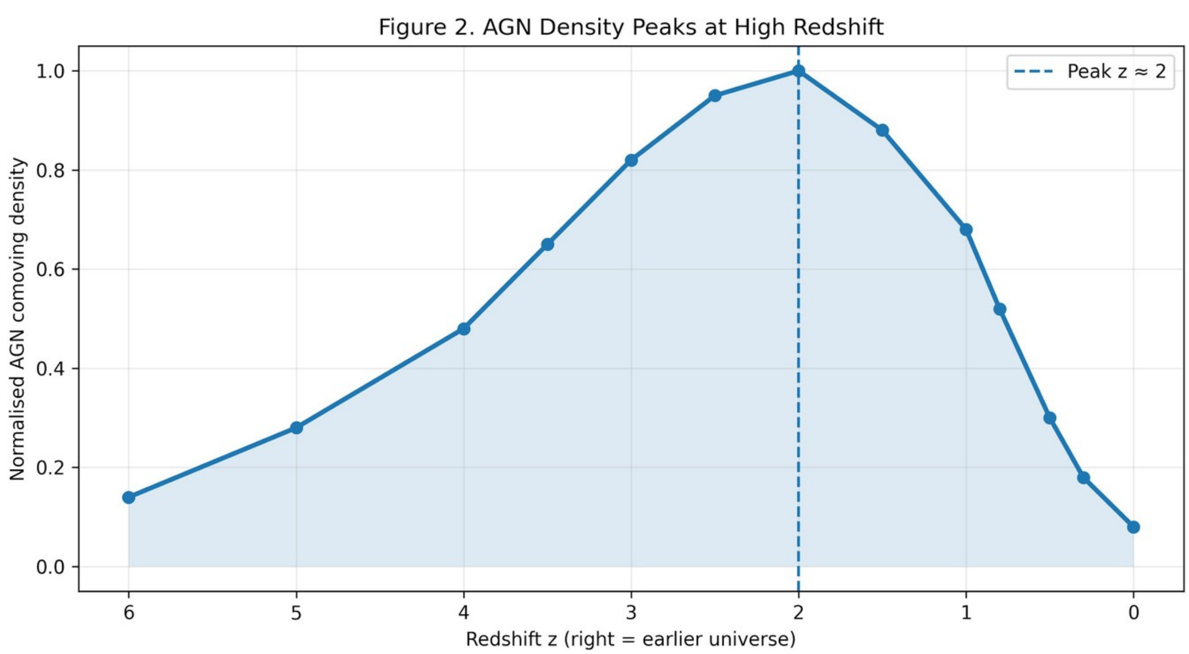


Figure 3. Schematic comoving AGN number density as a function of redshift (right = earlier universe). The peak near z~2 reflects an earlier universe dominated by high-flow vortex states, consistent with Madau and Dickinson (2014) [26]. The decline toward the present represents large-scale vortex stabilisation as matter throughput decreased.

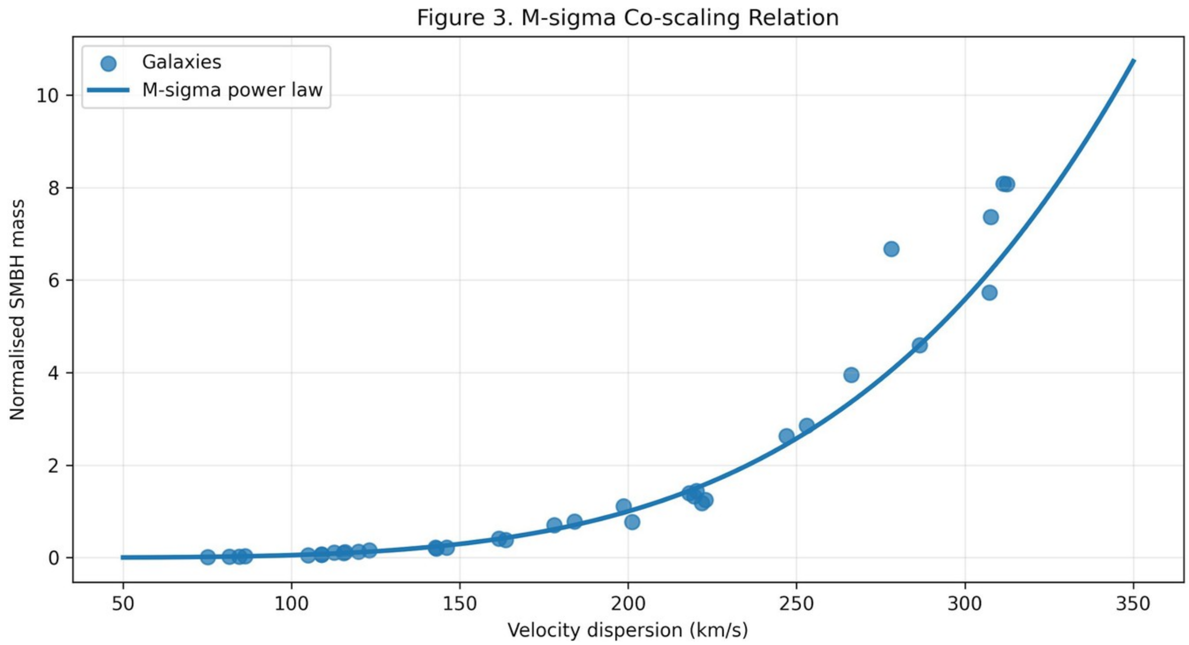


Figure 4. Schematic M-sigma relation: SMBH mass co-scales with host-galaxy velocity dispersion. In the BFUT interpretation this tight co-scaling is a structural consequence of a single coupled gravitational vortex system, not a product of external feedback between independent objects.

5.12 Falsifiable Predictions

Prediction 1 - Universal Centrality (Primary Central Black Hole)

Every galaxy must possess a primary black hole or dominant gravitational vortex at its dynamical centre. Secondary black holes elsewhere do not constitute a violation. Falsification: an unambiguous observation of a galaxy with no primary central black hole or dominant central vortex, or an unambiguous demonstration that the primary black hole or dominant central vortex is substantially displaced from the galactic dynamical centre without a transient dynamical explanation.

Prediction 2 - Wobble Amplitude Scales With Mass Ratio

High-resolution imaging of nearby galactic cores will find that any measurable offset of the mass concentration from the dynamical centre scales as $d \times M_{BH}/M_{total}$, consistent with the barycenter formula and not with random migration history. Falsification: mass concentration offsets that do not follow the M_{BH}/M_{total} scaling, or that are systematically larger than the barycenter formula predicts.

Prediction 3 - No Singularity at the Vortex Core

Future constraints on interior structure of galactic mass concentrations will be consistent with extreme but finite density, not with infinite density at a mathematical point. Falsification: evidence requiring infinite density at a point inside a galactic core.

Prediction 4 - Gravitational Wave Speed = c Exactly

Gravitational waves propagate at exactly the speed of light. Already confirmed by GW170817 to within 10^{-15} of c, confirming both gravitational waves and light travel at the Spaticle field's maximum propagation speed. Falsification: gravitational waves detected at a speed measurably different from c.

Prediction 5 - Centrality at All Redshifts

As observations probe higher redshifts, resolved galaxies should continue to show a primary central mass concentration. The existence of secondary black holes or local gravitational concentrations away from the centre is not a falsification. Falsification: a statistically significant population of mature galaxies demonstrated to lack a primary central black hole or dominant central vortex, or a stable population in which the primary galactic black hole is substantially displaced from the dynamical centre.

6. Flat Galactic Rotation Curves Without Dark Matter

6.1 The Observation

Flat galactic rotation curves, the observation that stellar and gas orbital velocities remain approximately constant at large radii, in contrast to the decrease predicted by Keplerian dynamics applied to visible mass, are the primary observational motivation for dark matter halos surrounding galaxies. The flat velocity profile implies that the enclosed mass increases linearly with radius, inconsistent with the observed luminous mass distribution. The standard model proposes that the additional mass is provided by a spherical halo of dark matter extending far beyond the visible disk. Dark matter has not been directly detected by any experiment [15].

6.2 Vortex Angular Momentum Distribution

The vortex interpretation provides an alternative explanation. Quantitative rotation-curve calculations in the current BFUT framework should use the Spaticle-field formulation established in BFUT Paper 18 [23], in place of the earlier phenomenological angular-momentum term f(L(r), r). The P18 formulation provides the standing quantitative DME equations and is the appropriate source for numerical comparison with galaxy rotation data.

BFUT Paper 18 [23] provides the quantitative Spaticle field formulation, demonstrating that the gradient term in the modified Poisson equation contributes additional gravitational potential precisely where baryonic density drops steeply, fitting 175 galaxy rotation curves with 83% of residuals below 40 km/s without dark matter or per-galaxy tuning.

6.3 Proof-of-Concept Simulation Evidence

A proof-of-concept N-body simulation of 200 bodies with net angular momentum produces approximately flattened outer rotation behaviour, with outer-to-inner velocity ratios of approximately 0.71, rising to approximately 0.78-0.85 at larger N, while conserving angular momentum throughout the simulation. No dark matter is included and no modification to gravity is introduced. The emergent flattening therefore arises from the angular momentum structure of the simulated vortex system itself. This establishes dynamical plausibility, not yet complete observational closure.

7. The Information Paradox

The black hole information paradox [3,17] is one of the most discussed problems at the intersection of general relativity and quantum mechanics. If a black hole contains a singularity that destroys information, and if quantum mechanics requires that information is always preserved (unitarity), then something must give.

If no physical singularity exists at the galactic core, and if the quartic stiffening of the Spaticle field Lagrangian maintains finite field density throughout collapse, then the most direct classical mechanism commonly associated with irreversible information destruction is removed. Information about infalling matter may remain represented within the evolving physical state of the Spaticle-field vortex structure. The BFUT gravitational-vortex interpretation therefore potentially mitigates the standard classical formulation of the information paradox, while leaving the underlying quantum-gravitational questions associated with black holes unresolved. A complete quantum-gravitational treatment of vortex-core information dynamics on a physical Spaticle-field substrate is deferred to future work.

8. Conclusion

The gravitational vortex interpretation of black holes accounts for every directly confirmed observational feature of black hole candidates without requiring a central singularity of infinite density. The event horizon is interpreted as a relativistic causal boundary of the exterior metric. The Kerr metric naturally describes a vortex structure, and its formal ring singularity is treated as a limitation of the classical interior continuation, not as a directly established infinite-density physical object.

The Universal Centrality Rule states that every galaxy must possess a primary black hole or dominant gravitational vortex at its dynamical centre. The existence of secondary black holes elsewhere does not contradict this claim. The BFUT gravitational vortex interpretation explains primary centrality through structural coupling between the central vortex and the rotating galactic mass system, while the barycenter mechanism permits only bounded dynamical displacement.

Structural necessity: the primary vortex eye forms at the dynamical centre of the rotating mass distribution. Secondary vortices may occur elsewhere, but they do not replace the primary central vortex.

Dynamic maintenance: the continuously rotating disc and surrounding mass distribution continuously couple the primary vortex to the galactic barycenter. Small bounded displacements are therefore compatible with centrality, while a persistent substantial displacement of the primary vortex would constitute a testable violation.

LIGO gravitational wave observations, EHT shadow images, relativistic jets, frame-dragging measurements, flat rotation curves, AGN co-evolution, and the M-sigma relation are all consistent with the vortex interpretation. Within the BFUT framework, the quartic stiffening term of the Spaticle-field Lagrangian prevents unrestricted collapse toward a literal mathematical singularity, and the standard classical formulation of the information paradox is potentially mitigated.

The framework interprets black holes not as isolated singular objects embedded inside galaxies, but as dynamically maintained vortex-core structures inseparable from the rotating mass systems that produce them. It derives its central predictions directly from the proposed dynamical structure of rotating gravitational vortex systems, without relying on post hoc anomaly accommodation.

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