



THE BLACK SPHERES

“Why a black hole is not a hole — and what it really is.

L'ARCHITECH

Gabriel Breton-Breault

« Darkness is not a void — it is a direction.

All that falls toward the black is not lost in an abyss;

it converges, with absolute precision, toward a center.

Geometry never lies. It is language that lies. »

— l'Architech

The Lie of the Hole

« To name a thing is already to understand it — or to begin misunderstanding it. »

Language is the primary instrument of scientific thought. Before the equation, before the telescope, before the numerical simulation, there is the word. And the word, when poorly chosen, does not merely mislead — it carves a cognitive rut into which entire generations of minds slide without ever noticing. Such is the founding paradox of modern astrophysics: one of its most fascinating, most real, most structured objects bears a name that suggests the exact opposite of what it is.

The *black hole*. Two simple words, immediately evocative, that have become one of the most celebrated scientific expressions in the world. They are spoken with reverence in classrooms, printed on magazine covers, whispered in documentaries against cosmic soundscapes. And yet, these two words constitute one of the most misleading metaphors in the entire history of physics.

For a black hole is not a hole. It is not an absence, not an opening, not a passage to elsewhere. It is not a void in the fabric of spacetime. It is, on the contrary, a **presence** — massive, structured, geometrically precise, physically coherent. It is an object with a defined mass, a defined radius, a defined boundary, and — in the vast majority of astrophysical cases — a defined rotation. It is, to use a term both more accurate and more beautiful: a **sphere**.

A black hole is not an absence in spacetime.

It is the most extreme form of presence that nature has ever manifested.

This essay aims to correct that fundamental misapprehension. It speaks to the curious reader as much as to the seasoned scientist, to the student discovering general relativity as much as to the professor teaching it. Its central thesis is simple, but its ramifications run deep: **a black hole is a sphere — a bounded, massive, geometrically ordered structure endowed with absolute directionality**. To understand this is to understand spacetime itself in an entirely new way.

We will proceed in five steps. The first establishes the physical foundations: what is a black hole, truly? The second explores the event horizon — that point of no return so frequently misrepresented. The third analyzes the linguistic and conceptual reasons why the word "hole" is profoundly inadequate. The fourth introduces an original conceptual framework — *directional physics* — which allows us to understand black holes as spheres of maximal directionality. The fifth, finally, draws the pedagogical and scientific consequences of this terminological correction. We will then conclude with the sphere as truth.

SECTION I

What Is a Black Hole? Definitions and Physical Reality

« *The truth of an object lies not in what we see of it, but in what it constrains.* »

A Rigorous Definition

A black hole is a **region of spacetime in which the gravitational field is so intense that no information, no matter, no electromagnetic radiation — not even light — can escape beyond a critical boundary** known as the event horizon. This definition, rigorous and precise, emerges directly from Einstein's field equations of general relativity (1915). It contains no notion of a "hole," an "opening," or a "passage." It describes a bounded region — a physical object with measurable properties.

The first to solve Einstein's equations for such an object was Karl Schwarzschild, writing from the front lines of the First World War in 1916 — mere weeks after the publication of general relativity. His solution describes the geometry of spacetime around a spherical, non-rotating mass with perfect symmetry. It remains one of the most fundamental exact solutions in all of theoretical physics.

The Schwarzschild Radius

At the heart of this solution lies a fundamental quantity: the **Schwarzschild radius**, denoted r_s , defined by the formula:

$$r_s = 2GM / c^2$$

where G is the universal gravitational constant, M is the mass of the object, and c is the speed of light in a vacuum. This radius represents the critical size below which, if all of an object's mass is compressed, an event horizon forms. For the Sun, this radius is approximately 3 kilometers. For the Earth, it would be barely 9 millimeters. What we are dealing with, then, is extraordinary density — but not a void, not an absence.

► Key Point — What r_s Measures

The Schwarzschild radius is not the "size" of a singularity. It is the radius of the event horizon — the sphere beyond which the escape velocity exceeds the speed of light. A black hole of one solar mass has a spherical horizon with a radius of approximately 3 km. It is an object with a mathematically defined surface.

A Physical Object with Measurable Properties

One of the most remarkable results of general relativity — known as the *no-hair theorem* — states that a stationary black hole is entirely characterized by just three physical quantities:

- **Mass (M)** — which determines the extent of its gravitational influence and the size of its horizon
- **Angular momentum (J)** — that is, the quantity of rotation, or spin
- **Electric charge (Q)** — rarely significant in astrophysical practice, but theoretically possible

An object defined by three real, measurable numbers is not a void. It is a physical entity just as real as a star or a planet — simply more extreme in its density and in the properties of the spacetime surrounding it.

Internal Structure: A Verbal Cross-Section of a Rotating Black Hole

For a rotating black hole — known as a Kerr black hole, named after physicist Roy Kerr who published its solution in 1963 — the structure is as follows, from the outside inward:

Ordinary Spacetime→ Accessible region, where geodesics can point in any direction. Gravity is normal, though increasing toward the center.

Ergosphere→ Region exterior to the horizon, unique to Kerr black holes. Spacetime here is dragged into rotation; even a "stationary" observer is forced to rotate in the direction of the black hole. Escape is still possible.

Outer Event Horizon→ The fundamental mathematical boundary. A sphere (or oblate spheroid for Kerr) where the escape velocity reaches exactly c . Every future-directed trajectory points inward.

Inner Event Horizon (Kerr)→ A second critical surface unique to rotating black holes. Associated with mass inflation instability. Its physics remains an active area of research.

Singularity (ring singularity for Kerr)→ A point (Schwarzschild) or mathematical ring (Kerr) where spacetime curvature diverges. This is not a place in space — it is a limit in time: the inevitable future of every interior trajectory.

Correcting the Three Most Widespread Misconceptions

Misconception	Physical Reality
(a) A black hole "sucks" everything in like a vacuum, even from great distances.	False. At sufficient distance, its gravity is identical to that of any object of equal mass. If the Sun became a black hole, the Earth would continue orbiting normally. The gravitational pull does not mysteriously increase — it obeys the same laws.
(b) A black hole is a passage or tunnel to another universe or another location in space.	False. In classical general relativity, the interior of a black hole leads nowhere: every interior trajectory converges toward the singularity. White holes and other tunnels are mathematically unstable solutions with no confirmed observational basis.

Misconception	Physical Reality
(c) A black hole is a point or a void — something infinitely small.	False. The event horizon is a sphere of well-defined size. A supermassive black hole such as M87* has a horizon approximately 38 billion kilometers in diameter — larger than the orbit of Pluto. It is an immense object, not a point.

SECTION II

The Event Horizon:The Point of No Return

« It is not a wall. It is not a door. It is the moment when the future runs out of options. »

The Nature of the Horizon

The event horizon is perhaps the most misunderstood concept in all of popular cosmology. It is often imagined as a luminous wall, a veil of flames, a visible edge of space. None of that is accurate. The event horizon is a **mathematical boundary** — a surface defined by the geometry of spacetime, not by any particular matter or energy. Locally, at the moment of crossing, nothing spectacular occurs — for an observer in free fall into a supermassive black hole, the passage through the horizon is imperceptible to the senses.

Its precise definition: it is the surface at every point of which the **escape velocity** is exactly equal to c , the speed of light in a vacuum. Inside it, the velocity required to escape would exceed c — which is physically impossible according to special relativity. Outside it, the escape velocity is less than c , and escape remains possible.

Two Radically Different Perspectives

General relativity offers a result here that is at once counter-intuitive and magnificent: the experience of the horizon is *radically different* depending on the position of the observer.

For the infalling observer: They cross the horizon in a finite proper time, without experiencing any local shock. For a sufficiently massive black hole (where tidal forces at the horizon of a supermassive black hole are relatively weak), the crossing is undetectable. Only the constraint on future trajectories changes irrevocably: all of them now point toward the singularity.

For the distant observer: They will never see the object cross the horizon. Gravitational time dilation — the distortion of time near an extreme mass — causes the image of the falling object to appear to "freeze" asymptotically as it approaches the horizon, its light reddening exponentially (gravitational redshift) until it fades entirely into invisibility.

The event horizon does not exist for the one who crosses it.

It exists only for those who remain outside.

Hawking Radiation and the Thermodynamics of Black Holes

In 1974, Stephen Hawking achieved a remarkable theoretical synthesis, uniting general relativity and quantum field theory to demonstrate that black holes are not perfectly black. Through a quantum mechanism tied to the creation of particle-antiparticle pairs near the horizon, a black hole emits **thermal radiation** at a temperature of:

$$T_H = \hbar c^3 / (8\pi G M k_B)$$

where $\hbar$ is the reduced Planck constant and k_B is the Boltzmann constant. This temperature is inversely proportional to mass: a black hole of one solar mass has a temperature of approximately 6×10^{-8} kelvins — practically zero on astrophysical scales. This radiation implies that black holes possess an **entropy**, expressed by the Bekenstein-Hawking relation:

$$S = A / 4 \quad (\text{en unités de Planck})$$

where A is the area of the event horizon. This formula is profound: it links a thermodynamic property (entropy) to a geometric property (the area of the horizon-sphere). It confirms that the horizon is indeed a **surface** — a measurable sphere — and not a point or a void.

Why the Shape Is Spherical — and Not a Funnel

A persistent visual misconception deserves to be corrected forcefully. The so-called "rubber sheet" diagram — depicting a three-dimensional funnel with a massive object deforming a flat membrane — is one of the most widely used and most misunderstood scientific illustrations in the world.

⚠ Warning — The Funnel Diagram

The funnel diagram does not represent the shape of a black hole. It represents a *two-dimensional projection* of spacetime curvature around a massive object — a pedagogical metaphor, not a photograph. A real black hole has no pointed "bottom" into which one falls. Its geometry is spherically symmetric (or oblately spheroidal for a rotating black hole). The event horizon is a closed sphere, not a tunnel.

The precise geometry of the horizon for a Kerr (rotating) black hole is that of an **oblate spheroid** — slightly flattened at the poles due to rotation — but always a closed, convex surface with no opening. The spherical symmetry is broken by rotation, but the topology remains that of a sphere. Nowhere in the exact Schwarzschild or Kerr geometry does any funnel structure, tunnel, or opening exist.



Illustration des différentes parties d'un trou noir : ergosphère, horizon des événements externe et interne, et singularité centrale.

Fig. 1 — The layered structure of a rotating Kerr black hole. Note the closed, spheroidal symmetry of the horizon, with no opening or tunnel. (AFP / Getty Images)

SECTION III

Why the Word "Hole" Is Misleading

« When language betrays reality, it is reality that pays the price — inside people's minds. »

Linguistic and Conceptual Analysis

The word "hole" evokes, in every language where it appears — *trou* in French, *Loch* in German, *buco* in Italian — a coherent mental schema: an empty space bounded by a surface, an opening allowing passage, an absence within a presence. To dig a hole in a wall is to create a discontinuity — a lack, a navigable void. That is precisely what black holes are not.

Let us analyze the semantic implications of the word "hole" and confront them with physical reality:

What "hole" implies	What physics establishes
A void, an absence of matter	A black hole contains an enormous mass — millions or billions of solar masses for supermassive black holes
An opening that allows passage	Nothing can exit from within the horizon. It is not an opening — it is an absolute enclosure
An absence of defined geometry	The geometry is precisely defined — spherical or spheroidal — and constitutes the very essence of the object
A lack of structure	Complex structure: ergosphere, multiple horizons (Kerr), singularity — each layer governed by precise equations
Something passive and hollow	A black hole radiates (Hawking), accretes matter, emits relativistic jets, and generates gravitational waves during mergers

The Origin of the Term and Its Acknowledged Limitations

The term *black hole* was popularized by American physicist **John Archibald Wheeler** at a conference in 1967, although informal usage predates this. Wheeler was a genius at scientific communication, and his terminological choice reflected a pedagogical intention: to seize the public's imagination. He wanted a term that was powerful, memorable, striking. He succeeded — too well.

What is often forgotten is that Wheeler himself acknowledged the metaphorical nature of the term. In his autobiography *Geons, Black Holes, and Quantum Foam* (1998), he notes that he had not invented but rather adopted it, and that he was aware "hole" was an image, not a description. Yet the metaphor overtook reality in the collective imagination, to the point of becoming inseparable from the object it so poorly designates.

► Historical Note — Wheeler and Terminology

Before Wheeler popularized the term "black hole," other expressions circulated within the scientific community: "collapsed star," "Schwarzschild object," or the

Soviet phrase *zvezdá, zamershaya vo vremeni* — "a star frozen in time." These designations, though more cumbersome, were paradoxically more faithful to the actual physics.

The Concrete Consequences of the Metaphor

This terminological problem is far from trivial. It generates measurable errors in reasoning. Research in science education consistently shows that students exposed to the term "black hole" without formal correction systematically imagine:

- An object one can "fall into" from any direction and "come out the other side" of
- An object that actively "sucks" everything surrounding it, like a drain
- An object with no defined boundary — just an increasingly dark expanse of space

These erroneous intuitions persist even after formal instruction, because they are embedded in the semantic structure of the word itself. The metaphor of the hole outcompetes physics in the architecture of the mind.

A Terminological Proposal

The author of this document proposes, with all the modesty that scientific tradition demands and all the boldness that intellectual rigor requires, that a more accurate terminology be progressively adopted. Two natural candidates emerge:

- **Black sphere** — a geometrically precise term that preserves the notion of darkness while restoring the object's true shape
- **Extreme gravitational sphere** — a descriptive term that foregrounds the physical nature of the object rather than its appearance

These designations are not merely more elegant. They are *epistemically more honest*: they orient the reader's intuition toward the reality of the object, rather than toward a visual fiction. And they allow, as we shall see in the next section, for the reception of a richer conceptual framework.

Calling a black sphere a "hole" is not a simplification.

*It is an inversion — presence is replaced by absence,
structure by void, geometry by lack.*

SECTION IV

Directional Geometry: A New Perspective

« A field is not a background — it is a direction. Every point in space has an arrow. »

Introduction to Directional Physics

Directional physics is a conceptual framework developed by the author to describe physical structures not solely through their scalar properties — mass, energy, charge — but through the **directional geometry of their field interactions**. Its founding postulate is as follows: a physical object is not only defined by what it *contains*, but by the *directional structure* of the fields it generates in the surrounding space.

In other words: every point in the space surrounding a massive object possesses a vector — a preferential direction imposed by the gravitational field. The totality of these vectors constitutes a directional signature that forms an integral part of the object's physical identity. An object is not only its mass; it is also the *direction* it imposes upon the world surrounding it.

◆ Definition — Directional Geometry

The directional geometry of a physical object is the vector structure of its interaction field at every point in the surrounding space. For a gravitational object, this structure is defined by the set of accessible future geodesics at each point — that is, the set of trajectories available to an object free from all other forces.

Directional geometry is therefore a global property of the spacetime region dominated by the object, not merely a local one.

Application to Black Holes: The Sphere of Maximal Directionality

Let us apply this framework to the black hole. At every point exterior to the event horizon, the gravitational field of the black hole defines an attraction vector — a clear direction pointing toward the center of mass. This vector is perfectly radial, perfectly oriented. This directionality is **spherically symmetric**: from any point in the surrounding space, the direction points toward the same center. This is, by geometric definition, the signature of a sphere.

But what distinguishes the black hole from every other massive object is what occurs at and beyond the horizon. At the event horizon, directionality becomes **absolute**: no future-directed vector exists that does not point inward. All causally permitted paths

converge toward the center. The partial directionality of the exterior has become total, without exception, without alternative. The black hole is therefore:

- An object of **maximal directionality**: beyond the horizon, only one physically permitted direction exists — inward
- An object with **spherical symmetry of directionality**: this absolute directionality is identical in all angular directions — which defines a sphere
- An object in which **directionality is irreversible**: unlike all other gravitational fields, this one admits no return trajectory beyond the boundary

The Horizon Redefined: The Surface of Absolute Directionality

Within the framework of directional physics, the event horizon receives a new definition — more intuitive and more profound:

The event horizon is the surface at which the directionality of the gravitational field becomes absolute — that is, the surface inside of which no future-directed vector can point outward.

This definition is strictly equivalent to the classical one (escape velocity equal to c), but it reveals a deeper geometric structure. The horizon is not merely a quantitative limit (a radius, a temperature) — it is a qualitative boundary between two directional regimes: the one where paths are free (exterior) and the one where they are absolutely constrained (interior).

Connection to General Relativity

This perspective is deeply consistent with the mathematical formalism of general relativity. In general relativity, objects free from all non-gravitational forces follow **geodesics** — paths of zero curvature through curved spacetime. Inside the event

horizon, all future-directed geodesics terminate at the singularity. Mathematically, no future-directed geodesic exists that moves away from the singularity. This is precisely what directional physics calls absolute directionality: the convergence of *all* free trajectories toward a single point.

This result — that all interior geodesics converge toward the singularity — was rigorously demonstrated by **Roger Penrose** in his singularity theorems of 1965, for which he received the Nobel Prize in Physics in 2020. Penrose showed that, under reasonable conditions, the formation of an event horizon necessarily implies the existence of a singularity. Absolute directionality and the singularity are two faces of the same geometric truth.

Enriching Related Fields

The directional physics framework opens new perspectives across several domains:

Gravitational waves and black hole mergers: During the merger of two black holes — such as the one detected by LIGO in 2015 (GW150914) — the directional geometries of two spheres interact, deform, and ultimately fuse into a single directional structure, releasing in fractions of a second a gravitational energy equivalent to approximately three solar masses. Understanding this merger as the collision and reconciliation of two complete directional geometries offers a richer physical picture than the language of curvature alone.

The information paradox: If all trajectories inside the horizon converge toward the singularity (absolute directionality), how can quantum information — presumed to be preserved by quantum mechanics — escape via Hawking radiation? The information paradox is, in directional terms, the paradox of a directionality that appears locally irreversible yet must be globally reversible. This framework offers no resolution — but it names the problem with a new geometric precision.

Images of black hole M87*: The images released by the Event Horizon Telescope (EHT) in April 2019 show precisely what directional physics predicts: a circular shadow — the spherical imprint of maximal directionality — surrounded by a luminous ring of photons in unstable orbit. The shape of this shadow is not accidental: it is the projection onto the plane of the sky of the directional sphere.

SECTION V

Implications for Scientific and Pedagogical Understanding

« Teaching with the wrong word is planting the wrong seed. It grows all the same — but it bears the wrong fruit. »

Terminological Precision as an Epistemic Imperative

The question is not merely whether "black hole" is a pretty or elegant term. The question is whether this term — at the scale of millions of students, undergraduates, and scientifically curious citizens — produces correct or incorrect mental models. Research in science education is clear on one point: first mental representations, those formed through early exposure to a concept, are extraordinarily resistant to subsequent correction. A child who learns that black holes are "holes" will remain, even thirty years into a career in physics, inclined to see them as openings rather than boundaries.

Terminology is not a cosmetic detail of science — it is science's interface with human thought. The words we choose for physical phenomena condition how those phenomena

are understood, remembered, transmitted, and ultimately manipulated intellectually. Geometrically precise terminology is not an academic luxury; it is a tool of cognitive clarity.

What Leading Physicists Have Actually Said

It is illuminating to note that the most rigorous theoretical physicists have systematically used precise geometric language in their technical work, even when their public communications defaulted to the popular term:

- **Roger Penrose** always spoke of "trapped surfaces" and "singularities" in his papers — pure geometric terms, entirely free of the hole metaphor
- **Kip Thorne**, in the technical treatise *Gravitation* (co-authored with Wheeler and Misner), consistently describes the horizon as a surface — a geometric property, not a void
- **Stephen Hawking**, in his work on black hole thermodynamics, always reasons in terms of *horizon area* — a quantity that presupposes a surface, a sphere, not a hole

This paradox is telling: the intellectual architects of the field reasoned in spheres, surfaces, and geodesics — yet communicated publicly with the word "hole." The fracture between technical language and popular language deepened until it produced two representations of the same physical reality: one correct, the other seductive but false.

Proposals for a Corrected Pedagogy

On the basis of the analysis developed in this document, the author puts forward the following pedagogical proposals:

1. **Systematically introduce, from the very first pedagogical contact, the spherical shape of the event horizon** — not the funnel diagram, which invariably produces the tunnel metaphor

2. **Accompany the term "black hole" with an immediate explicit correction:**
"This term is a historical metaphor; physically, it is a sphere of extreme gravity"
3. **Promote the circular shadow image produced by the EHT** as the canonical representation — it is true, it is available, and it shows a round structure, not a hole
4. **Introduce the notion of field directionality** as a pedagogical tool: visualizing field arrows converging spherically toward the center helps convey the nature of the object without the void metaphor
5. **Encourage the gradual replacement in textbooks** of the word "hole" with "extreme gravitational sphere," or at minimum with "Schwarzschild/Kerr object" in technical contexts

Directional Physics as a Bridge

The directional physics framework developed in Section IV is precisely designed to serve as a bridge between the mathematical rigor of general relativity and the intuition of the non-specialist public. It does not simplify physics — it translates its geometric structure into an immediately visual vector language. Saying that a black hole is a "sphere of maximal directionality" is no harder to understand than "hole," and no less precise than the Kerr equations. And it is infinitely more accurate.

CONCLUSION

The Sphere as Truth

« *It is not the night that is round — it is the boundary of the night.* »

Let us return to the origin of all this: a word. Two syllables. A name given to one of the most extraordinary realities the universe has ever produced. And that name — black hole — has, for more than half a century, burdened human consciousness with the weight of an inaccurate metaphor.

What we have shown in this document is at once simple and profound. A black hole is a **sphere**. Its event horizon is a closed surface — geometrically defined, thermodynamically measurable, physically real. Its mass is concentrated, not absent. Its structure is complex, not null. Its directionality is absolute, not arbitrary. It is not a hole in spacetime — it is the most extreme, the most pure, the most radical form that matter and energy can take when gravity triumphs over everything else.

Correcting a word may appear, from the outside, to be a minor academic exercise. But words are the vectors of thought, and thought is the vector of science. When a wrong word takes root at the heart of a fundamental concept, it does not stay there passively — it propagates. It shapes the questions students ask, the hypotheses researchers formulate, the metaphors that science communicators employ. It silently structures an entire network of representations. To correct the word is therefore to correct the network.

To say "black sphere" rather than "black hole"

is not to change a name.

It is to change a picture of the world.

Directional physics — the conceptual framework proposed here — offers, the author is convinced, a fertile path for the decades to come. By compelling us to think of physical objects not only as masses or energies, but as *directional structures*, it opens new

perspectives on black holes, gravitational waves, the information paradox, and perhaps on domains of fundamental physics yet unexplored. This is not a revolution — it is a precision. And in science, precision is everything.

The black sphere waits — somewhere at the center of our galaxy, 26,000 light-years away, at the heart of every massive galaxy in the observable universe. It has always been a sphere. We have simply taken our time in granting it that justice.

Darkness is not a void. It is a direction. And that direction — absolute, irreversible, spherically perfect — is the purest geometric truth that nature has ever written into the fabric of space and time.

— *l'Architech*

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