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Black, an infinite quest[1]

Le noir, une quête infinie

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ABSTRACT. Black has always been enigmatic and paradoxical. Absence of light, and therefore non-color for physicists, it is indeed color for chemists and artists. Matter or energy (still missing) for astrophysicists, it has never ceased to inspire philosophers and poets. This article begins by examining the evolution of scientific and artistic disputes over the nature of black. It then looks at the forms of its presence on Earth (mineral, vegetable and animal), and describes its pursuit in the cosmos (black holes, dark matter, dark energy). Returning to Earth, it looks at the processes involved in producing the color black, up to and including Vantablack and outrenoir. Finally, it traces the artistic uses and functions of black in relation to light and other colors and concludes with the infinite quest for black in its poetic and metaphysical resonances.
KEYWORDS. Black, color, light, night, black body, black hole, dark matter, dark energy, singularity, infinity, charcoal, Vantablack, monochrome, outrenoir.

1. Introduction

The mystery of darkness has captivated all of humanity since its earliest days. The awe-struck or terrified observation of the night sky was likely one of its earliest manifestations—and also its most enduring, as evidenced by the fear of the dark, which is ubiquitous among children and widespread in our societies. But doesn't every mystery spark a desire to unravel it? The enigma of black, in the form of a paradox, is not exceptional: as the absence of light, it is indeed a non-color for physicists but a color for chemists and artists, matter or energy (still missing) for astrophysicists, and, moreover, an inexhaustible source of inspiration for philosophers and poets. This article will first trace the long history of the debates that have stirred both the world of the arts and that of the sciences regarding the nature of black: color or non-color? We will then explore black in the mineral world and among living beings, sought after for its mystery, rarity, or beauty. Next, we will turn to the long scientific quest for cosmic darkness (black holes, dark matter, dark energy). Returning to Earth, we will then see how certain contemporary chemists and artists have mastered the chemistry of the color black to the point of creating it—and even transcending it. We will continue by examining the artistic roles and uses of black in its relationship with other colors and light. Finally, we will conclude by exploring the poetic and metaphysical resonances evoked by the infinite quest for black.

2. Color or Non-Color

It seems that the debate over the nature of black—whether it is a color or a non-color—is destined never to be fully resolved. Let us attempt to shed light on the reasons for this ambivalence by clarifying the ins and outs of the eternal dispute between those who observe black through the lens of light (scientists) and those who use it as a material color (painters and dyers).

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2.1. *From Black as a Color to Black as a Non-Color*

The story that has come down to us begins with Aristotle (384–322 B.C.), who was inspired by the early works of Pythagoras (~580–~495 B.C.). According to Aristotle, black is one of the two fundamental colors, the second being white. Between the two, he distinguishes yellow, orange, red, violet, green, and blue—colors produced by different mixtures of white and black—in fact, a "perfect" and "complete" mixture of white and black particles. His conception of colors assigns them to the physical matter of the world rather than to the light captured by the eye and the brain. For Aristotle, the white and black contained in natural bodies are equivalent to the light and darkness contained in the air. Darkness is an absence of light, and the black color of certain bodies stems from the fact that they do not reflect light. In his treatise *On Sensation and Sensible Objects*,[2] he thus advocates a method of inquiry based on the comparison of reflected rays rather than on the mixing of colors characteristic of painting, to which he attaches very little interest.

This Aristotelian conception of black as a color prevailed for about two thousand years, until Newton's (1642–1727) groundbreaking discoveries regarding the decomposition of white light through a prism, from which he derived his theory of colors—a theory in which black does not appear. In his work *Opticks*,[3] Newton linked color to light, with each color associated with a specific wavelength; since black has no wavelength, it represented the absence of light.

Newton's prism gave rise to the concept of the visible color spectrum, which ranges from red to violet but includes neither black nor white. The prevailing scientific view since Newton is thus that black and white are not colors in the strict sense: white is what we observe when all wavelengths of light are reflected off a single object, and black is what we see when very little light is reflected off an object. But to what extent? When we are immersed in darkness (illuminance less than 0.01 lux[4]) or when we close our eyes, we do not see black but a purely mental shade of gray, caused by an electrical current automatically generated by the retina that travels along the optic nerve even in the absence of light. Named Eigengrau (intrinsic gray) by Gustav Theodor Fechner,[5] this self-generated color is an intense gray tinged with blue. The concept of black light[6] does, however, exist and has numerous scientific, forensic, recreational, and artistic applications (fig. 1). Among these is the work by visual artist Lucio Fontana[7] *Ambiente spaziale a luce nera* (Spatial Environment with Black Light), presented at the Galleria del Naviglio in Milan (1949): in the center of a dark room, with walls and ceilings painted black, blocks of abstract shapes, covered in phosphorescent paint, come to life thanks to the black lights that make them appear. In his book *Noir : Histoire d'une couleur*,[8] color historian Michel Pastoureau discusses "the black-and-white imagination" that developed in the West after the advent of printing and with the rise of engraving, amplified by black-and-white photography: black and white gradually disappeared

[2] Aristotle, *On Sensation and Sensible Objects*, Chapter III (a supplement to the theory of color set forth in *De anima*), in *Aristotle's Psychology*, Forgotten Books, London, 2018.

[3] Isaac Newton, *Opticks*, London, 1704.

[4] Lux: the unit of illuminance in the International System of Units. One lux is the illuminance on a surface that receives, in a uniformly distributed manner, a luminous flux of one lumen per square meter.

[5] Gustav Theodor Fechner (1801–1887): German philosopher and psychologist. He was one of the founders of experimental psychology and psychophysics. In particular, he formulated the Weber–Fechner law, which establishes a general relationship between the physical magnitude of a stimulus and sensation.

[6] Black light (or Wood's light): composed of violet and ultraviolet rays that are absorbed and re-emitted as visible light by fluorescent substances, whether natural (such as corals) or artificial (such as fluorescent tubes).

[7] Lucio Fontana (1899–1968): Argentine painter and sculptor. In 1950, he founded Spatialism, which was associated with Informal Art, and he turned away from "the use of familiar artistic forms" to work toward "the development of an art based on the unity of time and space."

[8] Michel Pastoureau, *Noir : Histoire d'une couleur* (Black: The History of a Color), Le Seuil, Paris, 2008.

from the color palette, with black being reduced to a code of graphic representation, and white to a mere background.

Figure 1. *Art exhibition under black light*

2.2. *From Black as a Non-Color to Black as a Color*

In this brief history of ideas regarding the chromatic status of black (color versus non-color), which we have begun to outline, we have moved from black as a color (Aristotle) to black as a non-color (Newton). Let us add that Newton had a precursor in this regard in Leonardo da Vinci (1452–1519): having noticed that when he painted shadows with black paint, he did not obtain a true black color, he declared that black is not a color.

For black to gain its status as a color in painting (despite its inability to represent anything other than an absence), the definition of color had to be broadened: it would no longer be limited solely to the colors of the visible spectrum, but would extend to the various possible perceptions of color and light, as Goethe had already proposed in his *Theory of Colors* (1810). It is therefore necessary to distinguish between color in the broad sense (the quality of light or a surface), on the one hand, and luminance—a quantity corresponding to the visual sensation of brightness of a surface (it ranges from zero for black to one for white, taken as a reference)— and, on the other hand, from chromaticity, a quantity used to describe color (high chromaticity indicates a vivid color, while low chromaticity indicates a dull or pale color).

Today, black is described as a chromatic field encompassing the darkest shades, which nevertheless fall short of absolute black, an unattainable state. As a color, black is of particular interest to dyers, who obtain it from an unbleached or greige (colorless) raw material, and to painters, who can either create it by mixing the appropriate colors or purchase it in tubes like all the other colors on their palette, and then appreciate its effects in their paintings. Some painters even attribute a special value to black, as poetically expressed in Gaston Bachelard's famous aphorism: "Black is the refuge of color," which can be seen as a tribute to black as the matrix of all other colors that it brings out.

3. Mineral Black and Living Black

After surveying the ins and outs of black in its relationship to light and matter, let's now briefly examine the various forms in which it appears on our planet.

On Earth, the distribution of black is highly uneven across the mineral, plant, and animal kingdoms. However, wherever it appears, the color black almost always confers upon the object or living being it permeates a special desirability—often due to its mystery, rarity, or beauty, and more rarely because of its fertility. Mineral black is found in various "black soils": in certain grasslands and steppes of temperate continental climates, it is the chernozem (from the Russian *chyornaïa zemlia*, "black soil"),[9] a soil rich in clay and humus. In the Amazon, it is *terra preta* (from Portuguese, "black earth"), rich in organic matter and nutrients, discovered in the 1950s around pre-Columbian Indigenous settlements; ancient Amazonian civilizations had produced it 2,000,000 years ago by adding charcoal, organic waste, and broken pottery to the soil; this technique improved soil fertility and its resistance to erosion. Compared to conventional soils, terra preta stores more carbon, which reduces the amount of CO_2 in the atmosphere and contributes to the fight against climate change. Other black soils also exist in Cambodia as well as in Chiapas (Mexico).

Volcanic regions are rich in black stones, prized for their rarity: onyx, black agate, obsidian, black opal, and black tourmaline. Black diamonds, which are extremely rare and extracted from meteorites, may be of extraterrestrial origin.

Beneath the earth, black reigns over vast but hard-to-reach territories: bottomless wells, dark caverns and caves, coal mines, oil fields…

In the visible plant world, black is virtually absent. There are, of course, those so-called black flowers (there are about twenty of them: roses, tulips, irises, orchids, etc.), but they aren't really black. "And yet, and yet… The black radish alone should serve as a warning to us! For it could very well be—as the radish attests—that the true essence of flowers, stems, branches, and leaves, is that which anchors them to the nourishing earth: that immense network for capturing water, sap, protective bacteria, and fungi held in a fertile parasitic alliance, in short, the subterranean darkness of the roots."[10] Finally, there is that blackish soot called sooty mold, caused by the presence of microscopic pathogenic fungi, which develops on the leaves and sometimes the stems of plants after an attack by piercing-sucking insects (aphids, scale insects, etc.) that deposit honeydew.

In animals, however, apparent black is widely represented: the exoskeletons of insects and arthropods, fish,[11] birds, and terrestrial vertebrates. It can characterize a species (black lizard, black caiman, raven, black swan, Black Angus, etc.), a breed (cat, dog, guinea pig, horse, etc.) or certain individuals affected by melanism[12] (common European adder, duck, squirrel, leopard, fox, etc.).

4. Cosmic Darkness

4.1. *The Blackness of Night*

All around the Earth, the sky is dark at night on the side of the Earth facing away from the Sun, and since the early 17th century, scientists have been puzzled by this mystery: why is the night dark when so

[9] Some garden centers sell black peat (which is much cheaper) under the names "black soil" or "chernozem," which is low in minerals and therefore does not provide nutrients—and may even be toxic.

[10] Alain Badiou, *Le noir, éclats d'une non-couleur* (Black, flashes of a non-color), Autrement, Paris, 2015, p. 97.

[11] A few black fish with evocative names: Black Angelfish, Black Skirt Tetra, Black Ghost Knifefish.

[12] Melanism: a genetic mutation that results in increased production of melanin by the body.

many stars should be illuminating it with infinite light? The writer Edgar Allan Poe offers a first, rough explanation in his essay *Eureka* (1948): the distance to the invisible depths of the universe is so great that its light has not yet had time to reach us. This explanation would later be refined: on the one hand, stars have not always existed and are not eternal, which also limits our view of their light; and then, in 1964, the cosmic microwave background was discovered—a fossil radiation emitted by the universe at the very beginning of its evolution, when it was still in the form of a plasma, a blackbody[13] with a temperature of nearly 3,000 K. This radiation is invisible to our eyes because of the expansion of the universe, which redshifts its spectrum beyond the wavelengths to which our eyes are sensitive. As Étienne Klein so beautifully puts it, "In fact, the night is bright, but our eyes are not capable of seeing it. It is our gaze that darkens the night. "[14] We now know that galaxies emit a second, less intense diffuse background. The darkness of the night is thus tempered by the residual radiation produced by everything the universe has ever contained up to the present.

4.2. *Black Holes*

"The night sky purifies the color black of its earthly attachments. The darkness of the black body transcends the color spectrum; with the black hole, another dark threshold is crossed: black takes on a terrifying gravity. Not only can no light dispel this darkness, but it does not survive it. The adjective 'black' undergoes such an intensification that it is no longer content merely to oppose light; it threatens it. It no longer signifies a retreat from light, but rather that the black hole devours it…"[15]

Cosmic blackness is therefore multifaceted: the blackness of night is softened by the faint glow of the cosmic microwave background; conversely, the blackness of a black hole defies any relativization; as for the blackness of dark matter and dark energy, it denotes absence in the form of a lack—both of visible light and of the light of our knowledge. But there is more: "A mysterious link seems to connect the three black notes of the triplet of our ignorance: dark matter, dark energy, and black holes. A link probably tied to our conception of gravity and thus also, according to the theory of general relativity, to our notions of space and time."[16] This mystery, linked to all the negative connotations of the term "black," likely explains the fascination these enigmas hold for people, well beyond scientific circles.

Black holes have already been the subject of more than a hundred books in English and about twenty in French. The brief historical overview that follows outlines the key milestones that led to their discovery and characterization. Far from being exhaustive, this timeline covers only proven discoveries; we have chosen to exclude hypotheses (whether plausible or fanciful) that remain unconfirmed to date, even though some of them, such as the wormhole,[17] have received significant media attention.

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[13] Black body: an ideal physical object that absorbs all wavelengths of light it receives, but reflects or transmits none, hence its designation as "black." This absorption causes thermal motion that manifests as the emission of "black-body radiation," whose spectrum depends solely on the object's temperature. However, if this temperature is high enough, the emitted radiation falls within the spectrum of light visible to the human eye. The cosmic microwave background, at its current temperature of 2.728 K, almost perfectly replicates the radiation of a black body.

[14] Étienne Klein, https://www.radiofrance.fr/franceculture/pourquoi-la-nuit-est-elle-noire-par-etienne-klein-8366432

[15] Vincent Bontems, « La gravité du trou noir » (The Gravity of a Black Hole) in Vincent Bontems and Roland Lehoucq, *Les idées noires de la physique* (The Dark Ideas of Physics), Les Belles Lettres, Paris, 2016, p. 107.

[16] David Elbaz, *À la recherche de l'univers invisible Matière noire, énergie noire, trous noirs* (In Search of the Invisible Universe: Dark Matter, Dark Energy, Black Holes), Odile Jacob Poches, Paris, 2022, p. 115.

[17] Wormhole (a hypothesis proposed by Stephen Hawking in *A Brief History of Time*): the idea that it might be possible to travel through space and time by passing through the central singularity (the event horizon) of a black hole and then emerging through the event horizon of another black hole acting as a "white hole." But Hawking changed his mind when he realized that the energy required for a particle to pass through would immediately close the wormhole.

For a glimpse into works of science-fiction related to black holes and the fantasy of escaping Earth's constraints, readers can consult *Les idées noires de la physique* by Vincent Bontems and Roland Lehoucq, which provides a brief description of them.[18] Finally, let's mention *Une singularité*, a remarkable debut novel by Swiss author Bastien Hauser, in which the narrator draws a parallel between two black holes that obsess him: the famous M87, photographed on April 10, 2019, and the one he discovers on the same day in his own brain following a stroke, to the point of hallucinating the end of everything: "I look at my computer, my hands, the couch I'm sitting on; I imagine my apartment and the entire building being swallowed up. I see matter twisting and straining, stretching until it snaps, until it shatters the atomic bonds, until it's all just a thick mush. If the world is full of singularities, that's how it's going to end—it's inevitable."[19]

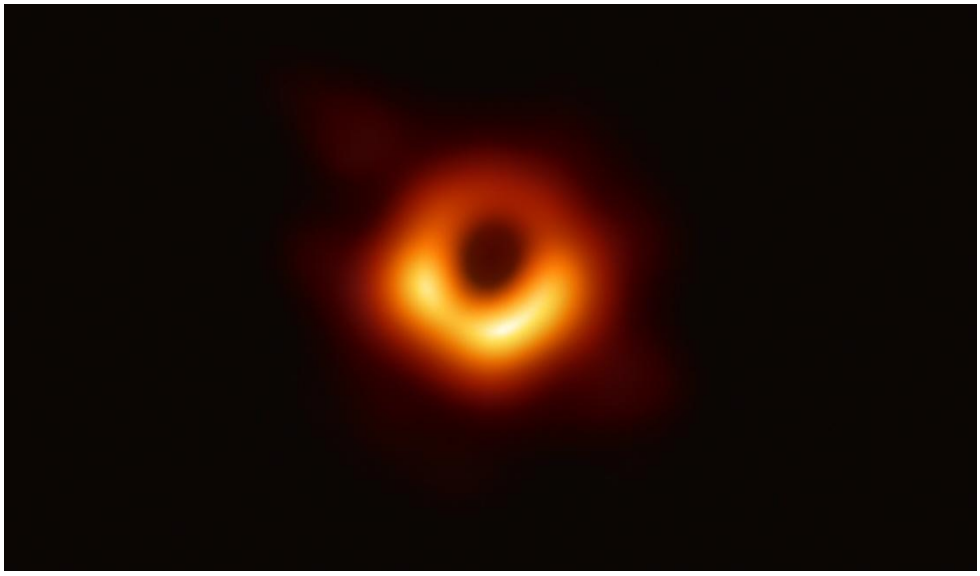

Figure 2. *Messier 87 Black Hole*

John Wheeler (1911–2008) first used the term "black hole" during a lecture given in 1967, in reference to the bottomless pit into which Lewis Carroll's Alice falls.[20] The history of the discovery of black holes, however, begins nearly two centuries earlier, with a conjecture proposed independently by Reverend John Michell (1783) and later by Pierre Simon de Laplace in *Exposition du système du monde* (The System of the World) (1796): "A luminous body, of the same density as the Earth, and whose diameter were 250 times greater than that of the Sun, would not, by virtue of its gravitational pull, allow any of its rays to reach us." This idea of an "occluded body," as it was then called, met with no success, however, and it was not until the theory of general relativity (1915) for it to resurface in connection with the curvature of spacetime.[21] The following year, Karl Schwarzschild (1873–1916) (whose name means "black shield"!) proposed the simplest model of a black hole: for a stationary sphere with no electric charge, the Schwarzschild radius is the radius below which the sphere is so compact that escaping from it would require a speed equal to that of light in a vacuum! In other words, not even light can escape

[18] Vincent Bontems et Roland Lehoucq, *op. cit*. See, 1° for books : Dan Simmons, *Ilium*/*Olympos* (1948), Frederick Pohl, *Gateway* (1977), Carl Sagan *Contact* (1985), Charles Sheffield, *The McAndrew Chronicles* (1988) ; 2° for movies: *The Black Hole by* Gary Nelson (1979), *Babylon 5* (an American television series by Joe Michael Straczynski, aired from February 22, 1993, to October 27, 1997, in syndication (seasons 1–4), then from January 21 to November 25, *Contact* by Robert Zemeckis (1997, adapted from the book by Carl Sagan), *Event Horizon* by Paul W. S. Anderson (1997), *Interstellar* (2014) by Sir Christopher Nolan.

[19] Bastien Hauser, *Une singularité*, Actes Sud, Paris, 2024, p. 52.

[20] See Jean-Pierre Luminet, *Les Trous noirs en 100* questions (Black Holes in 100 Questions), Taillandier, Paris, 2022, 2024.

[21] According to the theory of general relativity, the force of gravity reflects the geometry of spacetime, which curves under the influence of matter and energy. Thus, the path of light—which is sensitive to this curvature—is deflected in the vicinity of a massive body, which, below a certain radius, no longer allows light to escape.

from it. Beyond this radius critical point, the star continues to collapse in on itself until it reaches a true central gravitational singularity[22] (Georges Lemaître, 1933). If this celestial body is a neutron star[23] with a mass equal to or greater than approximately 3 solar masses, gravitational force overpowers all other forces, and the star collapses into what we now call a black hole (Robert Oppenheimer, 1939). It would take more than thirty years before an astrophysical object (the Cygnus X-1 stellar system)[24] was identified for the first time as a black hole thanks to the Uhuru satellite (1971). A few years later, Jean-Pierre Luminet produced the first realistic digital visualization of a black hole with its accretion disk[25] (1979) and predicted that the simulated image would apply to the central black hole of M87 (a prediction that was verified in 2019).

In the 2000s, discoveries came thick and fast: in 2006, four major classes of black holes were identified based on their mass (we will come back to that). In 2015, the first direct detection of a gravitational wave[26] involving the collision of two black holes[27] took place. In 2019, scientists confirmed the existence of a black hole with a mass of 142 solar masses, and that same year, an international collaboration combining instruments from about ten observatories and radio telescopes around the globe created a virtual telescope the size of Earth and thus obtained the first telescopic image of a giant black hole surrounded by a disk of hot gas at the center of the M87 galaxy, 50 million light-years from Earth (fig. 2). “And the black at the center of the image is the blackest black there is. It is not the black of color. It is the black of the void. The black in which nothing is ever reflected.”[28] Two years later came the first detection of an isolated black hole acting as a gravitational microlens.[29]

In 2022 and 2023, data collected by the European Gaia space probe led to the discovery of Gaia BH1 and Gaia BH2, which belong to a new category of black holes: dormant black holes.[30] In May 2022, the same international collaboration as before produced the first image of the black hole in our galaxy (the Milky Way): Sagittarius A*. Finally, in April 2024, by analyzing from Gaia, the oscillating trajectory of a giant star located 1,926 light-years from the Earth in the constellation Aquila, a team of researchers from the University of Geneva[31] has discovered an orbital motion caused by an extraordinarily massive dormant black hole (about 33 solar masses) named Gaia BH3. Astronomers now need to understand how these dormant black holes, with masses equal to or greater than 30 times that of the Sun, formed. Based

[22] Gravitational singularity: in general relativity, a region of spacetime in the vicinity of which certain quantities describing the gravitational field become infinite.

[23] Neutron star: a compact remnant, composed primarily of neutrons, resulting from the gravitational collapse of the core of certain massive stars that have exhausted their nuclear fuel.

[24] Cygnus X-1: a binary star system (a giant star and a rotating black hole) and a major source of X-rays, first observed in 1965. It is located about 7,000 light-years from Earth in the constellation Cygnus.

[25] Accretion disk: an astrophysical structure formed by matter orbiting a central celestial body (a young star, protostar, white dwarf, neutron star, or black hole).

[26] Gravitational wave: a minute ripple in spacetime that travels through the universe at the speed of light.

[27] This discovery earned the three Americans—Rainer Weiss, Barry Barish, and Kip Thorne—the Nobel Prize in Physics in 2017. They also developed the LIGO (Laser Interferometer Gravitational-Wave Observatory) instrument that made the measurement.

[28] Bastien Hauser, *op. cit.*, p. 37.

[29] Gravitational lens: A massive object (the lens) bends the path of light emitted by an object behind it (the source), thereby producing brighter (or distorted, or magnified) images of the source. Since 1993, microlensing has made it possible to observe objects with little or no light (exoplanets, binary stars, the Milky Way disk, etc.), to study dark matter, and, since 2021, to detect black holes.

[30] Dormant black holes are completely dark because, unlike star-black hole pairs that orbit each other while emitting X-rays, they are much farther away from their respective companion stars. As a result, only by observing the movements of the stars with a highly sensitive astrometric instrument can one detect a slight oscillation in their trajectory, which indicates the presence of a black hole.

[31] Gaia_detecte_un_trou_noir_dormant_dans_notre_galaxie.pdf. Press release, Geneva, April 15th, 2024.

on current knowledge, a black hole can be defined as an extreme case of gravitational collapse in which the curvature of spacetime and the energy at its center tend toward infinity, forming a sort of funnel from which no material particles or radiation can escape. The central void is the black hole's singularity. The effects produced by this concentrated mass allow us to define a sphere called the event horizon, inside which light can no longer escape from the black hole and whose radius depends solely on the central mass. Neither solid nor gaseous, this horizon is purely geometric, like the entrance to a well that one might cross without realizing it, but from which there is no turning back: "a bottomless abyss (black, deep, misty), which closes in around us as we fall, without us ever touching the bottom where the star that gave birth to it lies."[32]

Like all other astronomical objects, black holes have not existed since the beginning of time: they form, evolve, go dormant, and then disappear. Their masses, which vary greatly, allow them to be classified into several categories: stellar black holes, which are the most numerous, have masses ranging from about 3 to 60 times the mass of the Sun; most of them devour matter from a nearby companion star, which becomes very hot as it falls and emits X-rays. These systems belong to the family of X-ray binaries. The masses of intermediate-mass black holes are a few hundred or thousand solar masses and result from the successive merger of increasingly massive black holes. Supermassive black holes located at the center of most galaxies have masses ranging from several million to several billion solar masses! Venturing beyond what is known with certainty, "to these black holes whose existence seems to be corroborated by astronomical observations, we must add the hypothetical primordial black holes formed during the Big Bang, with a wide range of masses ranging from one-hundred-thousandth of a gram to one million solar masses; since the theory of general relativity places no limits on the size and mass of black holes, it has been proposed that our universe itself might, in a certain sense, be the interior of a black hole associated with a spacetime far larger than that of our observable universe."[33]

4.3. *Dark Matter, Dark Energy*

Contrary to the legends that glorify the flashes of genius said to be behind great discoveries (Archimedes' "Eureka", Newton's apple, Kekulé's dream of the Ouroboros, etc.), scientific advances generally occur in fits and starts and involve several great minds. Thus, it took more than a century for the idea of an occluded celestial body to become a reality under the name "black hole." Similarly, the phenomenon of missing mass, first identified in 1933 by the Swiss astronomer Fritz Zwicky (1898–1974) and since renamed dark matter, continues to be the subject of intense research, though this research has not yet succeeded in unraveling its nature.

The term "dark matter" was coined because the mass of galaxies and galaxy clusters appeared to be much greater than that of their visible matter (stars, gas, and dust). While studying a small group of seven galaxies in the Coma Cluster (or Berenice's Hair), Fritz Zwicky focused more specifically on their dispersion velocities,[34] with the aim of calculating the total mass of the cluster. By comparing the gravitational mass to the luminosity (derived from the amount of light emitted by the cluster), Zwicky found that the gravitational mass of the cluster was 400 times greater than its luminosity. There must therefore be invisible matter exerting a gravitational pull massive enough to keep the galaxies close together (otherwise they would be ejected). But at that time, astronomers were primarily focused on other topics, and this line of inquiry was not pursued. The question of the missing mass resurfaced first in the 1970s with the work of astronomer Vera Rubin (1928–2016), who tackled the same problem as Zwicky by analyzing galactic spectra, and then in the 1980s, with the observation of the cosmic microwave background. This research confirmed Zwicky's findings while refining them: the large-scale

[32] Carlo Rovelli, *Trous blancs* (White Holes), Flammarion, Paris, 2023, p. 54.

[33] Jean-Pierre Luminet, *op. cit.*, p. 134.

[34] A star cluster can be compared to a gas, in which the particles are stars. The speed at which the particles disperse is greater the hotter the gas is. In extreme cases, particles moving fast enough escape from the gaseous mass.

structures of the Universe cannot be composed solely of visible matter. The missing component is now called dark matter because the fact that it neither absorbs, reflects, nor emits any light makes it completely invisible: “The meaning of ‘black’ in dark matter therefore goes far beyond the conventional meaning of ‘black’ in physics; it is a ‘blacker black than black.’ One might even wonder whether the adjective ‘black’ is still appropriate for a substance that is, after all, invisible, intangible, and transparent.”[35] Furthermore, since dark matter interacts not at all, or only very slightly, with ordinary matter, its presence is detected only through its gravitational influence, which can be significant in certain astrophysical and cosmological models. The necessity of dark matter is clearly summarized by David Elbaz: “... we now know that no galaxy or star would exist without dark matter. The gravity of ordinary matter alone could not create clumps in the universe if it did not benefit from the gravitational wells of dark matter.”[36] In the current universe, dark matter accounts for a mass approximately six times greater than that of visible matter, and is estimated to constitute 27% of the universe’s content, with ordinary matter making up only 5%. The missing 68% corresponds to the amount of dark energy that would be necessary to explain the acceleration of the universe’s expansion as measured by supernovae[37] (fig. 3). But note that for a given volume, as the universe expands, the amount of dark energy increases at the expense of matter.

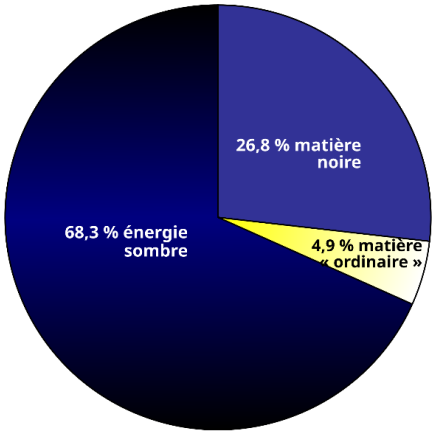

Figure 3. *Dark energy, dark matter, ordinary matter*

To date, various theories exist regarding the nature of dark matter. There are many candidates: molecular gas, dead stars, brown dwarfs,[38] black holes, etc. Estimates of the density of the Universe suggest the presence of non-baryonic particles—that is, particles different from ordinary matter. According to several physical theories that extend the Standard Model (such as supersymmetry or extra dimensions), dark matter particles would be light enough to be produced in the LHC (Large Hadron Collider)[39] and pass through the detectors without being detected; but they would carry energy and momentum, which would allow their existence to be inferred from the missing energy and momentum

[35] Vincent Bontems, *op. cit.*, p. 146.

[36] David Elbaz, *op. cit.*, p. 85.

[37] Supernovae: stars that explode and, for a few days, become as bright as an entire galaxy. They are visible from very far away, and their intrinsic brightness is remarkably constant. As a result, they serve as excellent distance markers. By observing their apparent brightness, we can deduce their distance, and by comparing this to their redshift, we can directly measure whether the expansion is slowing down or accelerating.

[38] Brown dwarf: an object more massive than a giant planet but not massive enough to be considered a star.

[39] LHC (Large Hadron Collider): the world’s largest and most powerful particle accelerator. It began operations on September 10, 2008, at CERN (Geneva, on the French-Swiss border). It consists of a ring with a circumference of 27 kilometers, made up of superconducting magnets and accelerating structures that increase the energy of the circulating particles. Inside the accelerator, two particle beams circulate at very high energies and at a speed close to that of light before colliding with one another.

following a collision; the hypothesis of such particles, called axions,[40] seems particularly promising. Other theories, on the contrary, suggest that dark matter might consist of very heavy exotic particles called WIMPs, short for Weakly Interacting Massive Particles, which are difficult to detect because they interact very weakly with ordinary matter. Finally, according to other proposals, dark matter could be a modified form of gravity—an idea that, however, seems to pose more problems than it solves.

Creating dark matter particles in the laboratory will not, however, solve the mystery of the "missing mass" in the universe, unless we can find some in the cosmos using new telescopes such as Subaru,[41] thanks to which a team from Yonsei University in Seoul detected, for the first time, strands of dark matter within a vast galaxy cluster.[42] These filaments form what is known as the cosmic web, which arose as a result of the evolution of the Universe from a homogeneous distribution of matter. In this network that spans the entire Universe, the filaments are dark matter, the nodes are galaxy clusters, and the strands connecting these nodes are intergalactic gas (consisting mainly of hydrogen and helium). Between the filaments and the galaxy clusters lie gigantic regions called cosmic bubbles or voids, where the density of matter is very low, and which must be taken into account when modeling the large-scale structure of the cosmic web. This structure results from the dynamic interaction between dark matter and dark energy, which will be briefly discussed now. Dark matter exerts a gravitational pull on ordinary matter, drawing it toward the densest regions of the cosmos, while dark energy helps accelerate the expansion of the Universe and thus influences the formation of cosmic superstructures.

"The expansion of the universe did indeed slow down at first, but 7.6 billion years after the Big Bang, it came to a halt. Then something extraordinary happened: the expansion began to accelerate! Galaxies were being blown along as if they were ships carried by a wind of madness. A prodigious energy was driving the universe to expand faster and faster! An energy of unknown origin that produced no detectable light: 'dark energy'.[43] The term 'dark energy,' also known as 'black energy,' dates back to 1998, a few months after the discovery of this acceleration. But, as is often the case in science, the idea had preceded its naming: in 1916 (when the static universe model was still the prevailing view), Einstein had postulated the existence of the cosmological constant, a constant "vacuum energy" exerting a repulsive gravitational force capable, under certain very specific conditions, of counterbalancing gravitational attraction. This explanation, which implies a uniform density of dark energy that remains constant over time throughout the entire universe, is consistent with current observations of the universe and remains the simplest provided that this constant is given a nonzero value: the vacuum would contain another field that would behave almost like vacuum energy, "a kind of fluid that permeates space and has a slightly different equation of state".[44,45] However, other hypotheses have been proposed, which lead either to modeling matter differently (phantom energy,[46] whose density would increase as the Universe expands; quintessence, which posits unknown particles as the source of dark energy; unified models of

[40] Axions: particles with virtually no mass, postulated in the 1970s to resolve various problems in quantum physics. Unlike commonly observed particles, their weak interaction with them allows them to pass through matter without being absorbed.

[41] Subaru Telescope: Built at an elevation of 4,139 meters on the summit of the extinct volcano Mauna Kea (Hawaii), it was inaugurated in 1999. It is the largest telescope at the National Astronomical Observatory of Japan. It is equipped with state-of-the-art technology, including the PFS (Prime Focus Spectrograph), a multi-object spectrograph currently undergoing sky testing.

[42] « Première détection de matière noire suspendue à la toile cosmique » (First Detection of Dark Matter Suspended in the Cosmic Web) by Brice Louvet, 16 September 2024, 6 h 25 min. https://sciencepost.fr/premiere-detection-de-matiere-noire-amas-du-coma/

[43] David Elbaz, *op. cit*., p. 65.

[44] Equation of state: the way a substance becomes more dilute as the universe expands.

[45] Sandrine Codis, in « L'énergie noire, obscur moteur du cosmos » (Dark energy, the hidden driving force of the cosmos), *Les Indispensables de Sciences et Avenir* n° 209, April/ June 2022.

[46] Phantom energy: According to the Big Rip cosmological model, this hypothetical form of energy would be responsible for an acceleration of the expansion of the universe, which would cause the various celestial objects to move an arbitrarily large distance apart from one another within a finite time, and then lead to their disintegration.

matter and dark energy…), or to modeling the gravitation (gravity f(R)[47], scalar fields,[48] brane cosmology[49]). All of these models remain highly speculative, however, because "over the past several years, tensions have emerged in the cosmological model regarding the rate of expansion, as well as contradictions between different measurements of the amount of matter in the Universe".[50] In order to elucidate the nature of dark energy and understand how the Universe has structured itself over the last ten billion years, during which its expansion has accelerated, the European Space Agency (ESA) launched the Euclid space telescope on July 1, 2023, for a seven-year mission. During this period, it will determine the shapes of billions of galaxies, enabling it to map the distribution of dark matter at various stages in the evolution of the Universe. We will then see whether dark energy—which accelerates the expansion—remains constant or changes over time, and how it behaves in different regions of the Universe.

In fact, it is the evolution of dark energy itself that will determine the future of the Universe, according to three possible scenarios: if the density of dark energy increases over time, all the matter in the Universe will disintegrate into an infinite void (the Big Rip model); if it does not increase, systems bound by gravity—such as the Solar System or the Milky Way—will remain in their present state, while the Universe beyond our local supercluster will appear to recede indefinitely; finally, in the least likely scenario, dark energy could dissipate or even reverse, and gravity could become dominant in a universe that would contract into a Big Crunch… Anticipating these cosmic futures lies at the heart of research that is itself expanding at an accelerated pace, and unleashes the imagination far beyond the astrophysicists who devote themselves to it day and night. The death of the Universe has always inspired artists, writers, and philosophers, and today, dark energy is readily equated with a force of death or disappearance. One example is the interdisciplinary symposium *« Mauvais genre » : L'énergie noire du système littéraire* ("Mauvais genre": Dark Energy in the Literary System) (Amiens, 2018), whose introductory text noted that: "Bad literature is doomed to oblivion. […] But might the 'bad,' thus repressed by 'good taste,' not be similar to this dark energy—invisible yet fundamental and predominant in the universe?"[51] For the philosopher Vincent Bontems, it is no longer enough for cosmologists "to observe that the universe is dying. They want to know who killed it. For this reason, their quest for dark energy evokes the plot of noir novels. The term "noir novel" refers to two distinct literary genres: the Gothic novel, which emerged in late 18th-century England (Horace Walpole, Mary Shelley, etc.), featuring terrifying creatures, and the American detective novel set after the World War I (Dashiell Hammett, Raymond Chandler, etc.), which chronicles the investigations in murky waters of "hard-boiled" detectives. "It turns out that the quest for dark energy suggests a connection between the two forms of darkness: the fantastical and the criminal."[52] Finally, our ignorance regarding the nature of dark energy allows the philosopher to go even further and cast doubt on its very existence: "In the realm of the imagination, our inquiry need not concern itself with the nonexistence of creatures that lurk in the darkness. All we have to do is believe in them for them to be there. The task, then, is to find an imaginary

[47] Gravity f®: a modified theory of gravity that generalizes Einstein's general relativity.

[48] Scalar field: It can be visualized as an n-dimensional space with a complex or real number associated with each point in the space.

[49] brane cosmology (or string and brane theory): a cosmological model according to which our universe is trapped within a structure called a brane, which is contained within a "superuniverse" with extra dimensions and capable of harboring other branes (and thus other universes).

[50] https://www.sciencesetavenir.fr/espace/univers/qu-est-ce-que-l-energie-noire-ou-energie-sombre-qui-accelere-l-expansion-de-l-univers_168370

[51] https://www.fabula.org/actualites/83904/colloque-interdisciplinaire-mauvais-genre-l-energie-noire-du-systeme-litteraire.html

[52] Vincent Bontems, *op. cit.*, p. 178.

being that fits the profile of the culprit we seek: a dark, powerful, malevolent creature, responsible for tearing the world apart and capable of obliterating even the memory of light."[53]

5. Creating Black

5.1. *From Pigment to Color*

Artists have always sought to create colors for their paintings; those of prehistoric times used natural pigments. To obtain black, they collected pigments—either mineral (clay, hematite,[54] manganese oxide[55]) or organic (bone or wood charcoal, formed from the partial decomposition of organic matter)—whose carbonization produced carbon black[56] and soot black.[57]

In France, it has been known since 2018 that the cave paintings in the Chauvet Cave (which is listed on the UNESCO World Heritage List) were all created using charcoal made from pine wood, as this tree may have been chosen for the softness of the charcoal produced after carbonization, which is best suited for smooth, deep-black lines ;[58] and in 2023, charcoal lines were discovered beneath the polychrome bison and reindeer in the Font-de-Gaume Cave at Les Eyzies.[59]

The exact dates and locations of the first writing inks (China or India) are not known with great precision. Objects painted with Chinese ink dating back 6,000 or 7,000 years have been found. According to the Chinese themselves, ink was invented in the Tian Mountains in 2697 B.C. It was initially a type of lacquer, which was applied to silk with a bamboo stick (calamus), and was later replaced by a black stone (ink stick) dipped in water. The black liquid squeezed from the stone could then be collected, or the stone could be calcined into a powder, which was subsequently used to make liquid ink.

In his *Natural History*, Pliny the Elder[60] provides a very precise summary of the various techniques for producing black known in his time: {25.} L [41] "Black pigment will also be classed among the artificial colours, although it is also derived from earth in two ways; it either exudes from the earth like the brine in salt pits, or actual earth of a sulphur colour is approved for the purpose. Painters have been

[53] *Ibid.*, p. 179-180.

[54] Hematite: a mineral species composed primarily of iron(III) oxide with the formula Fe_2O_3.

[55] Manganese oxide: a chemical compound of manganese and oxygen. There are several types, which differ in the oxidation state of manganese.

[56] Carbon black (also known as furnace black, thermal black, tunnel black, acetylene black, or, historically, soot black or lamp black): an amorphous, elemental form of carbon that is more homogeneous and finer than soot. It has numerous uses: as a pigment, in the manufacture of inks, in certain varnishes, lacquers, paints, plastics, fibers, ceramics, enamels, etc., as a filler in certain materials (rubber for tires), in carbon paper and black typewriter ribbons, and in the black electrostatic powders used in photocopiers. In the laboratory, it raises the melting point of certain products in solution, absorbs dissolved colored impurities, and precipitates suspended matter. Carbon black is also used as a food coloring (E152). In soil, it can cause black discoloration following fires. Finally, it is used to improve the UV resistance of certain polymers.

[57] Soot: a carbonaceous residue resulting from the carbonization of resins or resinous woods, which can be produced by the combustion of oil (in a lamp) or other fuels such as gas, fats, asphalt, paraffin, and resins. It is used as a pigment (listed in the Colour Index under code PBk6) and as an ingredient for black coloring in various polishes, inks, paints, and pencils. Since it consists mainly of carbon microparticles (less than 2.5 micrometers in diameter), it cannot settle by gravity and therefore remains suspended in the air for a long time. It penetrates deep into the lungs and may have carcinogenic or mutagenic effects.

[58] https://www.radiofrance.fr/franceinter/podcasts/l-edito-carre/grotte-chauvet-que-disent-les-charbons-de-bois-4012208

[59] https://www.hominides.com/charbon-de-bois-identifie-a-font-de-gaume/

[60] Pliny the Elder (1st century B.C.–1st century A.D.; died in 79, during the eruption of Vesuvius): Roman writer and naturalist, a follower of Stoicism. His monumental encyclopedia, titled *Natural History*, compiles the knowledge of his time on the natural sciences, astronomy, anthropology, psychology, and metallurgy.

known to dig up charred remains from graves thus violated to supply it. All these plans are troublesome and new-fangled; for black paint can he made in a variety of ways from the soot produced by burning resin or pitch, owing to which factories have actually been built with no exit for the smoke produced by this process. The most esteemed black paint is obtained in the same way from the wood of the pitch-pine. It is adulterated by mixing it with the soot of furnaces and baths, which is used as a material for writing. [42] Some people calcine dried wine-lees, and declare that if the lees from a good wine are used this ink has the appearance of Indian ink. The very celebrated painters Polygnotus and Micon at Athens made black paint from the skins of grapes, and called it grape-lees ink. Apelles invented the method of making black from burnt ivory; the Greek name for this is *elephantinon*. [43] There is also an Indian black, imported from India, the composition of which I have not yet discovered. A black is also produced with dyes from the black florescence which adheres to bronze pans. One is also made by burning logs of pitch-pine and pounding the charcoal in a mortar. The cuttlefish has a remarkable property in forming a black secretion, but no colour is made from this. The preparation of all black is completed by exposure to the sun, black for writing ink receiving an admixture of gum and black for painting walls an admixture of glue. Black pigment that has been dissolved in vinegar is difficult to wash out."[61]

In 260 B.C., the Chinese began making soot-black ink in the shape of a ball by burning lacquer with fir charcoal (fig. 4).

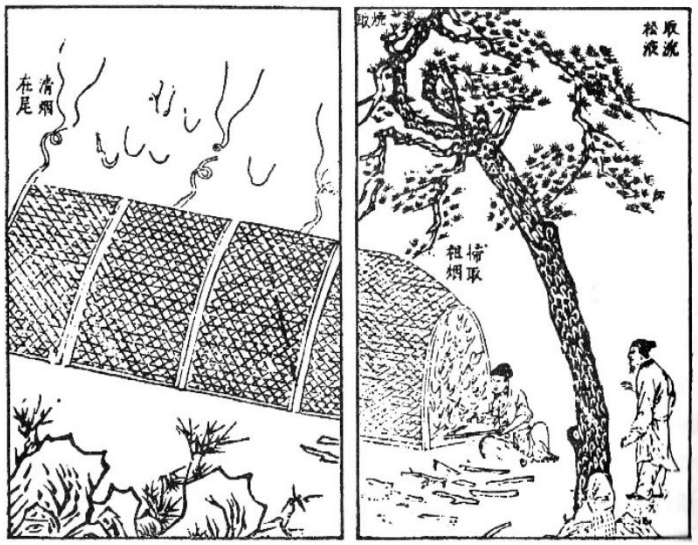

Figure 4. *Collecting pine soot - Song Yingxing*

In 620,[62] the King of Korea presented the Emperor of China with tablets of ink made from soot and deer-antler gelatin. The glossy sheen of this ink inspired the Chinese, who succeeded in imitating it, thereby creating authentic Chinese ink. Furthermore, during the Tang Dynasty (618–907), exquisite monochrome black porcelain was produced in the kilns of northern China. This black color came from the high iron content in the glaze; to achieve a dense, lustrous black, To achieve a velvety finish, the firing temperature had to be around 1,200°C. The heyday of black monochrome ware was between the 11th and 13th centuries (Song and Jin dynasties). They subsequently experienced a decline, but then made a remarkable resurgence in the 18th century in the Jingdezhen workshops, which began reproducing ancient glazes. These new blacks, known as "mirror black" or "metallic black," contain, in addition to iron, cobalt and manganese.

[61] https://www.attalus.org/translate/pliny_hn35a.html

[62] Reference for this paragraph: "At the Heart of Color: Masterpieces of Chinese Monochrome Porcelain (8th–18th centuries)", exhibition at the Guimet Museum (June 12 – September 16, 2024).

Beginning in the 9th century, first among the Arabs and then in the West, metallo-gallic inks[63] appeared, whose fluidity allowed for the use of bird quills for writing. These inks became commonly used in the West, while the tradition of carbon black inks continued in the East through the use of the brush.

In summary, the color black can be obtained using carbon black or soot, a black pigment made from minerals, vegetable charcoal, squid ink, or walnut shells boiled in water, as well as by using black glass, which is produced by adding certain metals to molten glass. It is also worth noting the very distinctive mixture used by the painter Raphael for the background of his painting Saint Mary Magdalene.[64] In the 19th century, the synthetic black aniline pigment was used to make paints and inks when carbon black was not well suited (paints for musical instruments or optical devices). Today, blacks of varying depths can be achieved using various color mixtures.[65] For example, for her painting *Nebula* (fig. 5), the artist Thirtsa Ullmann[66] created her black using Magenta red, emerald green, burnt sienna, and white. Commercially available black paints, made from synthetic dyes, are easier to apply and less expensive but offer fewer shades than pigments.

Figure 5. *Thirtsa Ullmann, Nebula*

[63] Metallo-gallic ink: a black-to-purple ink made from metal salts and various plant-based tannins. Containing no pigments or dyes, its black color is produced by the action of metal salts (iron or copper sulfate) added to the tannic material (gallnuts or tree bark combined with wine lees). This corrosive ink irreversibly degrades the paper, which has posed significant conservation challenges.

[64] "The black background of the work is characterized by the presence of bone black, copper, and earth pigments/ochres. The notable presence of copper suggests that Raphael created this black hue by combining a copper-based pigment with bone black to achieve a distinctive shade. A very small amount of vermilion/cinnabar, known for its ability to reflect light due to its crystalline structure, was also added. This mixture creates a more sophisticated black with depth rather than a simple black background that would be visually flat. In short, the incorporation of pigments such as mercury and copper in the creation of a complex black is an example of artistic ingenuity and a testament to Raphael's skill and creativity." Annalisa di Maria et al., "Raphael's Mary Magdalene, or When the Student Surpasses the Master", Arts and Sciences, vol. 7, no. 3, October 4, 2023.

[65] Color combinations for creating black: the complementary colors green and red, orange and blue, yellow and purple; the three primary colors in equal parts: magenta, cyan, and primary yellow, or brown (different shades of black can be obtained by slightly varying these proportions); burnt umber and ultramarine blue (a warm, natural black); ultramarine blue and cadmium red (a beautiful black/purple with rich nuances); Prussian blue, alizarin crimson, burnt sienna, or burnt umber (almost pure black).

[66] Thirtsa Ullmann (born in 1947): Israeli painter and art therapist. She studied at the École nationale supérieure des arts décoratifs in Paris (textile and material design), where she lived for forty years. Since 2009, she has lived and worked in Tel Aviv. She draws and paints with ink and oil on various media (canvas, very thin paper, gauze). Some of her works draw upon a form of body language that takes the shape of a circle: lying on her back, her hands guide the line around her body in a slow, sweeping gesture.

5.2. *Beyond Black*

The human ambition to create material black has not been limited to the various techniques we have just discussed, which have made it possible to achieve all sorts of shades of black—more or less natural, rich, or deep—but never absolute black.

The idea of creating an ultra-black material (one that reflects absolutely no light) is undoubtedly very old, but it remained for a long time merely a dream or an alchemical utopia,[67] before very recent advances in materials science made it a near reality, with impressive implications: a better understanding of the interactions between matter and light at the atomic scale; industrial applications (military camouflage, elimination of unwanted reflections in telescopes, increased absorption of rays by solar panels); and, finally, a creative challenge for certain artists. A premier raw material, carbon sheet—with its atoms arranged in a hexagonal pattern like a honeycomb—can be used as is (graphene) or wrapped around a sphere, an ellipsoid, a ring, or a tube (fullerenes). Among the fullerenes, researchers first turned to carbon nanotubes.[68] Arranged in parallel, they form a surface that is 99% empty; the photons striking the surface enter this mat, where they are trapped by the absence of matter. Such a coating absorbs 99.5% of light rays. In 2012, scientists at Surrey NanoSystems[69] succeeded, by modifying the arrangement of these nanotubes, in creating an even deeper black—a color called Vantablack—with an absorption coefficient of 99.965%, which renders the texture and contours of the objects it covers virtually indistinguishable.

Following research on nanotubes, scientists have turned their attention to nanoparticles. Since 2014, Andrea Fratalocchi, a researcher at KAUST University (Jeddah, Saudi Arabia), has been studying assemblies of gold rods and spheres: light striking this material is absorbed by the nanoparticles like a sponge with countless pores and cannot escape. This coating absorbs more than 99% of the light and differs from nanotube structures in that it is 100 times thinner while achieving the same result. Although they fall short of the absorption records set by nanotubes, nanoparticles are more stable at high temperatures: they can withstand temperatures exceeding 500°C, at which nanotubes oxidize or even burn.

However, the Vantablack story is far from over: in 2016, visual artist Anish Kapoor, an international figure in contemporary art, registered the exclusive rights to use it. He notably used it for his installation *Descent into Limbo*, a black hole so black that a visitor fell into it… The backlash was swift: this monopoly outraged many artists and critics, and British artist Stuart Semple immediately launched a campaign on Instagram with the hashtag #ShareTheBlack; three years later, he began selling on his Kickstarter page another ultra-black pigment that absorbs between 98 and 99 percent of visible light: “Black 3.0”—including a cherry-scented version—which is, of course, slightly less black than Vantablack, but accessible to everyone except Anish Kapoor and his associates!

The quest for the ultimate black doesn’t end there: in 2019, Vantablack’s absorption record was broken by scientists at the Massachusetts Institute of Technology (MIT), who invented—again using carbon nanotubes—a reflective material that, in their own words, “reflects 10 times less light than all other super-black materials, including Vantablack” (details of the study published in the journal *ACS-Applied Materials and Interfaces).* It was while testing the thermal and electrical properties of carbon

[67] See *nigrium nigrius nigro*, “the blacker than black” sought by alchemists.

[68] Carbon nanotubes (CNTs): discovered in 1991 by John Hagopian, an optics specialist at NASA. Their diameter is on the order of a nanometer (one-billionth of a meter), and they consist of one or more layers of carbon atoms rolled up on themselves to form a tube, which may or may not be closed at its ends by a hemisphere. They already have numerous practical applications: battery components, polymer composites, and improvements in mechanical, thermal, and electrical properties, and a highly absorptive black paint. In 2010, John Hagopian and Stephanie Getty developed NTC coatings that are “blacker than black,” which are key components in the search for exoplanets. Among the countless applications of NTCs currently under development are field-effect transistors for electronics, high-strength fabrics, and biosensors for biomedical and agricultural applications.

[69] Surrey NanoSystems: a supplier of industrial equipment in Newhaven, England. https://www.surreynanosystems.com/

nanotubes on a surface of aluminum foil that the MIT researchers noticed a thin layer of oxide on the surface of the aluminum, which prevented electricity or heat from passing through. After removing this layer with a saltwater solution, they allowed the carbon nanotubes to grow on the aluminum. This procedure not only improved the thermal and electrical properties of the material but also gave it that ultra-black color for which science still lacks an optical explanation but which could prove useful in astronomy to protect space telescopes from stray light. Also in 2019, a collaborative research project between MIT researchers (Brian Wardle et al.) and artist Diemut Strebe[70] resulted in the artwork *The Redemption of Vanity*: a 16.78-carat natural yellow diamond valued at $2 million (the shiniest material on earth) was coated with carbon nanotubes (the blackest black on earth), giving the impression that the diamond is disappearing… The artist views this literal devaluation of a $2 million diamond "as a challenge to the art market and a statement about the arts through aesthetic asceticism." *The Redemption of Vanity* was exhibited at the New York Stock Exchange from September 2019 to May 2020. How can we fail to mention, when discussing "beyond black," the "outrenoir" of artist Pierre Soulages ?[71] Here we are dealing with an entirely different quest: not a quantitative one—achieving an ever-darker black—but a qualitative one—how to illuminate black, in other words, to transmute matter into light. We will return to Soulages's "work in black" in Section 6: "Black in Art." Let us simply recall here the major stages of the artist's journey toward "black-light," which he would later name "outrenoir" to indicate that it encompasses, more than an optical phenomenon, "a different mental realm than that of simple black".

It was in 1947 that Pierre Soulages first experimented with the color black in all its intensity and its chromatic contrast with white. In the 1950s, the artist softened the contrast between white and black with subtle areas of ochre and blue. He made his own brushes and employed a highly personal use of tools to work the paint on the surface of his canvas, until it vibrated with black. Beginning in 1959, he applied color to the canvas first, before covering it with a thick layer of black; then he scrapes this material with a flexible-bladed spatula and scars it with a knife, allowing the color beneath the black to partially reappear. In 1979, he abandoned color and covered his canvases entirely with black paint. But this paint is sculpted by recesses and reliefs that are sometimes matte, sometimes glossy. Pierre Encrevé described these paintings as "monopigmentary works with chromatic versatility";[72] then, in 1990, Soulages coined the term "outrenoir". Beginning in 2004, his exclusive use of black acrylic paint allowed him to take full advantage of these interplays between light and color. Moving beyond purely material, monochromatic black, Soulages revealed its paradoxical luminosity.

6. Black in Art

The "black" that everyone recognizes as omnipresent in art history actually encompasses a multitude of material and visual realities, if only for technical reasons related to the production of pigments. But this multiplicity also has anthropological (social, cultural, and religious) roots, as three French

[70] Diemut Strebe: an artist of German origin; lives and works in Boston. Through various styles and media (biological materials, experimental montages, installations, and video), she combines art and science to address contemporary issues, often incorporating themes related to philosophy and literature. Strebe describes her practice as utilizing the interface between science and art, in the same way that gravitational lensing has been used to trace invisible matter. The artist collaborates with scientists, particularly in the fields of human and plant genetics, quantum physics, astrophysics, and engineering. She is represented by Ronald Feldman Fine Arts, New York.

[71] Pierre Soulages (Rodez, 1919 – Nîmes, 2022): French painter and printmaker. Associated with abstract art since the late 1940s; initially drawn to action painting and lyrical abstraction, he later worked outside any theoretical movement but can nevertheless be considered a major figure in informal painting. He is famous for his use of the reflections of black, which he termed "outrenoir". The extraordinary prolific nature of his work (paintings on canvas and paper, prints, stained-glass windows in the Abbey Church of Sainte-Foy de Conques) continued until the end of his long life. His work is included in the collections of the greatest European and American museums. In 2014, he inaugurated a museum bearing his name in Rodez, his hometown.

[72] Pierre Encrevé, in Jean-François Lasnier, "Art Is the Only Thing Worth Devoting One's Life To: Soulages, Black as the Origin," *Connaissance des Arts*, October 26, 2022.

exhibitions dedicated to black since 2018 have clearly demonstrated.[73] Both empty and full, black—which encompasses all the hues of the color wheel—is also a total absence of light—an absence that painters such as Soulages and Lee Bae will nevertheless manage to ward off. Ambivalent toward life and death, black has always represented night in the West and the fears it engenders—as in the Christian Middle Ages, the terror of hell, populated by demons and other monstrous creatures; but in ancient Egypt, black was associated with the fertility of the earth and with funerary deities, whose statuettes carved from volcanic rock accompanied the journey of the deceased. In the following paragraphs, we will see how artists throughout the ages have embraced the color black, sometimes as a tool for contrast (from chiaroscuro to black-and-white photography), and sometimes to explore its material qualities (degrees of density, opacity, and roughness) and reveal its luminosity.

6.1. *Emphasizing Contrasts*

Throughout history, painters and draftsmen have used black to accentuate the distinction between the background and the forms: black pencil, black marker, or India ink, which clearly achieve this separation; drop shadows that create a dual contrast (shadow-form, shadow-background); and a black background that makes the forms stand out—and vice versa.

Figure 6. *Caravaggio, The Annunciation*

[73] "Painting at Night" at the Centre Pompidou-Metz (October 13, 2018 – April 15, 2019), featuring works ranging from the 19th century to the present day. "The Black Model: From Géricault to Matisse" at the Musée d'Orsay (March 26 – July 21, 2019) on the "representation of Black people" in the history of art and "Black studies." "Black Suns" at the Louvre-Lens Museum (June 10, 2020 – January 25, 2021), intended as an "ode to a shade capable of reconciling opposing principles."

In the 17th century, painters of tenebrism[74] and chiaroscuro[75] made extensive use of this effect, beginning with Caravaggio (1571–1610), who was more of a tenebrist than a chiaroscurist: “Darkness in his paintings is something negative; darkness is where light is not, and it is for this reason that light strikes his figures and objects as if upon solid, impenetrable forms and does not dissolve them, as occurs in the work of Titian, Tintoretto, and Rembrandt.”[76] Thus, in *The Annunciation* (fig. 6), a late and very dark work by Caravaggio, the contrast is stark between the few luminous areas (the back and right arm of the angel Gabriel, Mary’s hands and upper face) and the majority of the painting, which is plunged into shadow; this starkness is further heightened by the forced position of the angel (his shoulder appearing dislocated, his wrist as if broken) in contrast to that of Mary, who is entirely restrained and submissive.

Figure 7. *Francisco de Goya, Saturn Devouring His Son*

[74] Tenebrism (from the Italian, *tenebroso*): a style of painting in which direct, undiffused light creates effects of contrast with the unlit areas serving as the background. Characteristic of Caravaggio, this technique already existed before him (in Italian and Northern European painting) and would live on among his Italian, Dutch, and later Spanish followers (El Greco, Francisco Ribalta, José de Ribera, Georges de La Tour, Rembrandt, Zurbarán). Tenebrism also reflects the conception of earthly life in Counter-Reformation culture, which viewed it as plunged into darkness, in contrast to divine light.

[75] Chiaroscuro: in painting or print, the contrast between light and dark areas. If this contrast is very pronounced, the work is referred to as a “chiaroscuro” painting. In a figurative work, the judicious use of tonal values to mimic the effect of light on forms suggests depth. The chiaroscuro technique was practiced in ancient Greek painting, beginning in the late 4th century B.C., with Hellenistic painting. Abandoned during the Middle Ages, it was revived during the Renaissance. Impressionism would move away from it, relying primarily on variations in hue to express light. Finally, the 1840s would see photography also based on “black and white.”

[76] Rudolf Wittkower, *Art and Architecture in Italy, 1600–1750*, 1958, 3rd edition 1973, Penguin.

In the second half of the 18th century and the first quarter of the 19th century, the chiaroscuro that "brings forth the monsters of the night"[77] was still in the spotlight: the dramatic aesthetic of Johann Heinrich Füssli (1741–1825), a precursor of Dark Romanticism,[78] would inspire even the Surrealists; Francisco de Goya (1746–1828), for his part, would harness the power of his chiaroscuro to depict historical scenes (revolutionary Spain) or scenes of horror, as evidenced by the masterpiece *Saturn Devouring His Son* (fig. 7), which belongs to the *Black Paintings* of his later years; the blackness of the background against which Saturn's muscular, disheveled body stands out, the blackness of the abyss of his mouth and his bulging eyes… Under the guise of mythology, this hallucinatory and bloody portrait of cannibalistic madness undoubtedly alludes to the torments of the aging Romantic painter himself. Nothing of the sort is found in the work of the Impressionist Édouard Manet (1832–1883), who often drew inspiration from everyday life and summed up his approach as follows: "Seek out the great light and the great shadow; the rest will come naturally—it is often a small thing…"; the "great light" and "deep shadow" that bathe, for example, the prosaic scene in *Moonlight over the Port of Boulogne* (fig. 8) are imbued here with mystery, and while drama cannot be ruled out, it is merely suggested (the blackness of the boats, the cloud-laden sky pierced by the pale light of the full moon).

Figure 8. *Édouard Manet, Moonlight on the Port of Boulogne*

Toward the end of the 19th century, the Symbolist painter Odilon Redon (1840–1916) was fascinated by darkness and everything associated with it. In the "black" works of his early period (drawings and lithographs), he gave free rein to his fantasies in a manner reminiscent of certain descriptions by Baudelaire and Edgar Allan Poe. During the 1890s, he gradually shifted from black to color, trading black charcoal for oil and pastel.[79] *The Smiling Spider* (fig. 9), one of his most famous works, is also one of the most unsettling: its ten legs and hairy body reduced to a humanoid head mark it as a biological impossibility, and its predatory "smile" is as repulsive as it is mesmerizing. Set against a light

[77] Philippe Dagen, https://www.lemonde.fr/culture/article/2008/04/28/toute-la-lumiere-et-le-gris-de-goya_1039327_3246.html

[78] Dark Romanticism: a pictorial and literary subgenre of Romanticism that explores the dark, mysterious, and supernatural aspects of the human soul. From its beginnings in the late 18th century, Romantic painting was fascinated by the sublime on the one hand, and the macabre, madness, and crime on the other. Far removed from the neoclassical canons then in vogue, painters such as William Blake, Johann Heinrich Füssli, and Francisco de Goya, followed by Victor Hugo, depicted scenes of an unsettling strangeness (supernatural beings, ghosts, vampires, etc.). See https://www.musee-orsay.fr/fr/agenda/expositions/lange-du-bizarre-le-romantisme-noir-de-goya-max-ernst.The aesthetic of "dark romanticism" would have a lasting influence on subsequent artistic movements (literature, film, contemporary art).

[79] https://www.connaissancedesarts.com/arts-expositions/odilon-redon-noirs-et-lumineux-dessins-symbolistes-11137628/

background, the black, rounded spider (note the delicate rendering of the hairs!) is followed by an encroaching shadow from which it may be trying to escape... Redon's admirably textured shadows and blacks would have a major impact on modern art, particularly on the Surrealists.

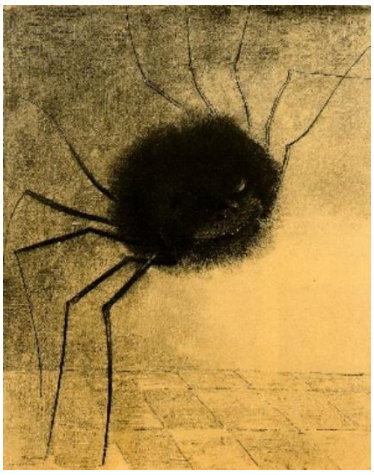

Figure 9. *Odilon Redon, The Smiling Spider*

In reaction to Impressionism and the analytical rigor of Pointillism, Cloisonnism[80] emerged in Pont-Aven, a movement led primarily by Émile Bernard (1868–1941) and Paul Gauguin (1848–1903). Émile Bernard's painting *The Harvest* (fig. 10) is a perfect example of this simplified aesthetic, in which black outlines the contours of white clothing (the women's headdresses and ruffles, and the men's shirts) and makes the human figures stand out against the yellow background of the harvested fields.

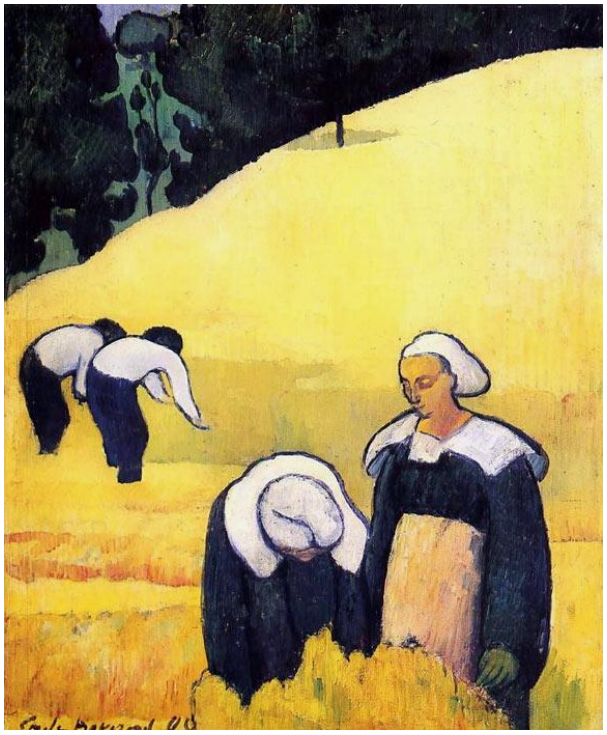

Figure 10. *Émile Bernard, The Harvest*

[80] Cloisonnism: a movement inspired by primitive art, stained glass, Épinal prints, and Japonism. It seeks to synthesize reality rather than represent it realistically. The outlines of the motifs are emphasized by thick black lines, and the colors are then applied in vivid, flat areas. Perspective, shadow, and shading are eliminated. In 1888, in Pont-Aven, Émile Bernard, Paul Gauguin, and Louis Anquetil developed Cloisonnism, which was linked to pictorial synthesis (simple forms and a limited color palette), giving rise to Pont-Aven Symbolism. They were joined by other artists, such as Maurice Denis, Vincent van Gogh, and Henri de Toulouse-Lautrec. However, lacking a manifesto or theory to support it, this movement was short-lived and eventually merged into Symbolism.

In an era marked by the flourishing of a wide variety of artistic movements, the painter Edvard Munch (1863–1944) stands out as a pioneer of pictorial expressionism. His best-known work is *The Scream*, of which there are several versions; in his drawing version (fig. 11), the black background makes the silent scream of the face—with its open mouth (also black) and wide-open eyes—all the more striking, surrounded by hands covering both ears and other arms raised toward the sky.

Figure 11. *Edvard Munch, The Scream*

6.2. *Black as Black*[81]

Abstract painting, which emerged in Europe between 1910 and 1915 with Wassily Kandinsky, Piet Mondrian, and Kasimir Malevich, did not appear overnight. In fact, several artistic movements of the late 19th century had already partially broken free from figurative art, such as Fauvism, which celebrated pure color, or Cubism, which detached forms from reality. By renouncing the faithful representation of visual reality, abstraction—which endures in contemporary art—is now free to present colors for their own sake, including black.[82] Each artist drawn to black will then bring out its texture or light, its power, violence, or purity.

Figure 12. *Kasimir Malevich, "Exhibition 0.10,"*

[81] A nod to *Art-as-Art*, the title of Ad Reinhardt's published writings, in which he summarizes his art as follows: "The sole purpose of fifty years of abstract art is to present art as art and nothing else […] by making it […] more absolute and more exclusive: non-objective, non-representational, non-figurative, non-imagistic, non-expressionist, non-subjective."

[82] In 1882, the poet Paul Bilhaud's work *Combat de nègres pendant la nuit* was the first monochrome presented as a painting in a formal exhibition of the *Arts incohérents*, an artistic movement led by Jules Lévy. Malevich was likely aware of it.

Before becoming one of the leading figures of abstract art, Kasimir Malevich[83] studied under a Symbolist master and later explored Cubism. His approach to black—and white—was driven by a thirst for the absolute, which led him to simplify colors and forms more and more, until he limited himself to black, gray, and white for colors, and to simple geometric shapes (squares, crosses, etc.). In December 1915, for the "Last Futurist Exhibition of Paintings 0.10", he installed his *Black Square* (or *Quadrangle*) high up in a corner of the room that also featured other works of his (fig. 12)—an unconventional display reminiscent of the arrangement of protective icons in Russian peasant homes. For Malevich, the quadrangle embodied the "zero degree of forms" and symbolized his rejection of all representation. Its radical nature immediately caused a scandal, and the painting became the emblem of Suprematism. However, the artist did not fade into the background behind his work: "Pure form is never perfect, the A square is not really a square. The artist's touch is visible in the texture of the paint: it is a vibration, leading to the 'free abyss'[84] in order to allow the being to enter infinite space."[85]

After Malevich, and especially after World War II, many other abstract artists turned away from representational painting, sometimes going so far as to question the artistic specificity of representation itself. One of the first was Ad Reinhardt,[86] a pioneer of Conceptual Art and Minimalism. Advocating purity in abstraction, he eliminated from his canvases everything that did not strictly fall within the realm of monochrome painting.[87] From 1954 until his untimely death in 1967, he created the series *Black Paintings*, which is said to have been inspired by Malevich's historic *Black Square*. But this black, which appears strictly monochromatic, conceals subtle compositions with intensely dark shades of red, blue, and green, perceptible only in person… With his *Black Paintings*, Reinhardt found what he claimed to be seeking: "the strictest formula for the freest artistic freedom".

In the 1950s, Ad Reinhardt was thus a master of black in the United States—along with Franz Kline,[88] whose black-and-white works were then very similar to those of Soulages. But unlike Soulages's *Outrenoirs*, Reinhardt's *Black Paintings* are radically devoid of gloss and any traces of the artist's hand. The following excerpt from Reinhardt's description of a *Black Painting* himself gives an idea of what he was aiming for: "a matte, flat, freehand-painted surface (without gloss, without texture, nonlinear,

[83] Kazimir Malevich (1879–1935): painter, draftsman, sculptor, and theorist, Malevich was one of the first abstract artists of the 20th century and the founder of the artistic movement he called "Suprematism." He taught himself to paint by observing the various artistic movements of his time. Around 1910, he joined the Russian avant-garde and developed the Zaum movement (the deconstruction of language based on sounds, and the definition of drawings by their titles). In 1915, he presented at the "Exhibition 0.10" (Dobychina Gallery, Saint Petersburg) 39 works, including *Quadrangle*, known as *Black Square on a White Background*, which would become the emblem of Suprematism. The aim was to make a clean break with the past in order to propose new forms. Also in 1915, he painted three works that would help lay the foundation for Suprematism: the *Black Square*, the *Black Cross*, and the *Black Circle*. In 1918, he painted *White Square on a White Background*, considered the first monochrome in contemporary painting. Stigmatized by the Soviet regime and then forgotten for decades, he would be fully recognized beginning in the 1970s as a master of abstract art.

[84] Kasimir Malevich, « Le Suprématisme », *Non-figuration et suprématisme*, cat. exp., Moscou, 1919, in *Écrits*, presented by Andréï Nakov, transl. From Russian André Robel, Paris, Ivréa, 1996, p. 227.

[85] Sandra Adam-Couralet, in *Formes simples*, dir. Jean de Loisy, cat. exp. at the Centre Pompidou-Metz, 13 June – 10 November 2014, Centre Pompidou-Metz / Fondation d'entreprise Hermès, p. 64.

[86] Ad Reinhardt (1913–1967): American painter, printmaker, and art theorist. Member of the American Abstract Artists (AAA) group. He turned to increasingly radical abstraction at an early stage, and beginning in 1953, he used only dark paint, close to black. Toward the end of his life, his works fell under the category of hard-edge painting, an extremely radical form of geometric abstraction.

[87] Monochrome: in painting, a non-figurative work executed in a single color, although the shade, textural effects, sheen, or material may vary.

[88] Franz Kline (1910–1962): an American painter and one of the leading figures of Abstract Expressionism and Action Painting. In the late 1940s, he turned to black-and-white works and large-scale canvases, which would come to characterize his style. His painting is intense and seems spontaneous, but is actually the result of numerous preparatory sketches. His works from the early 1950s appear to be heavily inspired by Pierre Soulages. The best-known pieces are in black and white, and some seem to allude to Japanese calligraphy—a connection that Kline denied, however, claiming instead that he drew inspiration from architecture.

without hard edges, without soft edges) that does not reflect its surroundings—a pure, abstract, non-objective, timeless surface, without space, without change, without relation, disinterested", in other words, the polar opposite of Soulages' surfaces—textured, glossy, reflective, and dynamic.

For his part, Pierre Soulages developed a typology of the various uses of black that he has experimented with, either alternately or simultaneously: "In my painting, where [black] dominates—from childhood to the present—I objectively distinguish three approaches to black, three different fields of action: Black on a background, a contrast more active than that of any other color in illuminating the highlights of the background; [Black associated with] colors, initially obscured by the black, emerging in places from the canvas, enhanced by the black that surrounds them; the texture of black (with or without directionality, energizing the surface or not): a material that serves as a matrix for shifting reflections."[89] In the photograph *Fragment de peinture* (May 15, 2022) from his series "Outre Soulages" (fig. 13), Christophe Hazemann[90]—who has long been familiar with Pierre Soulages and his work—makes this "matrix of shifting reflections" very perceptible, which gives the image an almost tactile depth and captures the viewer's gaze. Within the artist-work-viewer triad, where each of these elements constructs the other, the viewer thus responds to the artist "who knows how to take a step back / so that clarity may emerge / buried at the heart of nothingness"[91]

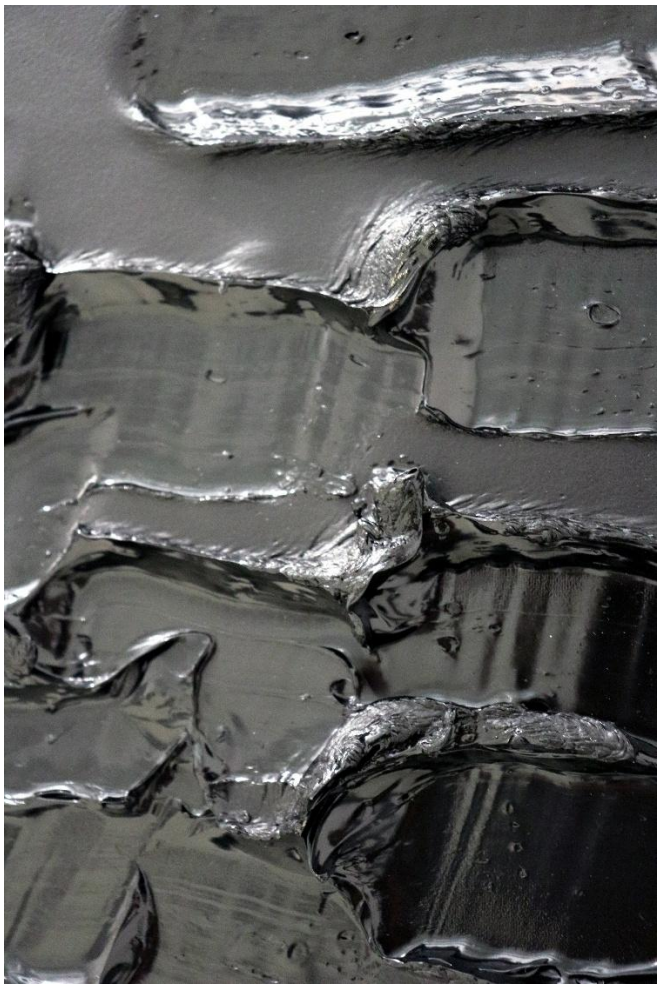

Figure 13. *Christophe Hazemann, Untitled, from the series Outre Soulages: fragment of Peinture*

[89] Henri Meschonnic, *Le rythme et la lumière avec Pierre Soulages* (Rythm and Light with Pierre *Soulages*) Odile Jacob, Paris, 2000.

[90] Christophe Hazemann (born in 1973): deputy director of the Soulages Museum in Rodez since 2017; visual artist and photographer; exhibition curator and teacher. Co-author, with poet Jean-Yves Tayac, of *Soulages. Le pas de côté* (The Sidestep), published by Éditions Méridiane (Liber series), Montpellier, 2024.

[91] Jean-Yves Tayac, « Le pas de côté », in *Soulages. Le pas de côté*, p. 48.

Pierre Soulages did not, strictly speaking, found a school, but he attracted many contemporary artists. André Marfaing[92] is one of those with whom he was closest: "Along with Soulages, Hartung, and Kline, Marfaing is one of the great 'black-blenders' who emerged after the last war, but he treats this color with caution, tenderness, and firmness. One can contrast Soulages—stormy, material, sensual, even beneath the rigor of his later paintings—with Marfaing's severity and asceticism."[93] A violent asceticism (his brushstrokes have been compared to slashes of a blade) in the service of an intense exploration of opposites (black and white, empty and full, being and nothingness) in which black would long predominate— a black brimming with nuances: from carbon to ebony and tar; bluish, ochre, or golden, much like Soulages' monochromes. But toward the end of his career, continuing his ardent quest for the absolute and purity, Marfaing would give more space to light.

Another leading artist whose pursuit of the absolute through black and gesture echoes that of Soulages, Yu-ichi Inoue[94] is considered one of the most creative representatives of the postwar Japanese artistic avant-garde, and one of the first to have "liberated calligraphy" to transform it into a contemporary art form. He is best known for his large ideograms, drawn while standing with gigantic brushes featuring long, bushy bristles. With their simple forms and thick lines in an intense black, they exude a powerful yet tranquil energy, as if the words had a life of their own. Fascinated by black, Pierrette Bloch[95]—whom her painter friends nicknamed the "queen of the night"—was also deeply influenced by her encounter with Pierre Soulages, to the point of asserting her preference for black, which she employs in a subtle and highly personal manner. Thus, in her *Inked Paper, Cut Out and Pasted on Hardboard No. 15* (fig. 14), black is at times background, at times form, or even both at once through interpenetration; deceptively geometric black forms (almost like stains) interact with more angular white or beige backgrounds… Unless, of course, these too are forms that contribute to the structure of this composition—certainly not random, but non-linear and ultimately indecipherable.

[92] André Marfaing (1925–1987): French painter and printmaker, associated with abstract art and a representative of Informal painting. In 1949, he left Toulouse for Paris, where he devoted himself to painting, turning to abstraction very early on. Under the influence of Pierre Soulages, he adopted black as the almost exclusive color in his work. André Marfaing received numerous awards and represented France at the Venice Biennale (along with Poliakoff, Messagier, Guitet, and Manessier).

[93] Frédéric Edelmann, *Le Monde*, October 18, 1986.

[94] Yu-ichi Inoue (1916–1985): Japanese painter and calligrapher. In 1952, he was one of the founders of the Japanese calligraphy collective Bokujinkai, which explored new ideas in art, philosophy, and literature, both in the East and the West. Beginning in 1954, he participated in numerous international exhibitions. After being diagnosed with cirrhosis of the liver in 1978, he withdrew from the Bokujinkai but continued to create at a steady pace until the end of his life, working in smaller formats. From July 14 to September 15, 2018, the Maison de la Culture du Japon in Paris (MCJP) hosted a retrospective dedicated to him.

[95] Pierrette Bloch (1928–2017): Swiss visual artist. Her work, associated with minimalism, incorporates painting, collage, weaving, and sculpture. In the early 1970s, she began creating ink-on-paper works, a practice she would continue throughout her life, incorporating pastel, graphite, charcoal, and chalk. At the same time, in 1973 she began creating black-on-black monochromes and working with textile fibers, which would influence her painting: the abstract, script-like forms produced by hemp or horsehair—knotted or felted—would find their way onto paper. In 2005, she received the Maratier Prize from the Pro-mahJ Foundation (Museum of Jewish Art and History) for her entire body of work. Numerous exhibitions have been dedicated to her.

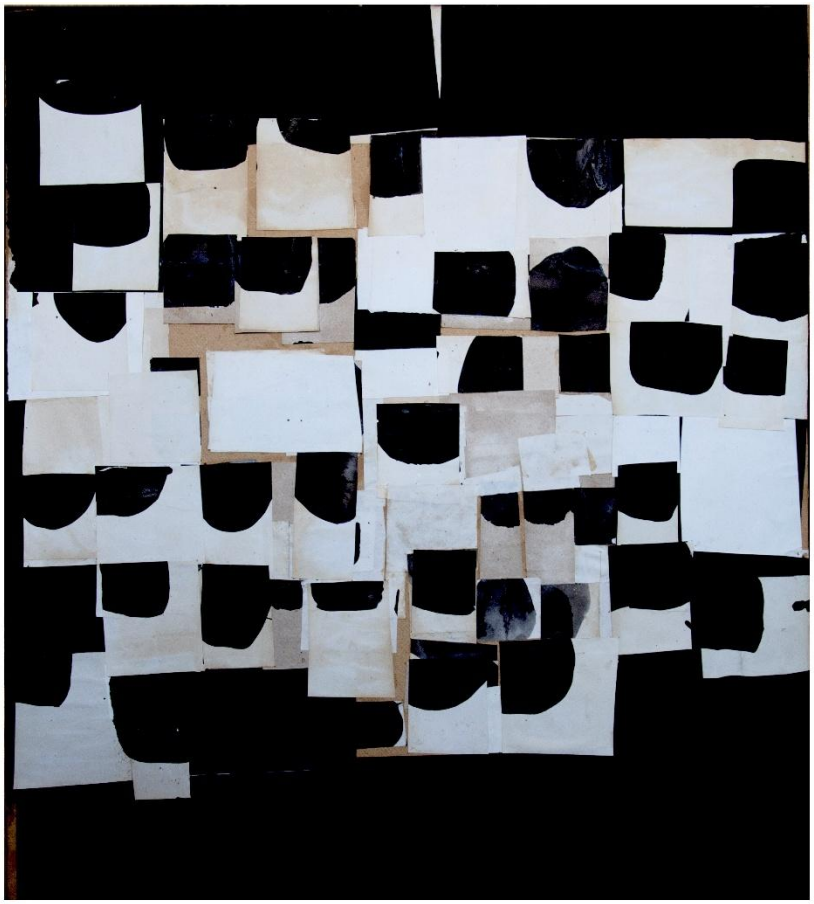

Figure 14. *Pierrette Bloch, Collage No. 15*

And here is yet another great admirer of Soulages, the Korean artist Lee Bae,[96] who imagines black more than he sees it. But unlike Pierre Soulages, Lee Bae is interested not only in the surface reflections of black, but also in the abysses it conceals: "Like bottomless wells where everyone will find the depth they are willing to see and the vertigo they are ready to feel. Like a black hole, in the astrophysical sense of the term, with matter so dense and compact that black sinks into black to the point of infinity. A realm beyond black, in short."[97]

Among contemporary artists captivated by black, an important place also belongs to Joachim Bandau,[98] who has been creating *Black Watercolors* since 1983—works recently exhibited at the Florent Maubert[99] Gallery. To achieve the deepest blacks, the artist applies layers of light gray watercolor

[96] Lee Bae (born in 1956): a South Korean artist who has lived in France since 1990. To explore all the nuances of black, he long used charcoal: toward the end of the 1990s, during his "charcoal period," he created paintings, then installations such as *Suspens* (enormous blocks of charcoal suspended one meter above the floor in the Kerguéhennec Chapel in 2016). Charcoal allowed Lee Bae to journey within black, but also to reconnect with the black of Chinese ink and his training as a calligrapher. He subsequently moved away from charcoal to explore other facets of black, particularly in its contrasts with white. Solo exhibitions at the Perrotin Gallery (Paris): "Black Mapping" (March 17–May 26, 2018) and "Le noir en constellation" (January 8–February 26, 2022).

[97] Henri-François Debailleux, https://www.leebae.art/text/1-review/la-matiere-noire/

[98] Joachim Bandau (born in 1936): German painter and sculptor. He studied at the Düsseldorf Academy of Fine Arts, where Gerhard Richter and Joseph Beuys, among others, were trained. In 1986, he received the Will Grohmann Prize from the Berlin Academy of Arts. Since the 1990s, he has used paint and watercolor to give form to blocks of black material, which he juxtaposes with several transparent filters reminiscent of X-rays, but also of Malevich's Suprematist compositions. In France, he is represented by the Maubert Gallery (Paris). Several of his works, including two *Aquarelles Noires*, were recently acquired by the Centre Pompidou and are on view in the exhibition "Pierre Bourdieu and Paul Virilio" (Oct. 14, 2024 – Mar. 31, 2025).

[99] Exhibition "Le Ruisseau noir" (December 16, 2023 – February 17, 2024): This title refers to Gustave Courbet's painting of the same name (1865), a deep, steep-sided gorge near Ornans called the Puits-Noir, emblematic of Courbet's intimate geography. Like Courbet,

(sometimes more than forty) using flat Japanese brushes. In this layering process, where time is recorded on the paper as in chronophotography, each new layer responds to the previous one, within a stretched temporality (sometimes spanning months or years) and a slight spatial shift. Thus, Bandau observes, "the viewer decodes the work in reverse". As in *Black Watercolor* (2012–2021) (fig. 15), where the gaze—initially drawn to the center by a black rectangle (the most recent one)—ventures toward the visible parts of the preceding, underlying, and offset rectangles, whose transparency increases with depth. The imperceptible tremor of the hand-drawn lines, the absolute detachment of this stratigraphy freed from gravity, and finally the allusion to time, which ultimately overcomes transparency, invite meditation and evoke emotion.

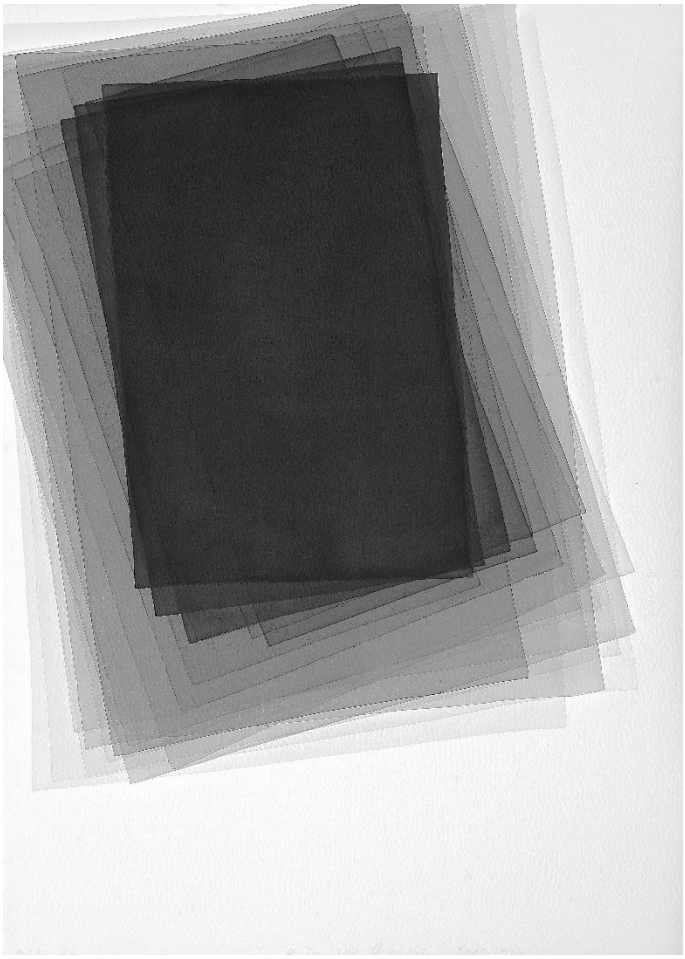

Figure 15. *Joachim Bandau, Black Watercolor*

To conclude this brief overview of contemporary art, let's take one last look at the exhibition "La chaleur du noir", which was held in Lille in 2023.[100] Far from the icy void with which black is often associated, it appears here in its many shades as a source of incandescent heat: for Lucie Marchand, the heat of asphalt, that modern incarnation of oil; for Yosra Mojtahedi, the warmth of life and of humanity ("I sculpt the shadow that emerges from the light"); for Fabrice Cazenave, the dark warmth of charcoal capturing the essence of plants and the energy they radiate.

Bandau (who narrowly escaped several bombings during the war) is drawn to dark, enclosed spaces, and more generally to forms of confinement.

[100] Exhibition: "The Warmth of Black". Works by Fabrice Cazenave, Lucie Marchand, and Yosra Mojtahedi (June 16 – October 14, 2023): 3Cinq Contemporary Art Center (Lille), in conjunction with the Art & Industry Triennial of Dunkirk / Hauts-de-France.

7. Conclusion

While every quest presupposes a desire, the intensity of that desire depends on its object. When that object embodies the infinite—as black does—the desire it arouses, which is necessarily infinite as well, reverberates throughout the quest in all its dimensions. A corollary of this dual infinity is incompleteness—in this case, the impossibility of bringing such a quest to a close (no matter how persistent it may be), whether it concerns the material or luminous nature of black, its actual or absent presence in the universe, or its functions in art. Among contemporary works, Pierre Soulages's *Outrenoirs*, which have inspired so many commentaries, bear witness to this at every moment. For the philosopher and writer Alain Badiou, "Deep down, the solitary and compact black of every Soulages painting shows that it could go on, that the limitation of the painting—and even its immensity—is but a moment of its own boundlessness." This is why black serves as the medium for the beyond-black. The Subject-painter and the Subject-viewer share the incompleteness that only black can bear witness to."[101] And for the philosopher and professor of aesthetics Bruno Duborgel, "The experience—always unfinished and fervent—of approaching this unknown […] would require something beyond language to express its mystery; one might call it a 'beyond-language.'"[102] The introduction of fervor is significant here, in that it clarifies the nature of the desire involved in this infinite quest for black. It is indeed an erotic desire—eroticism in the broadest sense, which does not exclude the *libido sciendi* and of which only poets can truly speak. Baudelaire, for example: "How I would like you, Night ! without those stars / Whose light speaks a language I know ! / For I seek emptiness, darkness, and nudity![103] Or Jean Gabriel Cosculluela, when, under his pen, the naked night becomes "nuidité.[104]

Finally, the appeal to the beyond (of language) and to the emptiness of the night points to the eschatological dimension of such a quest, destined to come up against the indecipherable mystery of the Origin and the End… which Pierre Soulages nevertheless hopes to penetrate: "We seek the moment of origin…",[105] he says, as if the origin (not to be confused with the beginning) were not hopelessly timeless. The same is true of the End, of which Leconte de Lisle's *The Last Vision* offers a striking description, echoing the biblical Genesis :[106] "And, hour by hour, you will engulf one another / O swirling masses of frantic stars / In the immeasurable dread of the vast expanses, / In the silent, black abysses of the sacred heavens! / And it will be the Blind Night, the great Shadowy Form / Shapeless, in its emptiness and barrenness, / The peaceful abyss where lies the vanity / Of what once was time and space and number."[107]

[101] Alain Badiou, *Le noir, éclats d'une non-couleur*, Autrement, Paris, 2015, p. 52.

[102] Bruno Duborgel, *Pierre Soulages, présences d'outrenoir*, Le Réalgar, coll. l'Orpiment, Saint Étienne, 2019.

[103] Baudelaire, *Obsession* (excerpt), in *Les fleurs du mal*, 1861.

[104] Jean Gabriel Cosculluela, *Nuidité du noir. Dialogue avec les outrenoirs de Pierre Soulages*, L'Étoile des limites, 2024.

[105] Pierre Soulages, excerpt from the documentary film *Pierre Soulages*, in which he speaks with his friend, the painter and filmmaker Jean-Michel Meurice (1981).

[106] Genesis, verse 2: "The earth was formless and empty, and darkness was over the deep…"

[107] Leconte de Lisle, « La Dernière vision », *Poèmes barbares* (1862). Librairie Alphonse Lemerre, Paris, 1900, p. 247-249.