SUPER BLACK



Jordan Tate



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Jordan Tate

With contributions by
Fred Bidwell
Nicholas O’Brien
& Lisa Kurzner

Designed by
The Laboratory of Manuel Bürger

PRE FACE

The idea of SUPERBLACK was born over a drink, as many impossible or improbable projects are. In October of 2012, my wife Laura and I were at a lively party at the Cincinnati home of Tom Schiff and we spoke with Jordan about our plans to open the Transformer Station as a place to show and share our love of contemporary photography.

We had been introduced to Jordan's work in a group show organized by curator Lisa Kurzner at MOCA Cleveland and were excited about the possibility of commissioning him for a project in the "Crane Gallery", which features an industrial horizontal crane capable of hefting up to 15 tons. Could Jordan create a virtual "Black Hole" – something dramatically dark and heavy to hang from it? It seemed like a good idea at the time.

What developed from that flight of fancy was a concept far more deep, although not quite so dense. Our original attraction to Jordan's work was his rigorous conceptual thinking expressed through a refined aesthetic and polished presentation. Characteristically, his concept for SUPERBLACK was elegant and yet mind-bending; employing nano-technology to explore the infinite void.

It's not so surprising that Jordan would create a project that might seem more science than art. Photographers have always had to have a strong background in technology to keep up with the evolution of the medium. After all, although the artist/impresario, Louis Daguerre gets credit for launching the art form, the first photograph was taken by his scientist partner, Nicéphore Niépce. Since then, photography has been distinguished by being the only (or perhaps, just the first) art form to be in a state of constant revolution and reinvention. No doubt, the constantly shifting science of photography focused many on its capabilities as a tool for observation, measurement and documentation. Perhaps that delayed its acceptance as an artistic mode of expression. The original promise of the camera was to capture reality in such detail that it could be a facsimile of truth and a window into meaning. But photography takes us frustratingly close to touching, never quite reaching understanding. Perhaps because the equipment and technology of the medium continues to advance while our perceptual and intellectual equipment stays stubbornly the same, we never break through to enlightenment — more data just generates more difficult questions.

Romantic amateurs like Julia Margaret Cameron unlocked photography's emotional potential largely by ignoring the technology (to the despair of modern conservators). The genius of George Eastman was to dumb the process down to the point that it could be a vehicle for personal expression for the masses. Digital technology, of course, outsmarted Kodak by putting a camera into everyone's pocket.

After almost 200 years of evolution photography has made imaging more accessible than anyone imagined. What will become of an art form where everyone can (and many do) create personal, beautiful and even moving images on a daily basis? Photography relentlessly challenges artists to stretch the emotional and conceptual limits of the medium.

At the entrance of the Boston Public Library, facing Copley Square, two sculptures flank the steps. Originally conceived by August Saint-Gaudens, this personification of Art and Science was completed by his disciple, Bela Lyon Pratt. Art sits on the right looking anxiously over at Science, paintbrush poised, looking for clues. Science sits smugly, eyes cast down, contemplating an orb held in her outstretched hand. What is it? The earth? The Universe? Higgs boson? A black hole? That seems to be for Science to know and Art to find out.

When I think of Jordan Tate's SUPERBLACK, I imagine Art striding across the steps to grab that orb from Science and make it her own.

SUPERBLACK takes on the split between art and science by attempting to rewire the left and right brain of photography and reconnect visual literacy to its technical grammar.

On one hand, Jordan follows in the footsteps of traditional masters of the craft with his digital-age exploration of the imaging gamut. This is not so different than Ansel Adams' Zone System, another way of trying to close the distance between what exists and what we can represent. On the other hand, Jordan takes us into forbidden territory where the rules don't apply and the results mock our ability to perceive and understand. In direct opposition to the spirit of Adams, or Muybridge or Edgerton where photographic technology allows us to capture, analyze and understand our world, SUPERBLACK takes us beyond the far end of the gamut, into Adams' Twilight Zone. SUPERBLACK contains the unthinkable. The place which is not a place but a state of being more foreign than death because it is not only a place where we cannot exist, it is a place where we do not matter. Jordan takes that idea and safely contains it...it exists inside the Black Body. Indifferent, invisible...taking us all in and expelling the energy reflected from our world as heat. Eventually all light is absorbed, the heat dissipates, and all that prevails is SUPERBLACK.

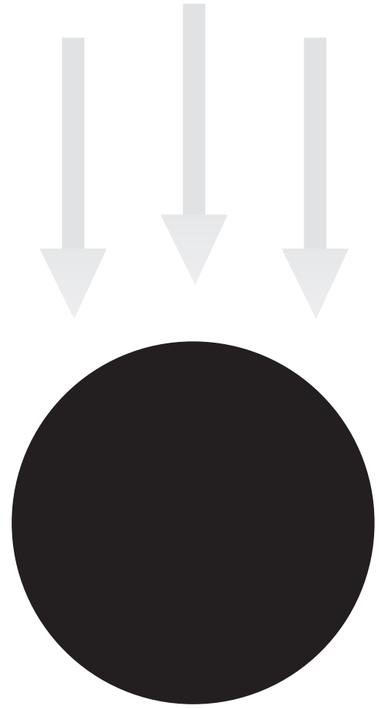
Science reaches over and reclaims the orb from Art. Jordan Tate has taken the impossible to its limits, shown us the nether limits of darkness and in the process has illuminated our senses and our minds.

The partnerships with artists that enable concepts like SUPERBLACK to come to light (or darkness) are what inspire the work of Transformer Station.

Fred Bidwell graduated from Oberlin College with an art history major. Afterwards, he worked as a commercial and fine arts photographer before changing his career to advertising. In 2012, Fred retired as Executive Chairman of JWT/OgilvyAction to devote his time entirely to his interests in the arts.

SUPERBLACK
by Jordan Tate, 2014

Multi-Walled Carbon Nanotube Array, Ultra-Diffusive Light Absorbing Foil, Cast Acrylic
30cm x 30cm x 30cm
Exhibited at the Transformer Station, Cleveland, OH



SUPERBLACK is a blackbody, an idealized physical body that absorbs nearly all electromagnetic radiation (visible light, infrared light, ultraviolet light, etc.) regardless of frequency or angle of incidence. It is structurally designed to maximize absorption and incorporates the darkest material that we are currently capable of reproducing—arrays of multi-walled, vertically-aligned carbon nanotubes. To imagine carbon nanotubes (and their scale), picture a vast field of microscopic tubes standing on end, each averaging 30 nanometers in diameter (for a sense of scale, this is roughly 50,000 times thinner than the lead in a #2 pencil.) The inner structure of SUPERBLACK is a trapezoid lined with a micro-etched metal alloy that funnels electromagnetic radiation into the carbon nanotube array, preventing visible light from escaping.

At its core, SUPERBLACK is an exploration of duality—black/white, void/full, subject/object. It is a structure that confines an infinite space, or rather, a space with limitless visual capacity: infinity bound. It is the culmination of nearly two years of research and drafting aimed at creating an experience of absolute blackness in the visual field—the master gamut.

“Bright colors are what depresses me. They’re so empty. Black is poetic.
How do you imagine a poet? In a bright yellow jacket?
Probably not.”



Bela Lyon Pratt, Art, 1911

NO/ THING



Ad Reinhardt, Abstract Paintings, 1960-1961

How can we envision nothing? Not an ending, or an absence, or even a vacuum, but really nothing: the absolute removal of matter, the void. *Nothing*, a 2011 BBC documentary hosted by physicist professor Jim Al-Khalili, sought out the methods of conceptualizing this phenomenon and stressed how difficult it is to conceptualize nothingness. In the program, Al-Khallili presented a hypothetical scenario inside a glass box in which he removed "everything [he] possibly could from inside it. All the air, dust, every last single atom until there was no thing left." After doing so, he asks us "What then exists inside the space in the box? Is it really nothing?" [1] Throughout the program, questions like this continue to arise and befuddle "the furthest reaches of human perception."

As our known universe balloons in difficult to fathom proportions, our fascination with the complete omission of matter has taken an intriguing turn. [2] Contemporary digital imaging has significantly helped this process by simulating and representing what the physical world looks like when approaching the void. [3] The use of contemporary technology has augmented and amplified our natural senses - electron microscopes, the Hubble Ultra Deep Field image, Black Silicon CCDs - so greatly that previously understood notions of the void must be continually rewritten. As a result of these enhancements, the rapid rate of scientific discovery has posed a struggle for artists and scientific imaging engineers to find appropriate and faithful representations of nothingness.

This space - if one could even call it as such - is not merely a physical phenomenon, but also embodies a metaphysical experience [4]. The void is not just the space beyond depth, where the z-axis of our vision cannot find end or horizons - it contains, within that infinite

[1] Stacey, Nic. "Nothing." *Everything and Nothing*. BBC, 2011.

[2] Whiting, A. B. "The Expansion of Space: Free Particle Motion and the Cosmological Redshift". The Observatory Vol 124 (2004). 174-189.

[3] P. Cowperthwaite. "Supercomputer Models of Merging Black Holes" Online Video Clip. Simulations Uncover *'Flashy' Secrets of Merging Black Holes*. NASA.gov, 27 Sep. 2012.

[4] In this sense, a hidden structure that makes reality perceivable.

regression, a metaphysical mirror for the spectator; an emptiness for deep introspection, a site of reflection far greater than any household polished glass.

The void as subject, however, has many historical precedents, but none so impactful as the philosophy and aesthetics of early 19th Century Romanticism. Although technologies of representation developed radically during this century [5] , painting still dominated as a platform for supplementing our senses. Within painting of this period the employment of negative space most elegantly approaches the potential for representing the void. One of the most illuminating precursors of this shift can be seen within Jacques-Louis David's *The Death of Marat*, and the vacuous space that looms above Marat's bathing corpse. Nearly half the painting is negative space, cementing this somber moment within one of the most important rebellions of western civilization. The negative space here doesn't only reflect a mourning of the victim, or a lamenting of a lost revolutionary. Instead, the murky darkness that recedes behind Marat's haloed face provides a telling segue between the Neoclassical tradition that informed David and an emerging metaphoric painting style as epitomized by Capsar David Friedrich. [6]

In this way, David's rendering of the murdered agitator is important not only as a historical representation, but as a document for shifting ideas within representational painting. [7] It is the use of negative space that transforms the work into more than a mere funerary portrait. The negative space takes on the properties of a void, allowing the mourning and despair of the event to regress into a

[5] Though tempting as it may be, a full history of the development of the photograph would detract from the importance of the shifting attitude that such a technology provided to representation and fine art. That being said, the radicality that is suggested here can be observed through the spectacle that photography presented to the masses. The novelty of taking a photograph was on par with parlor tricks and the carnival. The proliferation of this technology can be observed in the numerous itinerant tents and makeshift darkrooms that blossomed across post-Civil War America.

[6] A powerful example of this can be found works like *The Chasseur in the Forest* (1814) and *Früschnee* (1828). The mythological space of the woods within German folklore is particularly telling of the ways in which the void is represented as a dense combination of vastness and interiority.

[7] See T.J. Clarke's *Farewell* to an Idea for more on the implications of David's painting as an introduction/precursor to Modernism.

[8] Eric Davis' *Techgnosis* is a wonderful and engrossing treatise on historical and 20th Century notions of the body escaping/extending beyond "wetware." Most notably within that book is a section dedicated to Extropy - a system of beliefs that encourages the use of body modifications for the purpose of making humans immortal.

deeper self-reflection. When we behold Marat we are not just seeing the death of a historical figure, we are also observing the corporeal self as it floats into oblivion.

BURKE'S UNKNOWABLE

Where the darkness of a void becomes whole - a consuming, enveloping, immersive experience - an intimate sense of self surpasses the limitations of our flesh. [8] In this state of delving into the void - into an unknown and indescribable darkness - one approaches the sublime; a troubled zone of terror, fear, awe, and beauty. Edmund Burke - the more lyrical theorist on the sublime [9] - speaks of understanding the indescribable as a process of being wretched from reality. The sublime is not only a location of serene beauty and profound awe, but is also a place of terrible abandon. The terror invoked by the sublime lies in the knowledge that a true experience of the void is beyond explanation, and that in acknowledging this impossibility, the limitations of language and speech become all the more frighteningly real. [10]

The limitations of expression become intense moments of pain for Burke. Pain, and terror, are not merely the resulting affect of experiencing the unknowable, but also its root source. This pain, however, is the encapsulation of the most intense emotion available to the human psyche, and as such contains within it a kind of everlasting metaphysical scar. Awe and the sublime are the Pandora's box of the subconscious, a floodgate for imagination, an overwhelming astonishment that taps directly into the soul. The void that hangs above Marat's body becomes an attempt at containing the chaos - a negative space made to summarize the teeming sublime that flows out from the Frenchman's stab wounds.

[9] As compared to the staunchness of reasoning/logic posed by Kant's *Critique*. Lines like "the gloss of novelty fresh upon all objects that surroundings us," amongst others read almost more as prose. I'd attest that Burke lends himself better to inquiries on Romantic notions of the sublime on the basis of the stylistic prose alone. Part One, Section One titled Novelty is a telling introduction to the tone that Burke takes within his *Enquiry*.

[10] Burke, Edmund. *A Philosophical Enquiry into the Origin of Our Ideas of the Sublime and Beautiful*. New York: Oxford University Press, 2008.

As David's successors became more concerned with the sublime, pastoral imagery become a mainstay for attempting to collapse what Burke identified as the terribleness of awe. The advent of the photograph, and of the chemical processes that the darkroom requires, came to supplant painting as a dominant representational paradigm. Notably, photography offered an interesting opportunity for artists and scientists to consider objective representations of the sublime. By creating a visual consensus based on empirical representation (although now we might consider the flaw of such a claim), the photographic image and darkroom process coalesced the ideas of an observable objectivity. In so doing, it created a kind of container for the vastness of the world, a capturing and consolidation of the earth into a singular surface. [11]

AN ABSTRACT SELF

Although a linear history of events does not preclude an understanding of the cultural development that occurred at the turn of the 20th century, some cause and effect between the introduction of photography and the state of painting at the time can be illustrative in mapping a discourse on the void. Painters of the late 19th century - notably Paul Cézanne and Augustus Vincent Tack - were combatting the objective captivity of the world presented by the photograph. The alternative that these artists pursued sought to reintroduce subjectivity to the painterly conventions of landscape and still-lifes. Undoubtedly, the detail of the photographic image revealed metaphysical problems with representational technology. Paintings of the late 1800s started to reflect - or at the very least meditate on - that which photography could not capture:



Jacques-Louis David, Death of Marat, 1793

air, texture, quietude. Artists of this time began to see the limitations of using objective representation as a means of discussing the sublime - especially since the photograph could capture the observable materiality of these places much more accurately than the paintbrush. This type of questioning introduced an important leap during the later half of the 19th century with regards to tapping into the void: the abandonment of the body.

Where David and Friedrich employed the body as a counterweight to representing the void, artists working around the turn of the century drifted more towards "pure abstraction." This newfound abstraction, both in painting and in prose, employed familiar models of representation that had carried over from the Enlightenment and post-Renaissance thinking. However, as Romanticism became more Modern, the focal point of discovering the self became decentralized. This pivot point depended on relationships and communication of a more industrialized manner - making self-identification a complex affair. [12]

As Arthur Rimbaud quipped: "*Je est un autre* (I is someone else)." [13] Likewise, painterly abstraction, or non-representational painting, became a central mode for considering the ways in which the sublime could be observed unhinged from personal subjectivity. In some ways, the gesture of non-representational abstraction fought back against the terror of awe. Through harnessing chance, chaos, unpredictability, and the unconscious, modern artists began wrestling with the sublime using a new vernacular. This modern rhetoric was not based on observations of the outside world, but more on observations of interiority of the mind. In other words, the site of artistic inspiration went from out in the fields into the solitude of the studio.

[11] Berger, John. ed. Geoff Dyer. *Understanding a Photograph*. New York: Aperture, 2013.

[12] Baudelaire provides a notable example of a Romanticism that emerged out of industrialized society, or as a response to industrialization. Through the use of mass media like the newspaper, Baudelaire's poetry and reflections on contemporary society were able to be both widely distributed while maintaining a concentrated criticality on the role of the individual within an emergent bustling urban environment.

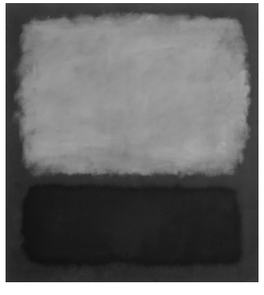
[13] Rimbaud, Arthur. Illuminations. Trans. John Ashbery. New York: W. W. Norton & Company, 2011. Print.

THE VOID WITHIN

It is in the exploration of interiority and consideration of the sublime that the work of Mark Rothko emerges. In his abstract expressionist paintings, the lines between the foreground subject and the regressive negative space are blurred to the point of irrelevance. If one were to look at *Marat* - or paintings by David's contemporaries like Francisco Goya - in the light of abstract expressionism, one could easily find a shared exploration of darkness. However, Rothko took the removal of the body that inspired early painterly abstraction one step further. By creating paintings where the artist's hand - as creator and laborer of work - is indiscernible, Rothko marries the metaphoric abstraction of Romanticism with the painterly abstraction of early modern impressionists. [14]

Even if brush work within Rothko's best known later works can be pinpointed, the overall affect of the piece takes much larger precedent than the observability of their handicraft. As a result, an opposite pole of objectivity emerges through a process of delving into pure abstraction. Contrary to photography, the objectivity found within the work of Rothko is not based on the mechanical representation of capturing. Instead an objective void is established through - quite ironically - a razor sharp subjective non-mechanical process. The crushing nuance of these paintings creates a different kind of void based on a hermetic interiority. Rothko's paintings almost present a back door for witnessing the result of a sublime experience. In so doing, the representation of the sublime is based more on its after-image than it is on its becoming.

Rothko was not merely exploring the materiality or plasticity [15] of painting as a medium, he wanted his works to



Mark Rothko,
Blue and Grey, 1962

embody a space for profound - almost monastic - meditation. Abstraction became a conduit for the soul; the surface of a painting became a portal into the infinite. Again, however, we find that the pursuit of representing a void would involve a process of containment of one kind or another. The plasticity presented by the canvas - although deceptively abysmal - reflects the capturing process analogous to photography. Both Rothko's paintings and the photograph are attempting to capture that which is fleeting - be it a momentary exchange on the city streets, or an epiphany reached via prolonged meditation.

The painting and the photograph share more than capturing the ephemeral. They both employ a specific process of abstraction that requires time for development. Both mediums acknowledge - either by technical/mechanical means or by meditative practices - that understanding of the sublime necessitates a process. The suddenness of an encounter with the sublime shocks a spectator through an unspeakable splendor. In order for the subject to even articulate the experience of such an event, a process of deliberation, meditation, and uncovering has to be undertaken. For painting, this process happens within the presence of the object; sitting, observing, contemplating, reacting. For photography this process happens in the darkroom; capturing, exposing, developing, drying. Although the process of observation can be applied to a photograph once it has made it out of the darkroom (and presented in the same fashion as a painting), both forms of representation share a conceit that a renegotiation of participating in a sublime act (or space) necessitates methodical consideration.

AN ULTIMATE BLACK

In order to step back from the void - for that is what articulations of the sublime are

[14] Rothko, Mark. Ed. Christopher Rothko. *The Artist's Reality: Philosophies on Art*. New Haven: Yale University Press, 2006.

[15] Rothko critiques some of his contemporaries for being too concerned with the materiality of paint, and not concerned enough with the actual surface of the painting. Instead of building outward from the surface of the work, as de Kooning or Hofman did, Rothko's work asks us to fall into the painting.

centrally responding to - an artist using any technology must equally employ negation and abstraction. For Rothko, the density of his paintings comes from their surprising lack of content - they are their own world; an island of awe. Through combining negation of a subject/object with painterly abstraction, artists realized that darkness could be a valuable tool for understanding the void. The outcome of this realization can be observed in Ad Reinhardt's Abstract Painting - a study on the ultimate darkness, a "transcendency" beyond definition. In these works, Reinhardt wanted to move beyond the material concern of the color black, and instead wanted to rediscover darkness as an "aesthetic-intellectual" concern because, in his words, black "is a non-color." [16]

The darkness in these works taps into a new approach for the creation of voids that has marked the second half of the 20th century: a void of non-representation, beyond merely lacking, one that approaches a more complete negation. The departure from representation - and withdraw from an artistic desire for subjectivity - that informs artworks discussing darkness has found sympathetic audiences in the scientific community. The need for an objective darkness has provided compelling conceptual ground for new approaches to consider what the void can represent and embody. By providing physical evidence of a material capable of capturing all forms of radiation, a new philosophical space opens up for artists to explore the affect of such a void. The darkness that SUPERBLACK embodies circumvents a problem that artists have been struggling with since Romanticism: how does one represent negation? As a way of solving this riddle, SUPERBLACK creates a new vernacular for darkness and the void. Now that the representation of negation has been given objective manifestation by a scientific community, it is up to artists to contemplate what this material signifies for our understanding.

[16] Ed. Barbara Rose. *Art-as-art: The Selected Writings of Ad Reinhard*t. Los Angeles: University of California Press, 1991.

"The void is not just the space beyond depth, where the z-axis of our vision cannot find end or horizons – it contains, within that infinite regression, a metaphysical mirror for the spectator."



Caspar David Friedrich, The wanderer above the sea of fog, 1818

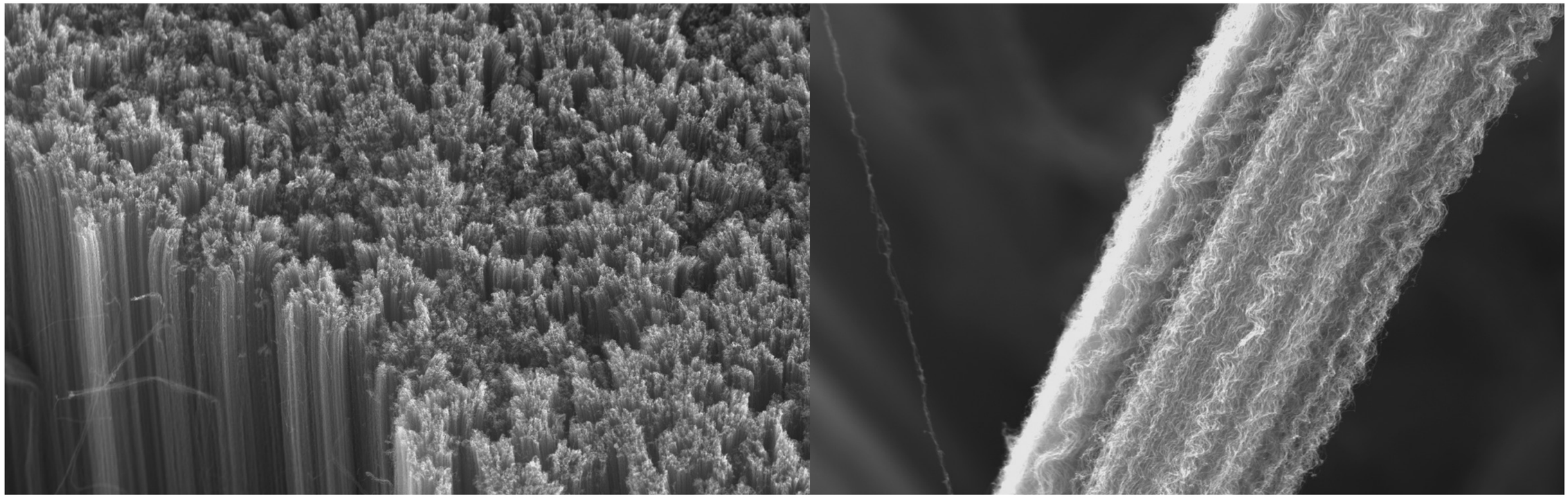
CLOSE TO SUPER BLACK

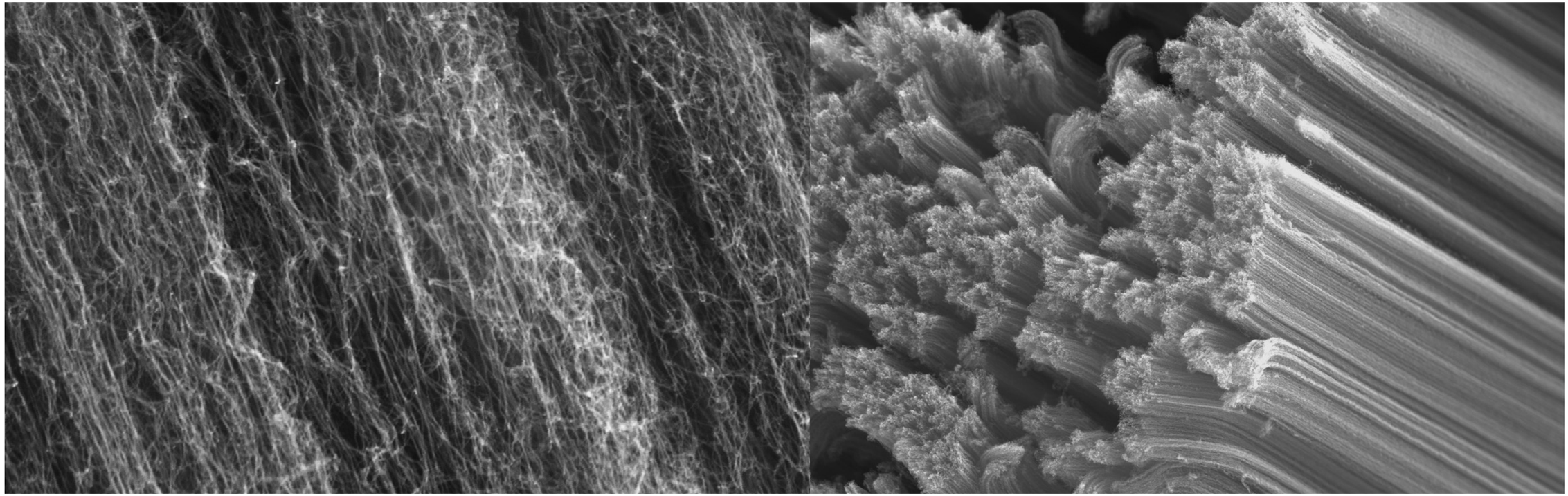
The carbon nanotube arrays used in SUPERBLACK were produced at Nanoworld Laboratories at the University of Cincinnati under Lab Director Veselin Shanov, Ph.D. and with the assistance Mark Haase. The following images are material details of carbon nanotube arrays produced during the research phase of SUPERBLACK. These images were made with a Philips/FEI (XL30) Scanning Electron Microscope in the Advanced Materials Characterization Center at the University of Cincinnati with the assistance of their Director, Dr. Pablo Rosales. Magnification in these images ranges from 50X-50,000X.

CLOSE TO SUPERBLACK

Zoom:
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CLOSE TO SUPERBLACK



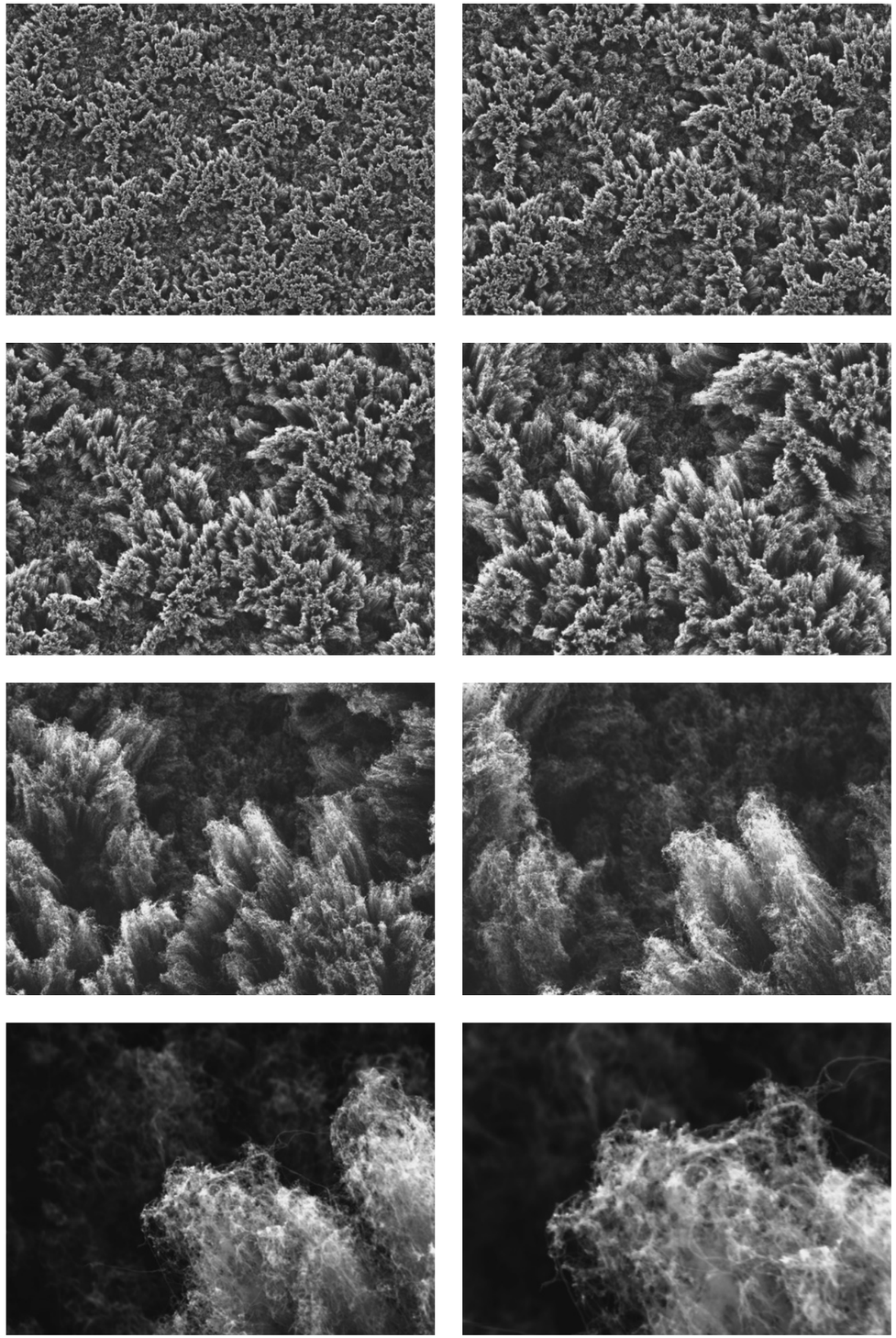


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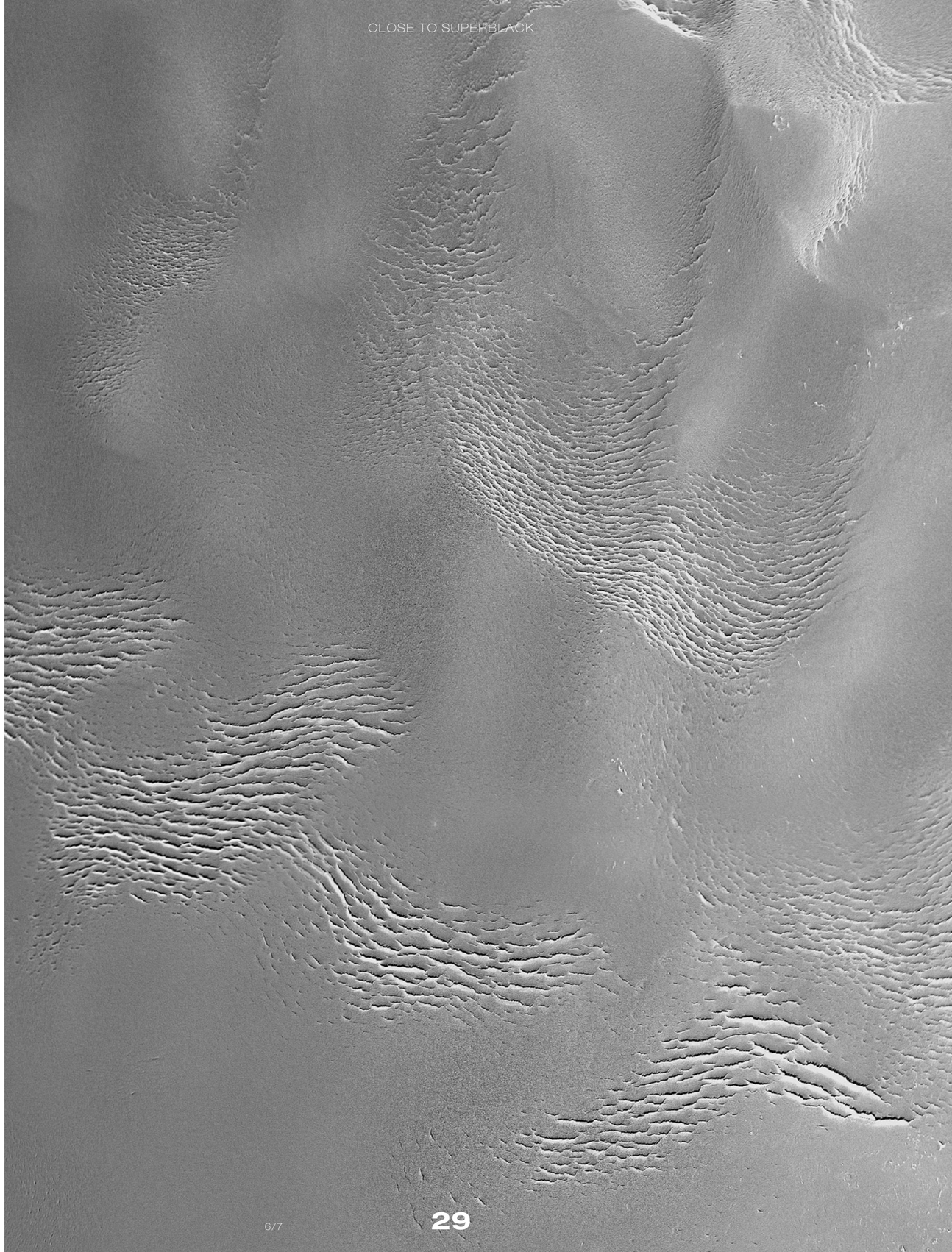
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left page series:
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CLOSE TO SUPERBLACK





“The contrast between black and white sits at the very apex of their hierarchy of universal terms: that is, all languages will make this basic distinction and make it before they make any others.”

this page:
80 X

q & A



[portrait Jordan Tate]

[portrait Jordan Tate] by Justin Hodges, 2013

INTERVIEW WITH JORDAN TATE BY LISA KURZNER

For artist Jordan Tate, images function primarily as markers, place-holders arranged to express relationships about cultural context, which even the most mindful of intellectual scorekeepers may gloss over. His work questions the photograph as physical object and perceptual illusion; in fact, his practice depends on dismantling first takes and examining how we understand a photograph's legibility in the broadest philosophical sense. If his aim is to deconstruct pictures, then what guides his selection of images and their resolution into photographic prints? The digital photographic dictionary - that seemingly infinite image source so dominant in our culture - commands authority here, granting Tate a sourcebook that is rich and varied. He views technology optimistically, not seeing it as a controlling endgame but as a means to identify humankind's position as a sentient being in the cosmos. At the same time, though, he designs his photographic projects as lesson plans in defining the limits of human perception. As such, this concept leads the artist to speak as plainly as he can with his tools, in hopes that the viewer takes nothing for granted.

LISA KURZNER You began your art career as a classical photographer working with film processed in a darkroom. At some point, your study of media philosophy and critical theory shaped a new direction in your artistic output. Can you reflect on this early transition? Do you see yourself as a philosopher of vision, or image maker, or both?

JORDAN TATE While I can appreciate the distinction that one could infer from the shift in my practice, I think that, fundamentally, my philosophy of image making hasn't necessarily changed. That said, I see myself acting in and upon a notion of photography that is inherently tied to technological capability.

Historically, photographers have been, by necessity, the most adaptive and dynamic practitioners - following quickly developing technologies throughout the evolution of the medium. The processes and practices of photography have evolved more rapidly and more profoundly than other prevalent media. Because of this, I see the shift in my work largely as a response that leverages these ideas within a contemporary framework and allows me to function at once as a photographer (in the practical and

technological sense), and as one challenging the dominant paradigms of the photograph.

As such, I see myself as someone more interested in the philosophy of photography than in the practical aspects of the medium. The photograph is not a thing, it is not an outcome, it is not an object. It is, in some sense, the distillation and physical manifestation of making sight objective.

LK We have discussed your interest in the idea of defining limits as central to your artistic concept. This in itself suggests a scientific, problem-solving mindset toward the artistic enterprise. Can you reflect on the shared concerns of art and science in your work and how images come to express equations of limits in your work?

JT I don't necessarily agree with the notion that operating as an artist or operating as a scientist are separate ideas. Clearly the contexts are different, the outcomes are different, and the purpose is different, but the process of hypothesizing (sketching), testing (making), and quantifying (evaluating), isn't disparate. Essentially, I view science as a mode of thinking and inquiring, and I view art as a mode of thinking and inquiring - neither forming a dominant paradigm in my worldview.

LK In an early segment from *New Work*, you appropriate the background of a magazine appropriation by Richard Prince. How important was that to your developing philosophical program?
Are you defining a system of understanding that is absolute, or relational, i.e.; dependent on being part of a cultural system and unaware?

JT I am more interested in rethinking the notions of the affect/effect of photography/art/culture than in seeking any notion of understanding. If I were to try to pin down the mission of my work - and this is where we could get into a discussion about image politics - it is to function as a catalyst. I do not seek understanding - and this isn't to say that I don't want my work to be understood, per se, but that I am more interested in the outcome, or the conversation beyond the work. While I am seeking answers, I am not aiming to necessarily provide them. The work is, as it has been for some time, exploratory. I'm not trying to avoid the responsibility that I feel to provide a context for my work - but I do find the notion of understanding problematic in the context of the work I am producing.

I think that this is a natural outcome of having multipart works. While the appropriation of the Prince image was significant and purposeful, it becomes a part of a much larger conversation when grouped with other ideas - and therefore not specifically important in the development of my philosophical program, but necessary in the contextualization of my practice. This fluidity is crucial - in not limiting myself to any particular mode of image making, I am able to engage more broadly in a critique of images. As such, I don't intend *New Work* to define a system of understanding, but rather to foster a critical awareness that these systems exist, and that they are, as you suggest, fundamentally relational - but also culturally relational in a manner that suggests absolute systems.

LK We could also digress into what aspects of institutional critique are most valuable to your work. Since much of your work is about how we process, encode and understand visual images, do you view this exercise as politically based?

JT I think this is a very astute observation. As previous answers suggest, meta-photography is valid and necessary, and you are correct in assuming some political structure present in the notions of institutional critique. As much as my concern with the photograph is a referent for my concern with epistemology, my concern with institutional critique is a microcosm of what I believe is a need for constant criticality. As such, the work is inherently political because implicit in any criticism is a disapproval of the structure it's critiquing, and as politics refers to the governing of the polis, so do institutions determine and implement contexts that govern our notion of reality.

LK You refer often to the Enlightenment, a term encapsulating the rationalization of thought in 17th century Europe, especially as it applies to scientific method. Direct observation took precedence over religious, spiritual or mystical explanation for natural phenomena. Optics was established as a science with a host of machines to measure, parse and harness light and reflected (photographic) imagery. Thus, the apparatus came into being, including all the forerunners of photographic equipment. [1]
Your work continues the poet-scientist experimental position, as it strives to express the limits of humankind's place in the universe, but extends beyond. Can you discuss how you adhere to this model and also move beyond into a critical discussion of imagery and perception in the postindustrial era?

JT This conversation for me stems from the idea of apparatus that you bring up and is inherently and cyclically tied to the notion of the poet-scientist as a consummate skeptic (in a sense) that situates his or herself in the liminal space between these two historically disparate philosophies.

These two movements (the Enlightenment and Romanticism - which for the sake of argument I will reduce to perspectives of objectivity and subjectivity), function for me within the framework that Vilém Flusser [2] lays out (an etymological extrapolation of object [3] and subject) in which he positions object and subject as necessary counterpoints to each other. Linguistically, the object (the thrown against) requires a subject against which to be thrown (i.e. the ideas of the Enlightenment must be thrown against the ideology of Romanticism). This positions the "poet-scientist" in the most appropriate position to engage in a critical discussion of imagery and perception in the postindustrial era. It is the full acceptance of neither paradigm that allows this logic to function. By extending the analogy of the apparatus beyond the device and beginning to address the

[1] For the scientific history of vision in 19th century Europe see Jonathan Crary, *Techniques of the Observer: On Vision and Modernity in the Nineteenth Century*, MIT Press, 1992.

[2] Vilém Flusser (May 12, 1920 – November 27, 1991) was a Czech-born philosopher, writer and journalist whose most influential writings (at least to this work) argued that the photograph was the first in a number of technical image forms to have fundamentally changed the way in which the world is seen.

[3] In English the word *object* is derived from the Latin *objectus* (pp. of obicere) with the meaning "to throw, or put before or against", from *ob-*(pref.) and *jacere*, "to throw".

apparatus as an epistemology [4], it allows us to critique (in the classical sense) both prevailing paradigms during the advent of the photograph (1800-1850) by not wholly accepting either one.

LK Culture—into media—into photography—into apparatus. This is how Andreas Müller-Pohle breaks down Flusser's philosophy of the apparatus [5]. I think it would be useful for you to identify your work within this concept of the technologically programmed world view of contemporary society. Can you discuss how your work expresses Flusser's ideas?

JT Müller-Pohle is reducing Flusser from an intellectual nomad to a much more specific thinker and applying that to a theory of photography. I tend to do the opposite, in that I accept Flusser's nomadic wanderances and use the specific examples (i.e. apparatus) to expand these ideas to a broader discussion of visual culture. Müller-Pohle is more invested in specific theories of the photograph whereas I am interested in the photograph as a paradigm for broader epistemological concerns (as a means to an end rather than end in and of itself.) Inasmuch as Müller-Pohl is discussing the combative relationship between the photographer and the apparatus, I position myself differently. Rather than attempting to overcome the apparatus, I aim to understand the limitations of the apparatus in order to see *how* it is limiting and affecting my experiences.

LK Poet and scientist Johan van Goethe published his color theory in 1810, in which properties of light and color are treated as separate values and phenomena. If photography is your tool to explore epistemological and phenomenological concerns, is your use of images to be understood similarly by everyone?

JT This is best discussed through the notions of color and perception. Our perception is inconsistent and malleable, but not flawed. Accepting the notion of "flawed" perception assumes that there is some objective truth that can be had. Color can serve as a metaphor for this example. Let us assume that we have painted a swatch of Pantone #286. When we view this swatch under different lighting conditions, or under the same lighting condition with varying surrounding colors, the apparent color of #286 shifts. While we can quantify the color of #286, this notion presupposes a standardized lighting environment.

In reality we are not quantifying a color, we are measuring a color in an agreed upon context. What's interesting here is that in our need to quantify, we are also limiting our ability to experience - we are offloading our ability to investigate the "problem of perception" to objective scientific means, thereby invalidating our experience of viewing this color in any other context - because if we accept the notion of a pantone value [6] as representative, every other viewing context is a deviation from that accepted standard. Thus, we are not acknowledging the inherent malleability of the world or that relationship to our adaptive perception.

[4] "The understanding, like the eye, whilst it makes us see and perceive all other things, takes no notice of itself; and it requires art and pains to set it at a distance and make it its own object." – John Locke, *An Essay Concerning Human Understanding.*

[5] European Photography v 22, no 70, winter 2001-02, pp 5-6.

[6] It is important to note that this implies a specific set of viewing conditions.

Following this logic, and thinking of the Descartes stick problem - when placed in water, a stick appears bent - our understanding of optics allows us to deconstruct the phenomena of refraction and understand that the stick is not bent. However, that assumes at some point we actually believed that the stick was bent, or that the bentness of the stick was a problem (because a context in which sticks bend in water fundamentally is no different than a context in which sticks appear bent in water when it is accepted as reality).

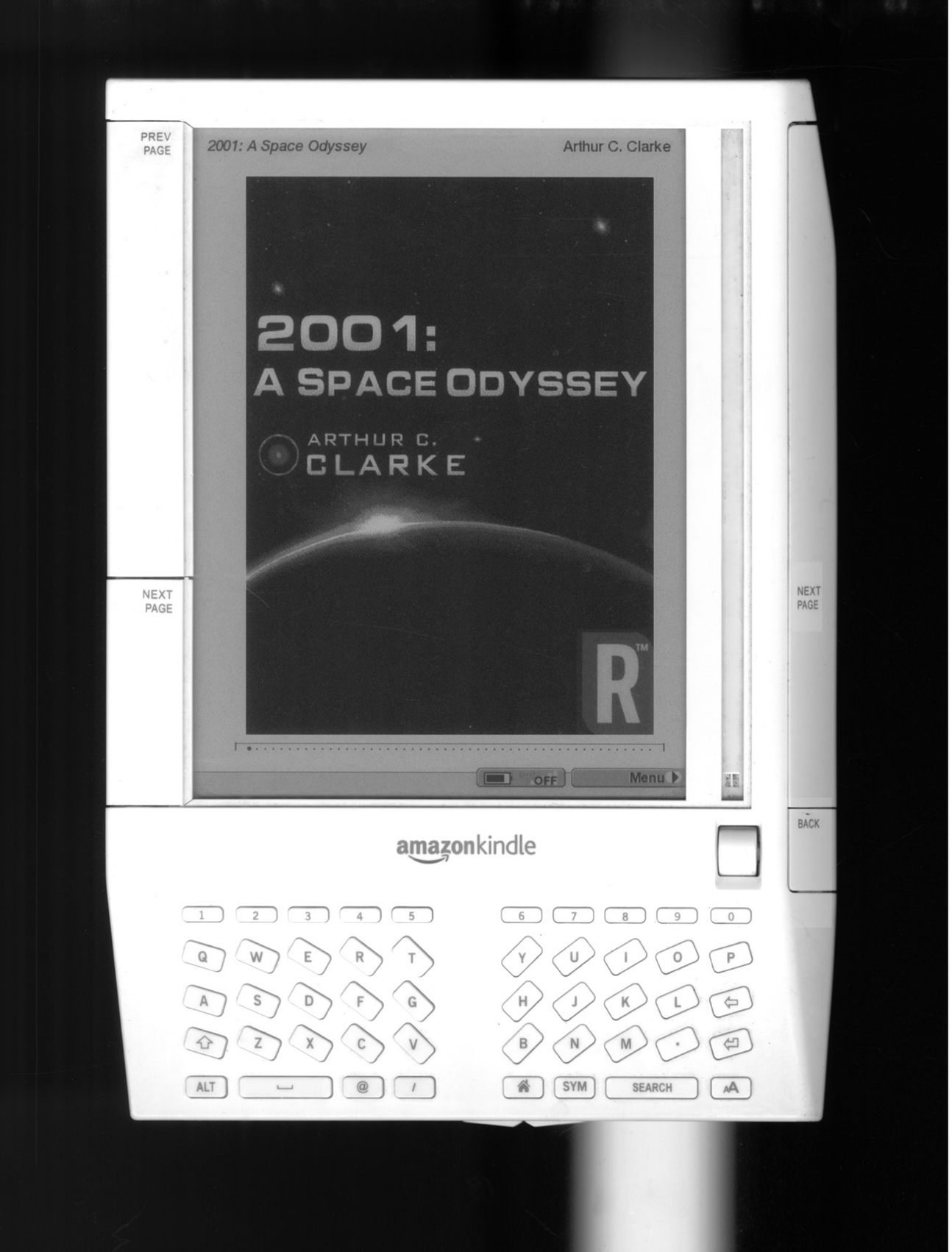
Likely, nobody believed that the stick was bent because we acknowledge the malleability of perception. In acknowledging the existence of misperception, hallucination etc., we must accept that our experience with the world is subjective. Ultimately, it is subjectivity that governs experience and objectivity that makes it communicable.

There is a necessity to communicate, and as such a necessity for shared language, which thus impels the development of a single point objective perception, i.e. the Pantone color swatch. The world is relative, and we are trying to objectify an inherently relative experience through "objective" photographic experience.

LK Having reviewed the historical and intellectual debate over photography as an art form and cultural phenomena, can you express, finally, where photography is taking you as an artist?

JT My philosophy of the photograph is shifting away from the notion of "object" or "image". There are several interpretations of the implicit and explicit functions of the photograph, and while I admit the validity of these arguments, I am most concerned with the notion of the photograph as an idea. What I mean by this is that the meta-photographic surge (from the early aughts onward) still, in many ways, focused on the notion of image-object as a necessary and substantial departure from previous iterations of photographic understanding. While I don't deny the significance of the departure, I think it still functions within the same problematic paradigm of what photography is on a fundamentally physical level. Granted, the recent meta-photographic inquiry is and was a necessary critique on how images function and exist in a contemporary photographic landscape, but in accepting the notion of the photograph as an idea, I am struck with the need to discuss the photograph as a notion that is separated from the necessity of physicality - which is a separation from the intense process-based critiques of recent meta-photographic work. I want to discuss photography as an affect, as a neurological structure, and as a methodology that has the potential to broaden our epistemology.

While I accept that acknowledging the objecthood of the photograph is a necessary concern, what springs from this mode of inquiry is the notion that the photograph is at once informed and limited by this reification. Ultimately, I argue that regardless of how informed a perspective on photography is, or how critical the vision, we still implicitly accept, and are governed by, problematically limited paradigms of understanding that begin with the photograph.



A
Black Odyssey

A photograph of the Moon flashed onto the screen. At the very center of the disk was a brilliant white crater ring, from which a striking pattern of rays fanned out. It looked exactly as if someone had hurled a bag of flour at the face of the Moon, and it had spattered out in all directions.

Another picture flashed on the screen; it looked like a contour map, though it showed magnetic intensity, not heights above sea level. For the most part, the lines were roughly parallel and spaced well apart; but in one corner of the map they became suddenly packed together, to form a series of concentric circles — like a drawing of a knothole in a piece of wood. Even to an untrained eye, it was obvious that something peculiar had happened to the Moon's magnetic field in this region; and in large letters across the bottom of the map were the words: TYCHO MAGNETIC ANOMALY-ONE (TMA-1).

The darkened assembly room became suddenly hushed and expectant as the picture on the screen changed. Though everyone had seen it many times, there was not a person who failed to crane forward as if hoping to find new details. On Earth and Moon, less than a hundred people had so far been allowed to set eyes on this photograph.

It showed a man in a bright red and yellow spacesuit standing at the bottom of an excavation and supporting a surveyor's rod marked off in tenths of a meter. It was obviously a night shot, and might have been taken anywhere on the Moon or Mars. But until now no planet had ever produced a scene like this.

The object before which the spacesuited man was posing was a vertical slab of jet-black material, about ten feet high and five feet wide: it reminded Floyd, somewhat ominously, of a giant tombstone. Perfectly sharp-edged and symmetrical, it was so black it seemed to have swallowed up the light falling upon it; there was no surface detail at all. It was impossible to tell whether it was made of stone or metal or plastic - or some material altogether unknown to humankind.

At last, one of humanity's oldest questions had been answered; here was the proof, beyond all shadow of doubt, that theirs was not the only intelligence that the universe had brought forth. But with that knowledge there came again an aching awareness of the immensity of time. Whatever had passed this way had missed humankind by a hundred thousand generations.

Excerpted and modified
from *2001: A Space Odyssey*
by Arthur C. Clarke

Floyd found his thoughts turning again and again to the three-million-year-wide gulf that had just opened up before him. Like all scientifically literate people, he was used to considering far longer periods of time - but they had concerned only the movements of stars and the slow cycles of the inanimate universe. Three million years! The infinitely crowded panorama of written history, with its empires and its kings, its triumphs and its tragedies, covered barely one thousandth of this appalling span of time.

In the six hours since he had landed on the Moon, Floyd had heard a dozen theories, but had committed himself to none. Shrine, survey marker, tomb, geophysical instrument - these were perhaps the favorite suggestions. So far, the hard black material of the slab had resisted all the rather mild attempts that Michaels and his colleagues had made to obtain samples. They had no doubt that a laser beam would cut into it - for, surely, nothing could resist that frightful concentration of energy - but the decision to employ such violent measures would be left to Floyd. He had already decided that X-rays, sonic probes, neutron beams, and all other nondestructive means of investigation would be brought into play before he called up the heavy artillery of the laser. It was the mark of a barbarian to destroy something one could not understand; but perhaps we were barbarians, beside the creatures who had made this thing.

[SURFACE OF THE MOON]

The vehicle began to creep cautiously down a ramp of hard-packed rock, into the interior of the crater. And there, exactly as he had seen it in the photographs, was TMA-1.

Floyd stared, blinked, shook his head, and stared again. Even in the brilliant earthlight, it was hard to see the object clearly; his first impression was of a flat rectangle that might have been cut out of carbon paper; it seemed to have no thickness at all. Of course, this was an optical illusion; though he was looking at a solid body, it reflected so little light that he could see it only in silhouette.

The bus came to a halt within twenty feet of the slab and broadside on so that all the passengers could examine it. Yet, beyond the geometrically perfect shape of the thing, there was little to see. Nowhere were there any marks, or any abatement of its ultimate, ebon blackness. It was the very crystallization of night, and for one moment Floyd wondered if it could indeed be some extraordinary natural formation, born of the fires and pressures attending the creation of the Moon.

At some signal, floodlights around the lip of the crater were switched on, and the bright earthlight was obliterated by a far more brilliant glare. In the lunar vacuum the beams were, of course, completely invisible; they formed overlapping ellipses of blinding white, centered on the monolith. And where they touched it, its ebon surface seemed to swallow them.

The outer door opened, and the dusty moonscape lay before them, glimmering in the earthlight.

The scene had changed since the party had arrived barely an hour ago. Though the stars, and the half-earth, were still as bright as ever, the fourteen-day lunar night had almost ended. The glow of the corona was like a false moonrise along the eastern sky - and then, without warning, the tip of the radio mast a hundred feet above Floyd's head suddenly seemed to burst into flame, as it caught the first rays of the hidden sun.

Though it would take more than an hour for the sun to clear the edge of the slowly turning moon, the stars were already banished. The crater was still in shadow, but the floodlights mounted around its rim lit the interior brilliantly. As Floyd walked slowly down the ramp toward the black rectangle, he felt a sense not only of awe, but of helplessness. Here, at the very portals of Earth, humankind was already face to face with a mystery that might never be solved. Three million years ago, something had passed this way, had left this unknown and perhaps unknowable symbol of its purpose, and had returned to the planets - or to the stars.

Floyd's suit radio interrupted his reverie. "Project supervisor speaking. If you'd all line up on this side, we'd like to take a few photos. Dr. Floyd, will you stand in the middle - Dr. Michaels - thank you. No one except Floyd seemed to think that there was anything funny about this. In all honesty, he had to admit that he was glad someone had brought a camera; here was a photo that would undoubtedly be historic, and he wanted copies for himself. He hoped that his face would be clearly visible through the helmet of the suit.

"Thanks, gentlemen," said the photographer, after they had posed somewhat self-consciously in front of the monolith, and he had made a dozen exposures.

"We'll ask the Base Photo Section to send you copies." Then Floyd turned his full attention to the ebon slab - walking slowly around it, examining it from every angle, trying to imprint its strangeness upon his mind.

Now the sluggish sun had lifted itself above the edge of the crater, and its rays were pouring almost broadside upon the eastern face of the block. Yet it seemed to absorb every particle of light as if it had never been.

Floyd decided to try a simple experiment; he stood between the monolith and the sun, and looked for his own shadow on the smooth black sheet. There was no trace of it.

He looked up at the Earth, beginning to wane in the morning

sky. Only a handful of the six billion people there knew of this discovery; how would the world react to the news when it was finally released? The political and social implications were immense; every person of real intelligence - everyone who looked an inch beyond his nose - would find their life, their values, their philosophy, subtly changed. Even if nothing whatsoever was discovered about TMA-1, and it remained an eternal mystery, humanity would know that they were not unique in the universe. Though they had missed them by millions of years, those who had once stood here might yet return: and if not, there might well be others. All futures must now contain this possibility.

Floyd was still musing over these thoughts when his helmet speaker suddenly emitted a piercing electronic shriek, like a hideously overloaded and distorted time signal. Involuntarily, he tried to block his ears with his spacesuited hands; then he recovered and groped frantically for the gain control of his receiver. While he was still fumbling four more of the shrieks blasted out of the ether; then there was a merciful silence.

All around the crater, figures were standing in attitudes of paralyzed astonishment. So it's nothing wrong with my gear, Floyd told himself; everyone heard those piercing electronic screams.

After three million years of darkness, TMA-1 had greeted the lunar dawn.

[DEEP SPACE]

A hundred million miles beyond Mars, in the cold loneliness where no one had yet traveled, Deep Space Monitor 79 drifted slowly among the tangled orbits of the asteroids. For three years it had fulfilled its mission flawlessly - a tribute to the American scientists who had designed it, the British engineers who had built it, the Russian technicians who had launched it. A delicate spider's-web of antennas sampled the passing waves of radio noise - the ceaseless crackle and hiss of what Pascal, in a far simpler age, had naively called the "silence of infinite space." Radiation detectors noted and analyzed incoming cosmic rays from the galaxy and points beyond; neutron and X-ray telescopes kept watch on strange stars that no human eye would ever see; magnetometers observed the gusts and hurricanes of the solar winds, as the Sun breathed million-mile-an-hour blasts of tenuous plasma into the faces of its circling children. All these things, and many others, were patiently noted by Deep Space Monitor 79, and recorded in its crystalline memory.

One of its antennas, by now unconsidered miracles of electronics, was always aimed at a point never far from the Sun. Every few months its distant target could have been seen, had there been any

eye here to watch, as a bright star with a close, fainter companion; but most of the time it was lost in the solar glaze.

To that far-off planet Earth, every twenty-four hours, the monitor would send the information it had patiently garnered, packed neatly into one five-minute pulse. About a quarter of an hour later, traveling at the speed of light, that pulse would reach its destination. The machines whose duty it was would be waiting for it; they would amplify and record the signal, and add it to the thousands of miles of magnetic tape now stored in the vaults of the World Space Centers at Washington, Moscow, and Canberra.

Since the first satellites had orbited, almost fifty years earlier, trillions and quadrillions of pulses of information had been pouring down from space, to be stored against the day when they might contribute to the advance of knowledge. Only a minute fraction of all this raw material would ever be processed; but there was no way of telling what observation some scientist might wish to consult, ten, or fifty, or a hundred years from now. So everything had to be kept on file, stacked in endless air-conditioned galleries, triplicated at the three centers against the possibility of accidental loss.

And now Deep Space Monitor 19 had noted something strange - a faint yet unmistakable disturbance rippling across the Solar System, and quite unlike any natural phenomenon it had ever observed in the past. Automatically, it recorded the direction, the time, the intensity; in a few hours it would pass the information to Earth.

As, also, would Orbiter M 15, circling Mars twice a day; and High Inclination Probe 21, climbing slowly above the plane of the ecliptic; and even Artificial Comet 5, heading out into the cold wastes beyond Pluto, along an orbit whose far point it would not reach for a thousand years. All noted the peculiar burst of energy that had disturbed their instruments; all, in due course, reported back automatically to the memory stores on distant Earth.

The computers might never have perceived the connection between four peculiar sets of signals from space-probes on independent orbits millions of miles apart. But as soon as he glanced at his morning report, the Radiation Forecaster at Goddard knew that something strange had passed through the Solar System during the last twenty-four hours. He had only part of its track, but when the computer projected it on the Planet Situation Board, it was as clear and unmistakable as a vapor trail across a cloudless sky, or a single line of footprints over a field of virgin snow.

Some immaterial pattern of energy, throwing off a spray of radiation like the wake of a racing speedboat, had leaped from the face of the Moon, and was heading out toward the stars.

Excerpted and modified
from *2001: A Space Odyssey*
by Arthur C. Clarke

credit: NASA, ESA, and The Hubble Heritage Team STScI/AURA

“Black is the velvet of night and the satiny ink of the paintbrush. If you know how to make ink correctly, you will never again be afraid of nightmares.”

SUPERBLACK GLOSSARY

A-Z

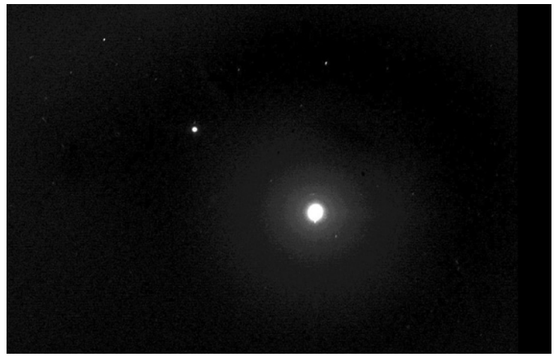
APPARATUS

1. DEFINITION:

The **apparatus** (as used here) is a notion developed by Vilém Flusser in which he argues that "apparatuses are indubitably things that are produced, i.e. things that are produced (brought forward) out of the available natural world. The totality of such things can be referred to as *culture*."

2. BACKGROUND:

"The Latin word *apparatus* is derived from the verb apparare meaning "to prepare". Alongside this there exists in Latin the verb praeparare, likewise meaning "to prepare". To illustrate in English the difference between the prefixes "ad" and "prae", one could perhaps translate *apparare* with "pro-pare", using "pro" in the sense of 'for'. Accordingly, an "apparatus" would be a thing that lies in wait or in readiness for something, and a "preparatus" would be a thing that waits patiently for something. The photographic apparatus lies in wait for photography; it sharpens its teeth in readiness. This readiness to spring into action on the part of apparatuses, their similarity to wild animals, is some thing to grasp hold of in the attempt to define the term etymologically." - Vilém Flusser



[fig. 1]



[fig. 2]

BLACK

1. DEFINITION:

Black is the color of coal, ebony, and of outer space. It is the darkest color, the result of the absence of, or complete absorption of light. It is the opposite of white and often represents darkness in contrast with light.

2. BACKGROUND:

Black was one of the first colors used by artists in neolithic cave paintings. In the Roman Empire, it became the color of mourning, and over the centuries it was frequently associated with death, evil, witches and magic. In the 14th century, it began to be worn by royalty, the clergy, judges and government officials in much of Europe. It became the color worn by English romantic poets, businessmen and statesmen in the 19th century, and a color of high fashion in the 20th century.

In the Western World today, it is the color most commonly associated with mourning, the end, secrets, magic, power, violence, evil, and elegance.

The word *black* comes from Old English *blæc* ("black, dark", also, "ink"), from Proto-Germanic **blakkaz* ("burned"), from Proto-Indo-European **bhleg-* ("to burn, gleam, shine, flash"), from base **bhel-* ("to shine"), related to Old Saxon *blak* ("ink"), Old High German *blach* ("black"), Old Norse *blakkr* ("dark"), Dutch *blaken* ("to burn"), and Swedish *bläck* ("ink"). More distant cognates include Latin *flagrare* ("to blaze, glow, burn"), and Ancient Greek *phlegein* ("to burn, scorch").

The Ancient Greeks sometimes used the same word to name different colors, if they had the same intensity. *Kuanos* could mean both dark blue and black. The Ancient Romans had two words for black: *ater* was a flat, dull black, while niger was a brilliant, saturated black. *Ater* has vanished from the vocabulary, but niger was the source of the country name Nigeria and the English word Negro.

Old High German also had two words for black: swartz for dull black and *blach* for a luminous black. These are paralleled in Middle English by the terms swart for dull black and *blaek* for luminous black. Swart still survives as the word swarthy, while *blaek* became the modern English *black*. In Latin, the word for black, *ater* and to darken, *atere*, were associated with cruelty, brutality and evil. They were the root of the English words "atrocious" and "atrocity".

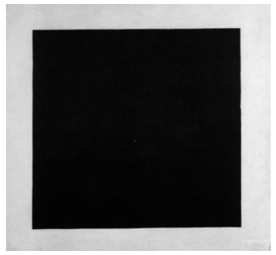
3. MODERN USAGE:

In the 1950s, black came to be a symbol of individuality and intellectual and social rebellion, the color of those who didn't accept established norms and values. In Paris, it was worn by Left-Bank intellectuals and performers such as Juliette Greco, and by some members of the Beat Movement in New York and San Francisco. Black leather jackets were worn by motorcycle gangs such as the Hells Angels and street gangs on the fringes of society in the United States. Black as a color of rebellion was celebrated in such films as The Wild One, with Marlon Brando. By the end of the 20th century, black was the emblematic color of the punk subculture punk fashion, and the goth subculture.

4. OPTICS:

Black can be defined as the visual impression experienced when no visible light reaches the eye. (This makes a contrast with whiteness, the impression of any combination of colors of light that equally stimulates all three types of color-sensitive visual receptors.)

In the visible spectrum, white reflects light and is a presence of all colors, and black absorbs light and is an absence of color. This is an important misconception as it assumes the primacy of the viewer and ignores practical function of black and white. While white light is the presence of all colors, white itself is empty, as it reflects in totality - in contrast, black materials absorb all light (color). Absorption of light is contrasted by transmission, reflection and diffusion, where the light is only redirected, causing objects to appear transparent, reflective or white respectively.



[fig. 3]

Pigments or dyes that absorb light rather than reflect it back to the eye "look black". A black pigment can, however, result from a *combination* of several pigments that collectively absorb all colors. If appropriate proportions of three primary pigments are mixed, the result reflects so little light as to be called "black".

This provides two superficially opposite but actually complementary descriptions of black. Black is the lack of all colors of light, or an exhaustive combination of multiple colors of pigment.

A material is said to be black if most incoming light is absorbed equally in the material. Light (electromagnetic radiation in the visible spectrum) interacts with the atoms and molecules, which causes the energy of the light to be converted into other forms of energy, usually heat. This means that black surfaces can act as thermal collectors, absorbing light and generating heat.

In physics, a black body is a perfect absorber of light, but, by a thermodynamic rule, it is also the best emitter. Thus, the best radiative cooling, out of sunlight, is by using black paint, though it is important that it be black (a nearly perfect absorber) in the infrared as well.

On January 16, 2008, researchers from Troy, New York's Rensselaer Polytechnic Institute announced the creation of the darkest material on the planet. The material, which reflects only .045 percent of light, was created from carbon nanotubes stood on end. This is 1/30 of the light reflected by the current standard for blackness, and one third the light reflected by the previous record holder for darkest substance.

5. PIGMENT:

The earliest pigments used by Neolithic people were charcoal, red ocher and yellow ocher. The black lines of cave art were drawn with the tips of burnt torches made of a wood with resin.

Different charcoal pigments were made by burning different woods and animal products, each of which produced a different tone. The charcoal would be ground and then mixed with animal fat to make the pigment.

Vine black was produced in Roman times by burning the cut branches of grapevines. It could also be produced by burning the remains of the crushed grapes, which were collected and dried in an oven. According to the historian Vitruvius, the deepness and richness of the black produced corresponded to the quality of the wine. The finest wines produced a black with a bluish tinge the color of indigo.

The 15th-century painter Cennino Cennini described how this pigment was made during the Renaissance in his famous handbook for artists: "...There is a black which is made from vine twigs; these twigs are to be burned; and when they are burned, throw water on them, and quench them; and then work them up like any other black. And is a color both black, and lean; and it is one of the perfect colors which we employ."

Cennini also noted that "there is another black which is made from burnt almond shells or peach stones, and this is a perfect black, and fine." Similar fine blacks were made by burning the pits of the peach, cherry or apricot. The powdered charcoal was then mixed with gum arabic or the yellow of an egg to make a paint.

Different civilizations burned different plants to produce their charcoal pigments. The Inuit of Alaska used wood charcoal mixed with the blood of seals to paint masks and wooden objects. The Polynesians burned coconuts to produce their pigment.

Lamp black was used as a pigment for painting and frescoes, as a dye for fabrics, and in some societies for making tattoos. Cennini described how it was made during the Renaissance: "...Take a lamp full of linseed oil and light this lamp. Then put it, so lighted, underneath a good clean baking dish, and have the little flame of the lamp come about to the bottom of the dish, two or three fingers away, and the smoke which comes out of the flame will strike the bottom of the dish, and condense in a mass. Wait a while; take the baking dish, and with some implement sweep this color, that is, this soot, off on to a paper, or into some dish; and it does not have to be worked up or ground, for it is a very fine color. Refill the lamp with the oil in this way several times, and put it back under the dish, and make as much of it in this way as you need." This same pigment was used by Indian artists to paint the Ajanta Caves, and as dye in ancient Japan.

Ivory black, also known as bone char, was originally produced by burning ivory and mixing the resulting charcoal powder with oil. The color is still made today, but ordinary animal bones are substituted for ivory.

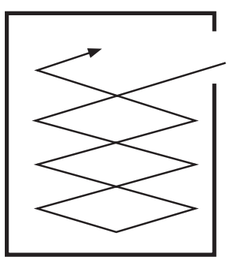
Mars black is a black pigment made of synthetic iron oxides. It is commonly used in water-colors and oil painting. It takes its name from Mars, the god of war and patron of iron.

6. INK:

The first known inks were made by the Chinese, and date back to the 23rd century BCE. They used natural plant dyes and minerals such as graphite ground with water and applied with an ink brush. Early Chinese inks similar to the modern inkstick have been found dating to about 256 BCE. They were produced from soot, usually produced by burning pine wood, mixed with animal glue. To make ink from an inkstick, the stick is continuously ground against an inkstone with a small quantity of water to produce a dark liquid which is then applied with an ink brush. Artists and calligraphists could vary the thickness of the resulting ink by reducing or increasing the intensity and time of ink grinding. These inks produced the delicate shading and subtle or dramatic effects of Chinese brush painting.



[fig. 4]



[fig. 5]

India ink (or Indian ink in British English) is a black ink once widely used for writing and printing and now more commonly used for drawing, especially when inking comic books and comic strips. The technique of making it probably came from China. India ink has been in use in India since at least the 4th century BCE, where it was called masi. In India, the black color of the ink came from bone char, tar, pitch and other substances.

The Ancient Romans had a black writing ink they called Atramentum librarium. It was usually made, like India ink, from soot, although one variety, called atrementum elaphantinum, was made by burning the ivory of elephants.

Gall-nuts were also used for making fine black writing ink. Iron gall ink (also known as iron gall nut ink or oak gall ink) was a purple-black or brown-black ink made from iron salts and tannic acids from gall nut. It was the standard writing and drawing ink in Europe, from about the 12th century to the 19th century, and remained in use well into the 20th century.

BLACK BODY

1. DEFINITION:

A **black body** is an idealized physical body that absorbs all incident electromagnetic radiation, regardless of frequency or angle of incidence.

2. BACKGROUND:

A black body in thermal equilibrium (that is, at a constant temperature) emits electromagnetic radiation called black-body radiation. The radiation is emitted according to Planck's law, meaning that it has a spectrum that is determined by the temperature alone, not by the body's shape or composition.

A black body in thermal equilibrium has two notable properties:

1. It is an ideal emitter: it emits as much or more energy at every frequency than any other body at the same temperature.

2. It is a diffuse emitter: the energy is radiated isotropically, independent of direction.

An approximate realization of a black surface is a hole in the wall of a large enclosure (see below). Any light entering the hole is reflected indefinitely or absorbed inside and is unlikely to re-emerge, making the hole a nearly perfect absorber. The radiation confined in such an enclosure may or may not be in thermal equilibrium, depending upon the nature of the walls and the other contents of the enclosure.

Real materials emit energy at a fraction—called the emissivity—of black-body energy levels. By definition, a black body in thermal equilibrium has an emissivity of $\varepsilon = 1.0$. A source with lower emissivity independent of frequency often is referred to as a gray body. Construction of black bodies with emissivity as close to one as possible remains a topic of current interest. A white body is one with a "rough surface [that] reflects all incident rays completely and uniformly in all directions."

BLACK-BODY RADIATION

1. DEFINITION:

Black-body radiation is the type of electromagnetic radiation within or surrounding a body in thermodynamic equilibrium with its environment, or emitted by a black body (an opaque and non-reflective body) held at constant, uniform temperature. The radiation has a specific spectrum and intensity that depends only on the temperature of the body.

2. BACKGROUND:

The thermal radiation spontaneously emitted by many ordinary objects can be approximated as black body radiation. A perfectly insulated enclosure that is in thermal equilibrium internally contains black-body radiation and will emit it through a hole made in its wall, provided the hole is small enough to have negligible effect upon the equilibrium.

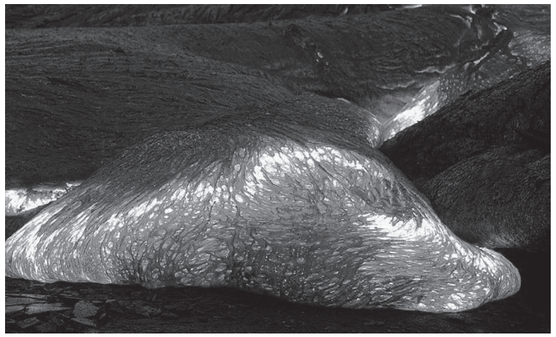
3. EMISSION:

A black body at room temperature appears black, as most of the energy it radiates is infrared and cannot be perceived by the human eye. At higher temperatures, black bodies glow with increasing intensity and colors that range from dull red to blindingly brilliant blue-white as the temperature increases.

The Draper point is the temperature at which all solids glow a dim red, about 798 K. At 1000 K, a small opening in the wall of a large

[fig. 1] Outer space seen from Mars, photo by NASA/JPL/Cornell/Texas A&M
[fig. 2] A photograph promoting the film *The Wild One* depicts actor Marlon Brando, 1953, photo by Columbia Pictures
[fig. 3] Kazimir Malevich, Black Square on a White Ground, 1915, Oil on linen, 79.5 x 79.5 cm

[fig. 4] Compressed charcoal, photo by Justin Hodges
[fig. 5] Approximate black body realization as a cavity with a hole.



[fig. 6]

uniformly heated opaque-walled cavity (let us call it an oven), viewed from outside, looks red; at 6000 K, it looks white. No matter how the oven is constructed, or of what material, as long as it is built so that almost all light entering is absorbed by its walls, it will contain a good approximation to black-body radiation. The spectrum, and therefore color, of the light that comes out will be a function of the cavity temperature alone. A graph of the amount of energy inside the oven per unit volume and per unit frequency interval plotted versus frequency, is called the *black-body curve*. Different curves are obtained by varying the temperature.

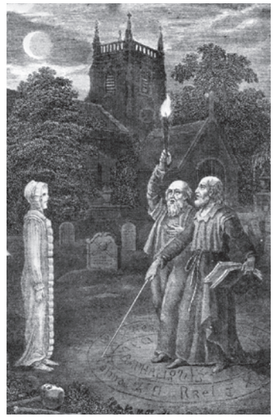
Although planets and stars are neither in thermal equilibrium with their surroundings nor perfect black bodies, black-body radiation is used as a first approximation for the energy they emit. The term *black body* was introduced by Gustav Kirchhoff in 1860. When used as a compound adjective, the term is typically written as hyphenated, for example, *black-body radiation*, but sometimes also as one word, as in *blackbody radiation*. Black-body radiation is also called *complete radiation* or *temperature radiation* or *thermal radiation*.

4. THERMODYNAMICS:

All matter emits electromagnetic radiation when it has a temperature above absolute zero. The radiation represents a conversion of a body's thermal energy into electromagnetic energy, and is therefore called thermal radiation. It is a spontaneous process of radiative distribution of entropy.

Conversely all matter absorbs electromagnetic radiation to some degree. When a black body is at a uniform temperature, its emission has a characteristic frequency distribution that depends on the temperature. Its emission is called black-body radiation.

The concept of the black body is an idealization, as perfect black



[fig. 7]

bodies do not exist in nature. Graphite and lamp black, with emissivities greater than 0.95, however, are good approximations to a black material. Experimentally, black-body radiation may be established best as the ultimately stable steady state equilibrium radiation in a cavity in a rigid body, at a uniform temperature, that is entirely opaque and is only partly reflective. A closed box of graphite walls at a constant temperature with a small hole on one side produces a good approximation to ideal black-body radiation emanating from the opening.

Black-body radiation has the unique absolutely stable distribution of radiative intensity that can persist in thermodynamic equilibrium in a cavity. In equilibrium, for each frequency the total intensity of radiation that is emitted and reflected from a body (that is, the net amount of radiation leaving its surface, called the *spectral radiance*) is determined solely by the equilibrium temperature, and does not depend upon the shape, material or structure of the body. For a black body (a perfect absorber) there is no reflected radiation, and so the spectral radiance is due entirely to emission. In addition, a black body is a diffuse emitter (its emission is independent of direction). Consequently, black-body radiation may be viewed as the radiation from a black body at thermal equilibrium.

BLACK MAGIC

1. DEFINITION:

Black magic has traditionally referred to the use of supernatural powers or magic for evil and selfish purposes.

2. BACKGROUND:

With respect to the philosophy of the duality of magics, black magic is the malicious counterpart of benevolent white magic. In modern times, some find that the definition of "black magic" has been convoluted by people who define magic or ritualistic practices that they disapprove of as "black magic". Like its counterpart white magic, the origins of black magic can be traced to the primitive, ritualistic worship of spirits as outlined in Robert M. Place's 2009 book, *Magic and Alchemy*.

Unlike white magic, in which Place sees parallels with primitive shamanistic efforts to achieve closeness with spiritual beings, the rituals that developed into modern "black magic" were designed to invoke those same spirits to produce beneficial outcomes for the practitioner. Place also provides a broad modern definition of both black and white magic, preferring instead to refer to them as "high magic" (white) and "low magic" (black) based primarily on intentions of the practitioner employing them. He acknowledges, though, that this broader definition (of "high" and "low") suffers from prejudices as good-intentioned folk magic may be considered "low" while ceremonial magic involving expensive or exclusive components may be considered by some as "high magic", regardless of intent.

BRIGHTNESS

1. DEFINITION:

Brightness is an attribute of visual perception in which a source appears to be radiating or reflecting light. In other words, brightness is the perception elicited by the luminance of a visual target. This is a subjective attribute/property of an object being observed.

2. BACKGROUND:

The adjective *bright* derives from an Old English *beorht* with the same meaning via metathesis giving Middle English *briht*. The word is from a Common Germanic **berhtaz*, ultimately from a PIE root with a closely related meaning, **bhereg-* "white, bright". "Brightness" was formerly used as a synonym for the photometric term *luminance* and (incorrectly) for the radiometric term *radiance*. As defined by the US *Federal Glossary of Telecommunication Terms* (FS-1037C), "brightness" should now be used only for non-quantitative references to physiological sensations and perceptions of light.

A given target luminance can elicit different perceptions of brightness in different contexts. In the RGB color space, brightness can be thought of as the arithmetic mean μ of the red, green, and blue color coordinates (although some of the three components make the light seem brighter than others, which, again, may be compensated by some display systems automatically).

Brightness is also a color coordinate in the HSB or HSV color space (hue, saturation, and brightness or value). With regard to stars, brightness is quantified as apparent magnitude and absolute magnitude.

CARBON NANOTUBES

1. DEFINITION:

Carbon nanotubes (CNTs) are allotropes of carbon with a cylindrical nanostructure. Nanotubes are members of the fullerene structural family. Their name is derived from their long, hollow structure with the walls formed by one-atom-thick sheets of carbon, called graphene.

2. BACKGROUND:

Graphene sheets are rolled at specific and discrete ("chiral") angles, and the combination of the rolling angle and radius decides the nanotube properties; for example, whether the individual nanotube shell is a metal or semiconductor. Nanotubes are categorized as single-walled nanotubes (SWNTs) and multi-walled nanotubes (MWNTs). Individual nanotubes naturally align themselves into "ropes" held together by van der Waals forces, more specifically, pi-stacking. These cylindrical carbon molecules have unusual properties, which are valuable for nanotechnology, electronics, optics and other fields of materials science and technology. In particular, owing to their extraordinary thermal conductivity and mechanical and electrical properties, carbon nanotubes find applications as additives to various structural materials.

3. PRODUCTION:

The prevailing method for the mass-production of Carbon Nanotubes is Chemical Vapor Deposition (CVD). In CVD, a substrate is prepared with a layer of metal catalyst particles, most commonly nickel, cobalt, iron, or a combination of these materials. The diameters of the nanotubes that are to be grown are related to the size of the metal particles. This can be controlled by patterned (or masked) deposition of the metal, annealing, or by plasma etching of a metal layer. To initiate the growth of nanotubes, two gases are bled into the reactor: a process gas (such as ammonia, nitrogen or hydrogen) and a carbon-containing gas (such as acetylene, ethylene, ethanol or methane). Nanotubes grow at the sites of the metal catalyst; the carbon-containing gas is broken apart at the surface of the catalyst particle, and the carbon is transported to the edges of the particle, where it forms the nanotubes. The catalyst particles can stay at the tips of the growing nanotube during growth, or remain at the nanotube base, depending on the adhesion between the catalyst particle and the substrate.

4. OPTICS:

Within materials science, the optical properties of carbon nanotubes refer specifically to the absorption, photoluminescence, and Raman spectroscopy of carbon nanotubes. Spectroscopic methods offer the possibility of quick and non-destructive characterization of relatively large amounts of carbon nanotubes. There is a strong demand for such characterization from the industrial point of view: numerous parameters of the nanotube synthesis can be changed, intentionally or unintentionally, to alter the nanotube quality. Microscopy, optical absorption, photoluminescence and Raman spectroscopies allow quick and reliable characterization of this "nanotube quality" in terms of non-tubular carbon content, structure (chirality) of the produced nanotubes, and structural defects. Those features determine nearly any other properties such as optical, mechanical, and electrical properties.

Carbon nanotubes are unique "one dimensional systems" which can be envisioned as rolled single sheets of graphite (or more precisely graphene). This rolling can be done at different angles and curvatures resulting in different nanotube properties. The diameter typically varies in the range 0.4–40 nm (i.e. "only" ~100 times), but the length can vary ~10,000 times, reaching 18.5 cm. Thus the nanotube aspect ratio, or the length-to-diameter ratio, can be as high as 132,000,000:1, which is unequalled by any other material. Consequently, all the properties of the carbon nanotubes relative to those of typical semiconductors are extremely anisotropic (directionally dependent) and tunable.

Whereas mechanical, electrical and electrochemical (supercapacitor) properties of the carbon nanotubes are well established and have immediate applications, the practical use of optical properties is yet unclear. The aforementioned tunability of properties is potentially useful in optics and photonics. In particular, light-emitting diodes (LEDs) and photo-detectors based on a single nanotube have been produced in the lab. Their unique feature is not the efficiency, which is yet relatively low, but the narrow selectivity in the wavelength of emission and detection of light and the possibility of its fine tuning through the nanotube structure. In addition, bolometer and optoelectronic memory devices have been realized on ensembles of single-walled carbon nanotubes.

5. BLACK BODY APPLICATIONS:

An ideal black body should have emissivity or absorbance of 1.0, which is difficult to attain in practice, especially in a wide spectral range. Vertically aligned "forests" of single-wall carbon nanotubes can have absorbances of 0.98–0.99 from the far-ultraviolet (200 nm) to far-infrared (200 μm) wavelengths, making them an ideal material for the construction of black bodies.

CHAOS

1. DEFINITION:

Chaos (Greek χάος, khaos) refers to the formless or void state preceding the creation of the universe or cosmos in the Greek creation myths, more specifically the initial "gap" created by the original separation of heaven and earth.

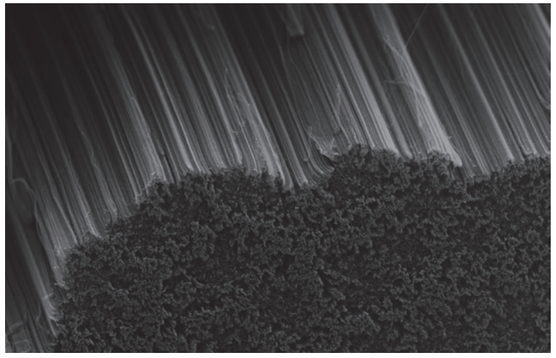
2. BACKGROUND:

Greek χάος means "emptiness, vast void, chasm, abyss", from the verb χαίνω, "gape, be wide open, etc.", from Proto-Indo-European *ghen-, cognate to Old English geanian, "to gape", whence English yawn.

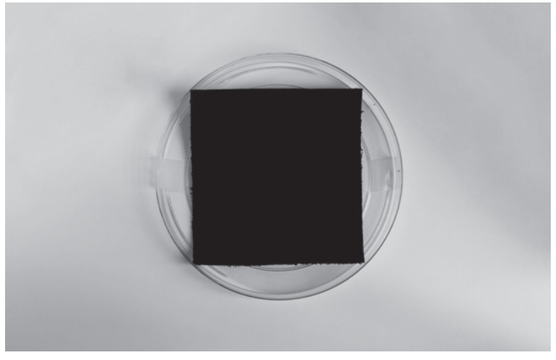
Hesiod and the Pre-Socratics use the Greek term in the context of cosmogony. Hesiod's chaos has often been interpreted as a moving, formless mass from which the cosmos and the gods originated, but Eric Voegelin sees it instead as creatio ex nihilo, much as in the Book of Genesis. The term tohu wa-bohu of Genesis 1:2 has been shown to refer to a state of non-being prior to creation rather than to a state of matter.

3. CHAOSKAMPF

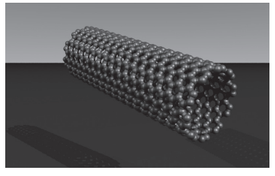
The motif of Chaoskampf (German for "struggle against chaos") is ubiquitous in myth and legend, depicting a battle of a culture hero deity with a chaos monster, often in the shape of a serpent or dragon. The same term has also been extended to parallel concepts in the religions



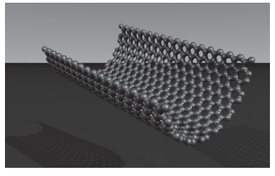
[fig. 8]



[fig. 9]



[fig. 10]



[fig. 11]

[fig. 6] Advancing Pahoehoe toe, Kilauea Hawaii 2003, photo by Hawaii Volcano Observatory (DAS)
[fig. 7] Ebenezer Sibley, John Dee and Edward Kelly evoking a spirit

[fig. 8] Image of Carbon Nanotubes made with a Philips/FEI (XL30) Scanning Electron Microscope in the Advanced Materials Characterization Center at the University of Cincinnati. Magnification: 500 X
[fig. 9] Sample of multi-walled carbon nanotube array produced by NANOWORLD Laboratories at the University of Cincinnati.
[fig. 10] Carbon nanorim armchair povray.png, illustration by Arne Rosenfeldt
[fig. 11] Same as above.

of the Ancient Near East, such as the abstract conflict of ideas in the Egyptian duality of Maat and Isfet.

The origins of the Chaoskampf myth most likely lie in the Proto-Indo-European religion whose descendants almost all feature some variation of the story of a storm god fighting a sea serpent representing the clash between the forces of order and chaos. Early work by German academics in comparative mythology popularized translating the mythological sea serpent as a "dragon." Indo-European examples of this mythic trope include Thor vs. Jörmungandr (Norse),Tarhunt vs. Illuyanka (Hittite), Indra vs. Vritra (Vedic), Θraētaona vs. Aži Dahāka (Avestan), and Zeus vs. Typhon (Greek) among others.

CHIAROSCURO

1. DEFINITION:
Chiaroscuro (English pronunciation: **/kiˌɑːrəˈskjʊərəʊ/**; Italian: **[kjaroˈkuːro]**; Italian for *light-dark*) in art is the use of strong contrasts between light and dark, usually bold contrasts affecting a whole composition.

2. BACKGROUND:
Chiaroscuro is also a technical term used by artists and art historians for using contrasts of light to achieve a sense of volume in modeling three-dimensional objects such as the human body. Similar effects in the lighting of cinema and photography are also often called chiaroscuro.

DARK MATTER

1. DEFINITION:
Dark matter is a type of matter hypothesized in astronomy and cosmology to account for a large part of the mass that appears to be missing from the universe.

2. BACKGROUND:
Dark matter cannot be seen directly with telescopes; evidently it neither emits nor absorbs light or other electromagnetic radiation at any significant level. Instead, the existence and properties of dark matter are inferred from its gravitational effects on visible matter, radiation, and the large-scale structure of the universe. According to the Planck mission team, and based on the standard model of cosmology, the total mass–energy of the known universe contains 4.9% ordinary matter, 26.8% dark matter and 68.3% dark energy. Thus, dark matter is estimated to constitute 84.5% of the total matter in the universe and 26.8% of the total content of the universe.

DARKNESS

1. DEFINITION:
Darkness, as the polar opposite to brightness, is understood to be an absence of visible light. It is also the appearance of black in a colored space.

2. BACKGROUND:
Humans are unable to distinguish color when either light or darkness predominate. In conditions of insufficient light, perception is achromatic and ultimately, black. The emotional response to darkness has generated metaphorical usages of the term in many cultures.

The perception of darkness differs from the mere absence of light due to the effects of after images on perception. In perceiving, the eye is active, and that part of the retina that is unstimulated produces a complementary afterimage.

3. PHYSICS:
In terms of physics, an object is said to be dark when it absorbs photons, causing it to appear dim compared to other objects. For example, a matte black paint does not reflect much visible light and appears dark, whereas white paint reflects much light and appears bright. For more information see black.

Light cannot be absorbed without limit. According to the principle of the conservation of Energy, energy cannot be created or destroyed; it can only be converted from one type to another. Consequently, most objects that absorb visible light re-emit it as heat. So, although an object may appear dark, it is likely bright at a frequency that humans cannot perceive.

4. QUANTIFICATION:
One scientific measure of darkness is the Bortle Dark-Sky Scale, which indicates the night sky's and stars' brightness at a particular location, and the observability of celestial objects at that location.

The color of a point, on a standard 24-bit computer display, is defined by three RGB (red, green, blue) values, each ranging from 0-255. When the red, green, and blue components of a pixel are fully illuminated (255,255,255), the pixel appears white; when all three components are unilluminated (0,0,0), the pixel appears black.

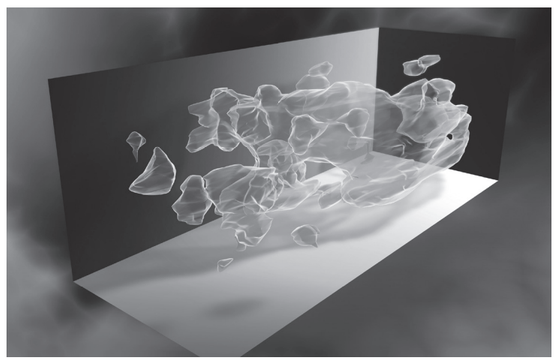
DENSITY

1. DEFINITION:
The **density**, or more precisely, the volumetric mass density, of a substance is its mass per unit volume. The symbol most often used for density is ρ (the lower case Greek letter rho). Mathematically, density is defined as mass divided by volume: ($\rho = m/V$) where ρ is the density, m is the mass, and V is the volume.

2. BACKGROUND:
For a pure substance the density has the same numerical value as its mass concentration. Different materials usually have different densities, and density may be relevant to buoyancy, purity and packaging. Osmium and iridium are the densest known elements at standard conditions for temperature and pressure but certain chemical compounds may be denser. To simplify comparisons of density across different systems of units, it is sometimes replaced by the dimensionless quantity "specific gravity" or "relative density", i.e. the ratio of the density of the material to that of a standard material, usually water. Thus a specific gravity less than one means that the substance floats in water.

The density of a material varies with temperature and pressure. This variation is typically small for solids and liquids but much greater for gases. Increasing the pressure on an object decreases the volume of the object and thus increases its density. Increasing the temperature of a substance (with a few exceptions) decreases its density by increasing its volume. In most materials, heating the bottom of a fluid results in convection of the heat from the bottom to the top, due to the decrease in the density of the heated fluid. This causes it to rise relative to more dense unheated material.


[fig. 12]


[fig. 13]


[fig. 14]

[fig. 12] Giovanni Baglione, Sacred and Profane Love, 1602
[fig. 13] Cosmos 3D dark matter map, by NASA/ESA/Richard Massey
[fig. 14] Gustave Doré, The Creation of Light

ELECTRO MAGNETIC RADIATION

1. DEFINITION:
Electromagnetic radiation (**EM radiation** or **EMR**) is one of the fundamental phenomena of electromagnetism, behaving as waves propagating through space, and also as photon particles traveling through space, carrying radiant energy.

2. BACKGROUND:
EMR is characterized by the frequency or wavelength of its wave. The electromagnetic spectrum, in order of increasing frequency and decreasing wavelength, consists of radio waves, microwaves, infrared radiation, visible light, ultraviolet radiation, X-rays and gamma rays. The eyes of various organisms sense a somewhat variable but relatively small range of frequencies of EMR called the visible spectrum or light. Higher frequencies correspond to proportionately more energy carried by each photon; for instance, a single gamma ray photon carries far more energy than a single photon of visible light.

In a vacuum, it propagates at a characteristic speed, the speed of light, normally in straight lines. EMR is emitted and absorbed by charged particles. As an electromagnetic wave, it has both electric and magnetic field components, which oscillate in a fixed relationship to one another, perpendicular to each other and perpendicular to the direction of energy and wave propagation.

Electromagnetic radiation is associated with EM fields that are free to propagate themselves without the continuing influence of the moving charges that produced them, because they have achieved sufficient distance from those charges. Thus, EMR is sometimes referred to as the far field. In this language, the *near field* refers to EM fields near the charges and current that directly produced them, as for example with simple magnets and static electricity phenomena. In EMR, the magnetic and electric fields are each induced by changes in the other type of field, thus propagating itself as a wave. This close relationship assures that both types of fields in EMR stand in phase and in a fixed ratio of intensity to each other, with maxima and nodes in each found at the same places in space.

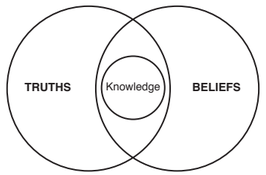
3. ENERGY:
EMR carries energy—sometimes called radiant energy—through space continuously away from the source (this is not true of the near-field part of the EM field). EMR also carries both momentum and angular momentum. These properties may all be imparted to matter with which it interacts. EMR is produced from other types of energy when created, and it is converted to other types of energy when it is destroyed. The photon is the quantum of the electromagnetic interaction, and is the basic "unit" or constituent of all forms of EMR. The quantum nature of light becomes more apparent at high frequencies (thus high photon energy). Such photons behave more like particles than lower-frequency photons do.

4. PHYSICAL PROPERTIES:
In classical physics, EMR is considered to be produced when charged particles are accelerated by forces acting on them. Electrons are responsible for emission of most EMR because they have low mass, and therefore are easily accelerated by a variety of mechanisms. Rapidly moving electrons are most sharply accelerated when they encounter a region of force, so they are responsible for producing much of the highest frequency electromagnetic radiation observed in nature. Quantum processes can also produce EMR, such as when atomic nuclei undergo gamma decay, and processes such as neutral pion decay.

THE ENLIGHTENMENT

1. DEFINITION:
The **Age of Enlightenment** (or simply the **Enlightenment** or **Age of Reason**) was a cultural movement of intellectuals beginning in the late 17th- and 18th-century Europe emphasizing reason and individualism rather than tradition.

2. BACKGROUND:
The purpose of the Enlightenment was to reform society using reason, challenge ideas grounded in tradition and faith, and advance knowledge through the scientific method. It promoted scientific thought, skepticism, and intellectual interchange. It opposed superstition and intolerance, with the Catholic Church as a favorite target. Some Enlightenment *philosophes* collaborated with Enlightened despots, who were absolute rulers who tried out some of the new governmental ideas in practice. The ideas of the Enlightenment have had a long-term major impact on the culture, politics, and governments of the Western world.



[fig. 15]

3. ORIGINS:
Originating about 1650 to 1700, it was sparked by philosophers Baruch Spinoza (1632–1677), John Locke (1632–1704), Pierre Bayle (1647–1706), Voltaire (1694–1778) and physicist Isaac Newton (1643–1727). Ruling princes often endorsed and fostered these figures and even attempted to apply their ideas of government in what was known as enlightened absolutism. The Scientific Revolution is closely tied to the Enlightenment, as its discoveries overturned many traditional concepts and introduced new perspectives on nature and man's place within it. The Enlightenment flourished until about 1790–1800, after which the emphasis on reason gave way to Romanticism's emphasis on emotion, and a Counter-Enlightenment gained force.

EPISTEMOLOGY

1. DEFINITION:
Epistemology (**/ɪsˌtiːmələdʒi/** from Greek ἐπιστήμη, epistēmē, meaning "knowledge, understanding", and λόγος, logos, meaning "study of") is the branch of philosophy concerned with the nature and scope of knowledge and is also referred to as "theory of knowledge". It questions what knowledge is and how it can be acquired, and the extent to which knowledge pertinent to any given subject or entity can be acquired.

2. BACKGROUND:
Much of the debate in this field has focused on the philosophical analysis of the nature of knowledge and how it relates to connected notions such as truth, belief, and justification.

In epistemology in general, the kind of knowledge usually discussed is propositional knowledge, also known as "knowledge that." This is distinguished from "knowledge how" and "acquaintance-knowledge." For example: in mathematics, it is known that $2 + 2 = 4$, but there is also knowing *how* to add two numbers and knowing a *person* (e.g., oneself), *place* (e.g., one's hometown), *thing* (e.g., cars), or *activity* (e.g., addition). Some philosophers think there is an important distinction between "knowing that," "knowing how," and "acquaintance-knowledge," with epistemology being primarily concerned with the first of these.

3. GETTIER PROBLEM:
Edmund Gettier is remembered for his 1963 argument the Gettier Problem, which called into question the theory of knowledge that had been dominant among philosophers for thousands of years. In a few pages, Gettier argued that there are situations in which one's belief may be justified and true, yet fail to count as knowledge. That is, Gettier contended that while justified belief in a true proposition is necessary for that proposition to be known, it is not sufficient. As in the diagram, a true proposition can be believed by an individual but still not fall within the "knowledge" category.

LIGHTNESS

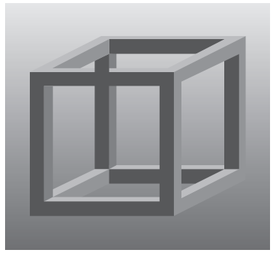
1. DEFINITION:
Lightness (sometimes called **value** or **tone**) is a property of a color, or a dimension of a color space, that is defined in a way to reflect the subjective brightness perception of a color for humans along a lightness–darkness axis.

2. BACKGROUND:
Various color models have an explicit term for this property. The Munsell color model uses the term *value*, while the HSL color model and Lab color space use the term *lightness*. The HSV model uses the term *value* a little differently: a color with a low value is nearly black, but one with a high value is the pure, fully saturated color.

In subtractive color (i.e. paints) value changes can be achieved by adding black or white to the color. However, this also reduces saturation. Chiaroscuro and Tenebrism both take advantage of dramatic contrasts of value to heighten drama in art. Artists may also employ shading, subtle manipulation of value.

This subjective perception of luminance in a non-linear fashion is one thing that makes gamma compression of images worthwhile. Beside this phenomenon there are other effects involving perception of lightness. Chromacity can affect perceived lightness as described by

[fig. 15] Propositions: Euler diagram representing a definition of knowledge, illustrating the Gettier Problem.



[fig. 16]

the Helmholtz–Kohlrausch effect. Though the CIE L*a*b* space and relatives do not account for this effect on lightness, it may be implied in the Munsell color model. Light levels may also affect perceived chromacity, as with the Purkinje effect.

NECKER CUBE

1. DEFINITION:

A **Necker cube** is an optical illusion first published as a rhomboid in 1832 by Swiss crystallographer Louis Albert Necker.

2. BACKGROUND:

The effect is interesting because each part of the picture is ambiguous by itself, yet the human visual system picks an interpretation of each part that makes the whole consistent. The Necker cube is sometimes used to test computer models of the human visual system to see whether they can arrive at consistent interpretations of the image the same way humans do.

3. EFFECT:

Humans do not usually see an inconsistent interpretation of the cube. A cube whose edges cross in an inconsistent way is an example of an impossible object, specifically an impossible cube.

With the cube above, most people see the lower-left face as being in front most of the time. This is possibly because people view objects from above, with the top side visible, far more often than from below, with the bottom visible, so the brain "prefers" the interpretation that the cube is viewed from above. Another reason behind this may be due to the brain's natural preference of viewing things from left to right, therefore seeing the leftmost square as being in front.

There is evidence that by focusing on different parts of the figure one can force a more stable perception of the cube. The intersection of the two faces that are parallel to the observer forms a rectangle, and the lines that converge on the square form a "y-junction" at the two diagonally opposite sides. If an observer focuses on the upper "y-junction" the lower left face will appear to be in front. The upper right face will appear to be in front if the eyes focus on the lower junction. Blinking while being on the second perception will probably cause you to switch to the first one.

It is possible to cause the switch to occur by focusing on different parts of the cube. If one sees the first interpretation on the right it is possible to cause a switch to the second by focusing on the base of the cube until the switch occurs to the second interpretation. Similarly, if one is viewing the second interpretation, focusing on the left side of the cube may cause a switch to the first.

4. AFFECT:

The Necker cube has shed light on the human visual system. The phenomenon has served as evidence of the human brain being a neural network with two distinct equally possible interchangeable stable states. Sidney Bradford, blind from the age of ten months but regaining his sight following an operation at age 52, did not perceive the ambiguity that normal-sighted observers do.

The Necker cube is used in epistemology (the study of knowledge) and provides a counter-attack against naïve realism. Naïve realism (also known as direct or *common-senserealism*) states that the way we perceive the world is the way the world actually is. The Necker cube seems to disprove this claim because we see one or the other of two cubes, but really, there is no cube there at all: only a two-dimensional drawing of twelve lines. We see something which is not really there, thus (allegedly) disproving naïve realism. This criticism of naïve realism supports representative realism.

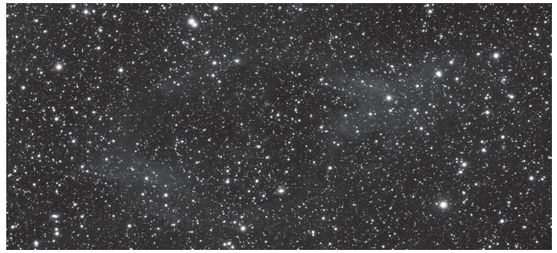
NEGATION

1. DEFINITION:

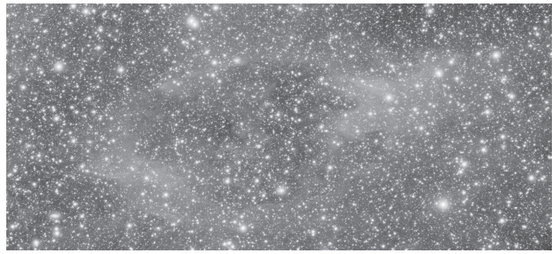
"No agreement exists as to the possibility of defining **negation**, as to its logical status, function, and meaning, as to its field of applicability... and as to the interpretation of the negative judgment." - F.H. Heinemann 1944

2. BACKGROUND:

In logic, negation, also called logical complement, is an operation that essentially takes a proposition p to another proposition "not p", written ¬p, which is interpreted intuitively as being true when p is false and false when p is true. Negation is thus a unary (single-argument) logical connective. It may be applied as an operation on propositions, truth values, or semantic values more generally. In classical logic, negation is normally identified with the truth function that takes truth to falsity and vice versa. In intuitionistic logic, according to the Brouwer–Heyting–Kolmogorov interpretation, the negation of a proposition p is the proposition whose proofs are the refutations of p.



[fig. 17]



[fig. 18]

OLBERS' PARADOX

1. DEFINITION:

Olbers' Paradox named after the German astronomer Heinrich Wilhelm Olbers (1758–1840) and also called the "dark night sky paradox", is the argument that the darkness of the night sky conflicts with the assumption of an infinite and eternal static universe.

2. BACKGROUND:

The darkness of the night sky is one of the pieces of evidence for a non-static universe such as the Big Bang model. If the universe is static and populated by an infinite number of stars, any sight line from Earth must end at the (very bright) surface of a star, so the night sky should be completely bright. This contradicts the observed darkness of the night. The paradox is that a static, infinitely old universe with an infinite number of stars distributed in an infinitely large space would be bright rather than dark. To show this, we divide the universe into a series of concentric shells, 1 light year thick. Thus, a certain number of stars will be in the shell 1,000,000,000 to 1,000,000,001 light years away. If the universe is homogeneous at a large scale, then there would be four times as many stars in a second shell between 2,000,000,000 to 2,000,000,001 light years away. However, the second shell is twice as far away, so each star in it would appear four times dimmer than the first shell. Thus the total light received from the second shell is the same as the total light received from the first shell. Thus each shell of a given thickness will produce the same net amount of light regardless of how far away it is. That is, the light of each shell adds to the total amount. Thus the more shells, the more light. And with infinitely many shells there would be a bright night sky.

Dark clouds could obstruct the light. But in that case the clouds would heat up, until they were as hot as stars, and then radiate the same amount of light. Kepler saw this as an argument for a finite observable universe, or at least for a finite number of stars. In general relativity theory, it is still possible for the paradox to hold in a finite universe: though the sky would not be infinitely bright, every point in the sky would still be like the surface of a star.

3. SOLUTIONS

Poet Edgar Allan Poe suggested that the finite size of the observable universe resolves the apparent paradox. More specifically, because the universe is finitely old and the speed of light is finite, only finitely many stars can be observed within a given volume of space visible from Earth. The density of stars within this finite volume is sufficiently low that any line of sight from Earth is unlikely to reach a star.

However, the Big Bang theory introduces a new paradox: it states that the sky was much brighter in the past, especially at the end of the recombination era, when it first became transparent. All points of the local sky at that era were brighter than the surface of the sun, due to the high temperature of the universe in that era; and most light rays will terminate not in a star but in the relic of the Big Bang.

This paradox is explained by the fact that the Big Bang theory also involves the expansion of space which can cause the energy of emitted light to be reduced via redshift. More specifically, the extreme levels of radiation from the Big Bang have been redshifted to microwave wavelengths (1100 times longer than its original wavelength) as a result of the cosmic expansion, and thus form the cosmic microwave background radiation. This explains the relatively low light densities present in most of our sky despite the assumed bright nature of the Big Bang. The redshift also affects light from distant stars and quasars, but the diminution is minor, since the most distant galaxies and quasars have redshifts of only around 5 to 8.6.

PHOTOGRAPHY

1. DEFINITION:

Photography (derived from the Greek φῶς (phos), meaning "light", and γραφή (graphê), meaning "drawing, writing", together meaning "drawing with light") is the art, science, and practice of creating durable images by recording light or other electromagnetic radiation, either chemically by means of a light-sensitive material such as photographic film, or electronically by means of an image sensor.

2. BACKGROUND:

Photography is the result of combining several technical discoveries. Chinese philosopher Mo Di and Greek mathematicians Aristotle and Euclid described a pinhole camera in the 5th and 4th centuries BCE. In the 6th century CE, Byzantine mathematician Anthemius of Tralles used a type of camera obscura in experiments, and Ibn al-Haytham (Alhazen) studied the camera obscura.

PERCEPTION

1. DEFINITION:

Perception (from the Latin *perceptio*, *percipio*) is the organization, identification, and interpretation of sensory information in order to represent and understand the environment. All perception involves signals in the nervous system, which in turn result from physical stimulation of the sense organs.

2. BACKGROUND:

Perception is not the passive receipt of sense signals, but can be shaped by learning, memory, and expectation. Perception involves these "top-down" effects as well as the "bottom-up" process of processing sensory input. The "bottom-up" processing is basically low-level information that's used to build up higher-level information (e.g., shapes for object recognition). The "top-down" processing refers to a person's concept and expectations (knowledge) that influence perception. Perception depends on complex functions of the nervous system, but subjectively seems mostly effortless because this processing happens outside conscious awareness.

3. HISTORY:

Since the rise of experimental psychology in the late 19th Century, psychology's understanding of perception has progressed by combining a variety of techniques. Psychophysics measures the effect on perception of varying the physical qualities of the input. Sensory neuroscience studies the brain mechanisms underlying perception. Perceptual systems can also be studied computationally, in terms of the information they process. Perceptual issues in philosophy include the extent to which sensory qualities such as sounds, smells or colors exist in objective reality rather than the mind of the perceiver.

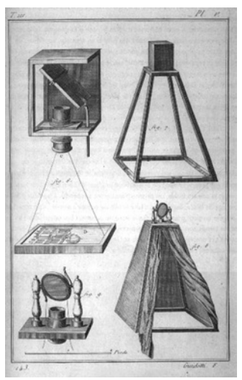
Although the senses were traditionally viewed as passive receptors, the study of illusions and ambiguous images has demonstrated that the brain's perceptual systems actively and pre-consciously attempt to make sense of their input. There is still active debate about the extent to which perception is an active process of hypothesis testing, analogous to science, or whether realistic sensory information is rich enough to make this process unnecessary.

4. PROCESS:

The perceptual systems of the brain enable individuals to see the world around them as stable, even though the sensory information may be incomplete and rapidly varying. Human and animal brains are structured in a modular way, with different areas processing different kinds of sensory information. Some of these modules take the form of sensory maps, mapping some aspect of the world across part of the brain's surface. These different modules are interconnected and influence each other. For instance, a taste is strongly influenced by its corresponding odor.

The process of perception begins with an object in the real world, termed the *distal stimulus* or *distal object*. By means of light, sound or another physical process, the object stimulates the body's sensory organs. These sensory organs transform the input energy into neural activity—a process called *transduction*. This raw pattern of neural activity is called the proximal stimulus. These neural signals are transmitted to the brain and processed. The resulting mental re-creation of the distal stimulus is the percept. Perception is sometimes described as the process of constructing mental representations of distal stimuli using the information available in *proximal stimuli*.

An example would be a person looking at a shoe. The shoe itself is the distal stimulus. When light from the shoe enters a person's eye and stimulates their retina, that stimulation is the proximal stimulus. The image of the shoe reconstructed by the brain of the person is the percept. Another example would be a telephone ringing. The ringing of the telephone is the distal stimulus. The sound stimulating a person's auditory receptors is the proximal stimulus, and the brain's interpretation of this as the ringing of a telephone is the percept.



[fig. 19]



[fig. 20]

PHOTON

1. DEFINITION:

A **photon** is an elementary particle, the quantum of light and all other forms of electromagnetic radiation, and the force carrier for the electromagnetic force, even when static via virtual photons. Like all elementary particles, photons are currently best explained by quantum mechanics and exhibit wave–particle duality, exhibiting properties of both waves and particles. For example, a single photon may be refracted by a lens or exhibit wave interference with itself, but also act as a particle giving a definite result when its position is measured.

2. BACKGROUND:

The modern photon concept was developed gradually by Albert Einstein to explain experimental

[fig. 16] Illustration of a Necker Cube
[fig. 17] Artists rendering of the ultra deep field.
[fig. 18] Artist rendering of the ultra deep field as understood by Olber's Paradox.

[fig. 19] Illustration of a Camera Obscura by Jean le Rond d'Alembert, 1751
[fig. 20] A military scientist operates a laser in a test environment, photo by US Air Force



[fig. 21]



[fig. 22]

observations that did not fit the classical wave model of light. In particular, the photon model accounted for the frequency dependence of light's energy, and explained the ability of matter and radiation to be in thermal equilibrium. It also accounted for anomalous observations, including the properties of black body radiation, that other physicists, most notably Max Planck, had sought to explain using *semiclassical models*, in which light is still described by Maxwell's equations, but the material objects that emit and absorb light do so in amounts of energy that are *quantized* (i.e., they change energy only by certain particular discrete amounts and cannot change energy in any arbitrary way). Although these semiclassical models contributed to the development of quantum mechanics, many further experiments starting with Compton scattering of single photons by electrons, first observed in 1923, validated Einstein's hypothesis that *light itself* is quantized. In 1926 the chemist Gilbert N. Lewis coined the name *photon* for these particles, and after 1927, when Arthur H. Compton won the Nobel Prize for his scattering studies, most scientists accepted the validity that quanta of light have an independent existence, and Lewis' term *photon* for light quanta was accepted.

RELATIONALISM

1. DEFINITION:

Relationalism is any theoretical position that gives importance to the relational nature of things. For relationalism, things exist and function only as relational entities. Relationalism may be contrasted with relationism, which tends to emphasize relations per se.

2. BACKGROUND:

Relationalism in a broader sense applies to any system of thought that gives importance to the relational nature of reality. But in its narrower and philosophically restricted sense as propounded by the Indian philosopher Joseph Kaipayil and others, relationalism refers to the theory of reality that interprets the existence, nature, and meaning of things in terms of their relationality or relatedness. On the relationalist view, things are neither self-standing entities nor vague events but relational particulars. Particulars are inherently relational, as they are ontologically open to other particulars in their constitution and action. Particulars, as relational particulars, are the ultimate constituents of reality. Particulars interact and make the very fabric of reality.

In discussions about space and time, the name relationalism (more appropriately called relationism) refers to Leibniz's relationist notion of space and time as against Newton's substantivalist views. According to Newton's substantivalism, space and time are entities in their own right, existing independently of things. Leibniz's relationism, on the other hand, describes space and time as systems of relations that exist between objects.

ROMANTICISM

1. DEFINITION:

Romanticism (also the **Romantic era** or the **Romantic period**) was an artistic, literary, and intellectual movement that originated in Europe toward the end of the 18th century and in most areas was at its peak in the approximate period from 1800 to 1850. Partly a reaction to the Industrial Revolution, it was also a revolt against the aristocratic social and political norms of the Age of Enlightenment and a reaction against the scientific rationalization of nature.

2. BACKGROUND:

Romanticism was embodied most strongly in the visual arts, music, and literature, but had a major impact on historiography, education and the natural sciences. Its effect on politics was considerable and complex; while for much of the peak Romantic period it was associated with liberalism and radicalism, in the long term its effect on the growth of nationalism was probably more significant.

The movement validated strong emotion as an authentic source of aesthetic experience, placing new emphasis on such emotions as apprehension, horror and terror, and awe—especially that which is experienced in confronting the sublimity of untamed nature and its picturesque qualities, both new aesthetic categories. It elevated folk art and ancient custom to something noble, made spontaneity a desirable characteristic (as in the musical impromptu), and argued for a "natural" epistemology of human activities as conditioned by nature in the form of language and customary usage. Romanticism reached beyond the rational and Classicist ideal models to elevate a revived medievalism and elements of art and narrative perceived to be authentically medieval in an attempt to escape the confines of population growth, urban sprawl, and industrialism, and it also attempted to embrace the exotic, unfamiliar, and distant in modes more authentic than Rococo *chinoiserie*, harnessing the power of the imagination to envision and to escape.

Although the movement was rooted in the German *Sturm und Drang* movement, which prized intuition and emotion over Enlightenment rationalism, the ideologies and events of the French Revolution laid the background from which both Romanticism and the Counter-Enlightenment emerged. The confines of the Industrial Revolution also had their influence on Romanticism, which was in part an escape from modern realities; indeed, in the second half of the 19th century, "Realism" was offered as a polarized opposite to Romanticism. Romanticism elevated the achievements of what it perceived as heroic individualists and artists, whose pioneering examples would elevate society. It also legitimized the individual imagination as a critical authority, which permitted freedom from classical notions of form in art. There was a strong recourse to historical and natural inevitability, a *zeitgeist*, in the representation of its ideas.

SCANNING ELECTRON MICROSCOPE

1. DEFINITION:

A **scanning electron microscope** (**SEM**) is a type of electron microscope that produces images of a sample by scanning it with a focused beam of electrons. The electrons interact with atoms in the sample, producing various signals that can be detected and that contain information about the sample's surface topography and composition.

2. BACKGROUND:

The electron beam is generally scanned in a raster scan pattern, and the beam's position is combined with the detected signal to produce an image. SEM can achieve resolution better than 1 nanometer. Specimens can be observed in high vacuum, in low vacuum, and (in environmental SEM) in wet conditions.

The most common mode of detection is by secondary electrons emitted by atoms excited by the electron beam. The number of secondary electrons is a function of the angle between the surface and the beam. On a flat surface, the plume of secondary electrons is mostly contained by the sample, but on a tilted surface, the plume is partially exposed and more electrons are emitted. By scanning the sample and detecting the secondary electrons, an image displaying the tilt of the surface is created.

SUBLIME

1. DEFINITION

In aesthetics, the **sublime** (from the Latin sublīmis) is the quality of greatness, whether physical, moral, intellectual, metaphysical, aesthetic, spiritual or artistic. The term especially refers to a greatness beyond all possibility of calculation, measurement or imitation.

2. BACKGROUND

Edmund Burke's concept of the sublime was developed in *A Philosophical Enquiry into the Origin of Our Ideas of the Sublime and Beautiful* (1756). Burke was the first philosopher to argue that the sublime and the beautiful are mutually exclusive. The dichotomy is not as simple as Dennis' opposition, but antithetical to the same degree as light and darkness. Beauty may be accentuated by light, but either intense light or darkness (the absence of light) is sublime to the degree that it can obliterate the sight of an object. The imagination is moved to awe and instilled with a degree of horror by what is "dark, uncertain, and confused." While the relationship of the sublime and the beautiful is one of mutual exclusiveness, either one can produce pleasure. The sublime may inspire horror, but one receives pleasure in knowing that the perception is a fiction.

VISIBLE LIGHT

1. DEFINITION:

Visible light (commonly referred to simply as **light**) is electromagnetic radiation that is visible to the human eye, and is responsible for the sense of sight.

2. BACKGROUND:

Visible light is usually defined as having a wavelength in the range of 400 nanometres (nm or 1×10−9 m), to 700 nanometres – between the infrared, with longer wavelengths and the ultraviolet, with shorter wavelengths. These numbers do not represent the absolute limits of human vision, but the approximate range within which most people can see reasonably well under most circumstances. Various sources define visible light as narrowly as 420 to 680 nm to as broadly as 380 to 800 nm. Under ideal laboratory conditions, people can see infrared up to at least 1050 nm, children and young adults ultraviolet down to about 310 to 313 nm.

Primary properties of visible light are intensity, propagation direction, frequency or wavelength spectrum, and polarization, while its speed in a vacuum, 299,792,458 meters per second, is one of the fundamental constants of nature. Visible light, as with all types of electromagnetic radiation (EMR), is experimentally found to always move at this speed in vacuum.

In common with all types of EMR, visible light is emitted and absorbed in tiny "packets" called photons, and exhibits properties of both waves and particles. This property is referred to as the wave–particle duality. The study of light, known as optics, is an important research area in modern physics.

In physics, the term *light* sometimes refers to electromagnetic radiation of any wavelength, whether visible or not.

ULTRAVIOLET CATASTROPHE

1. DEFINITION:

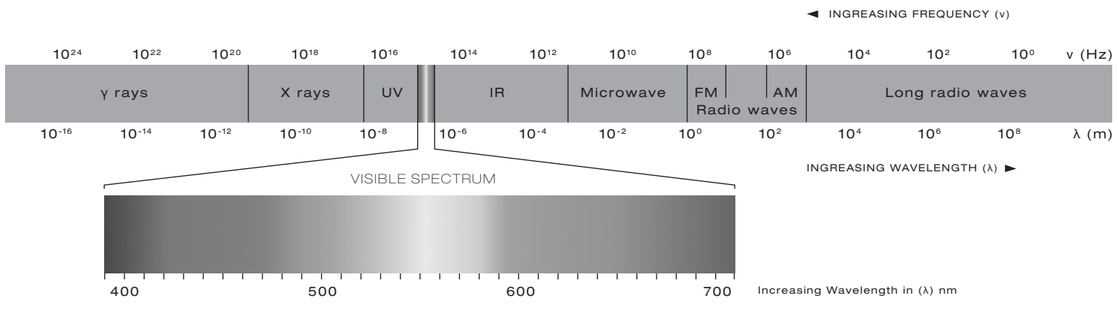
Ultraviolet catastrophe, also called the Rayleigh–Jeans catastrophe, was a prediction of late 19th century/early 20th century classical physics that an ideal black body at thermal equilibrium will emit radiation with infinite power.

2. BACKGROUND:

The term "ultraviolet catastrophe" was first used in 1911 by Paul Ehrenfest, although the concept goes back to 1900 with the first derivation of the λ^{-4} dependence of the Rayleigh–Jeans law; the word "ultraviolet" refers to the fact that the problem appears in the short wavelength region of the electromagnetic spectrum. Since the first appearance of the term, it has also been used for other predictions of a similar nature, as in quantum electrodynamics and such cases as ultraviolet divergence.

3. SOLUTION:

Max Planck solved the problem by postulating that electromagnetic energy did not follow the classical description, but could only be emitted in discrete packets of energy proportional to the frequency, as given by Planck's law. This has the effect of reducing the number of possible excited modes with a given frequency in the black body described above, and thus the average energy at those frequencies. The radiated power eventually goes to zero at infinite frequencies, and the total predicted power is finite. The formula for the radiated power for the idealized system (black body) was in line with known experiments, and came to be called Planck's law of black body radiation. Based on past experiments, Planck was also able to determine the value of its parameter, now called Planck's constant. The packets of energy later came to be called photons, and played a key role in the quantum description of electromagnetism. This therefore implies that the radiated power per unit frequency should follow the Rayleigh–Jeans law, and be proportional to frequency squared. Thus, both the power at a given frequency and the total radiated power is unlimited as higher and higher frequencies are considered.



[ilustration] Electromagnetic spectrum, expanded section represents visible light.

[fig. 21] Thomas Cole, The Savage State, 1836
[fig. 22] Tunnel of the Large Hydron Collider (LHC) of the European Organization for Nuclear Research, known as CERN, photo by Julian Herzog

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