

1 Out of the Blue

A mystery must emerge before it can be solved. Thousands of years may have passed before someone wondered about the sky's color. Questions tend to accumulate more around unfamiliar, strange happenings than around the everyday and ordinary. Yet unasked questions also point to fundamental beliefs and prohibitions.

Though their civilizations were very different, both ancient Greece and China tended not to speak about the sky's color. In the ancient Chinese *Book of Songs (Shi Jing)*, the phrase *cang tian* denotes vast or azure heaven, the overarching and immense vault of the sky and by implication the Power ruling it. The songs address the sky with yearning, calling to a realm far above human suffering, as in this lament over the old capital of the state of Zhou and the king who lost it:

Blue Heaven far, far above me,
What kind of man is he?¹

Here, the impassive remoteness of the blue sky contrasts with human suffering and loneliness.

For the ancient Greeks and Chinese, azure had distinctly inhuman connotations, because death changes the healthy red

color of the body to an unearthly blue, cyanosis. At Fengdu, in the main gorge of the Yangzi river, stands a temple reputed by Taoist tradition to be the gate of Hell, the entrance to the after-life that must be traversed by dead souls.² The gates are painted a garish sky blue, not to be touched by the living, at peril of premature death. In contrast, yellow was the imperial color, reserved for the emperor's use, and red the color of life and celebration, used even today for marriages. Yet in India the divinities were often portrayed with dark blue skins and the poet Kālidāsa celebrated a sky "as dark blue as a sword."³

Purple was the imperial color of Rome, but blue was definitely the color of the barbarians. The ancient Britons dyed their bodies blue, a frightening sight to enemies who associated this color with death; the Roman historian Tacitus described the blue-daubed Britons' "spectral army." British women injected blue dye beneath the skin. In contrast, the Romans wore blue to denote mourning and considered blue eyes a kind of deformity, a sign of bad character, a barbarian trait.⁴ Likewise, in the Qur'an demons have blue eyes, denoting their evil, infidel nature. According to the twelfth-century Persian poet Farid ud-din Muhammad Attar, "heaven bears the blue color of sorrow as a sign of mourning that it has not attained the goal of its search to know the essence of God."⁵

For the ancients, the heavenly realm was divine. Because of its superlative power, the sacred could be dangerous, hence better left unuttered. If so, it would be better not to name the sky's color or touch its alien power. Recounting the Greek creation stories, Hesiod tells that Sky (*Ouranos*) was the first child of Earth, "equal in size with herself, to cover her on all sides."⁶ The poet Aeschylus tells that "pure sky [*Ouranos*] desires to penetrate the earth, and the earth is filled with love so that she longs

for blissful union with the sky. The rain falling from the beautiful sky impregnates the earth, so that she give birth to plants and grain for beasts and men."⁷ Among the descendants of this primal union was the high god Zeus, dwelling in the sky with the other Olympian gods. The deities identified with the earth stood apart from those of the sky.

Even now, *heaven* connotes a divine realm radically different from earth, whereas *sky* is a more neutral term. Modern science turned *heaven* into *sky* and then *atmosphere*. Yet we continue to refer to "the heavens," showing how deeply rooted is the ancient conception. The Greeks contrasted the heavens, *ouranos*, with what they called *physis*, a realm of growth and change extending between the earth and the moon. Our word "physics" typically refers to inanimate matter, but the Greek word *phyein* means to grow and change as living organisms do. Though we moderns characteristically think of the earth as just another planet in space, the Greek words *ouranos* and *physis* indicated utterly different realms. Of the two, *ouranos* was nobler, the realm of celestial, immortal bodies. *Physis* is the mortal realm where we are born, grow, and die.

Among the earliest Greek thinkers, Parmenides gave visionary form to the search to discern something constant and unchanging behind the manifold flux of the world. In his poem, an unnamed goddess sets forth the quest on which we now embark:

Gaze steadfastly at things which, though far away, are yet present to the mind. . . . On the one hand, there is the fire of the upper sky [*aether*], gentle, rarefied, and everywhere identical with itself; on the other hand, there lies opposed to it utter darkness, dense and heavy. . . . You shall come to know the nature of the sky [*aether*], and the signs of the sky, and the unseen works of the pure bright torch of the sun and how they

came into being. . . . You shall know also the encompassing heaven [*ouranos*], whence it arose, and how Necessity grasped and chained it so as to fix the limits of the stars.⁸

Since the heavens transcend terrestrial phenomena, special words describe their substance, as opposed to the air we see around us. *Aether* literally means ever-running or ever-blazing, characterizing the ceaseless radiance of the celestial realm. Where *ouranos* denotes deep heaven and *aēr* the lower air, close to the earth, aether is the upper realm of the atmosphere, the domain of clouds and of Zeus. Thus, one of the Golden Verses of the Pythagorean brotherhood tells that “when after divesting yourself of your mortal body you arrive in the pure upper aether, you will be a god, an immortal, incorruptible; and death shall have no dominion over you.” The Sicilian Empedocles thought that the human soul is a mixture of air and aether, a blend of earth and heaven. He also thought that the aether “is formed by air being congealed by fire into crystalline form,” as the lower air comes into contact with higher celestial fires.⁹

Others thought aether might be a kind of fire, for the sky shows bewilderingly many colors and appearances—the fiery colors of dusk, rainbows, all the varieties of clouds. It is not clear that the blue color has some special status or importance as *the* color of the sky. The Old Norse *ský* (whence the Middle English *skie*) meant clouds, only later including the rest of the atmosphere by association.

Thus, there are many reasons why the sky’s color might not seem an important question, or why we should not try to classify it according to our common colors. There are so few color words in ancient Greek that British statesman W. E. Gladstone speculated that the Greeks were color-blind. Later scholars did not sustain this whimsical conjecture. Instead, they note that

Greek color words seem more concerned with feeling, with richness or saturation, where ours emphasize hue.¹⁰

Consider the specific words the Greeks used to denote blue colors. For instance, Homer uses the word *glaukos* to describe the sea and the eyes of Athena. This word might indicate the color grayish-blue, but some scholars think that it describes a bright, gleaming quality, rather than a color. It may denote the glint of light off the sea or the shining eyes of the goddess.

Indeed, the nineteenth-century art historian John Ruskin thought that Athena was “the Queen of the Air” who (among her many aspects) represented the sky itself in her blue eyes and the blue aegis or mantle she wore. According to Ruskin, her “crested and unstooping” helmet represents “the highest light of aether”; her maidenhood represents the stainless purity of the clear blue sky. Ruskin considers this sky neither distant nor merely material, for “whenever you throw your window wide open in the morning, you let in Athena, as wisdom and fresh air in the same instant; and whenever you draw a pure, long, full breath of right heaven, you take Athena into your heart, through your blood; and, with the blood, into the thoughts of your brain.” In his conception, the blue sky as Athena is the source of human vitality and wisdom itself.¹¹

Ruskin goes beyond the letter of Greek myths in order to touch what he thought was their unspoken spirit. His eloquent interpretations still leave us struggling with basic questions about the meaning of the simplest words, including those for color. The Greek word *kyanos* comes closest to our dark blue and is the origin of terms like cyan, cyanosis, cyanide, and Latin derivatives like cerulean. The Greeks used this word to refer to the blue of lapis lazuli, a precious stone from Egypt, Scythia, and Cyprus, now mined mostly in Afghanistan. The color *kyanos*

also came to mean a dark hue, as in the blue highlights of raven-black hair.

In all these cases, the color blue refers to earthly objects and conveys a certain sense of the uncanny. Homer depicts the terrifying shield of the great chieftain Agamemnon as decorated with blue rings and snakes, bearing

at the heart a boss of bulging blue steel
and there like a crown the Gorgon's grim mask—
the burning eyes, the stark, transfixing horror—
and round her strode the shapes of Fear and Terror.¹²

Homer uses this same word *kyanos* to describe the menacing prows of warships, a dark cloud of Trojans, the blackness that engulfs the dying, or the dark brows of Zeus. Occasionally, he applies this word to rare and beautiful objects, such as the blue enamel legs of a table in the tent of Nestor, the venerable statesman.¹³ In the *Odyssey*, Homer describes “a circling frieze glazed as blue as lapis” in the fabulous palace of Alcinous, king of the godlike Phaiacians.¹⁴ Yet their blueness gives even these peaceful objects an uncanny aura. Homer may have had in mind the amazing blue friezes that adorned the Minoan palace at Knossos, the wonder of his world, site of the labyrinth and seat of ancient kings. Whether terrifying or richly rare, this intense blue stood outside the ordinary, never applied to ordinary objects. Notably, the adjective *kyanos* was not used to describe the sky.

Even later Greek authors do not discuss its color. This seems to indicate that either they had not noticed this as an unanswered question, or that the very terms “sky” and “color” did not seem compatible for them. Asking about the color of the sky might confuse earthly color with the altogether different appearances of the heavens. This is not a question of blasphemy against the superhuman powers of the sky, but of insisting on

what seemed completely natural distinctions. How can we speak about the color of a feather in the same way as the color of the sky?

The early Greek thinkers tended to confine themselves to the colors of earthly objects. For instance, Plato speculated that “white and bright meeting, and falling upon a full black, become dark blue [*kyanos*], and when dark blue mixes with white, a light blue [*glaukos*] color is formed.”¹⁵ This account of sky blue as a mixture of brightness and darkness I shall call the *darkness theory*. Yet Plato noted that “God only has the knowledge and also the power which is able to combine many things into one and again resolve the one into many. But no man either is or ever will be able to accomplish either.” If so, probing into the hidden nature of color is beyond human power.

But setting aside the ultimate nature of color and light still leaves the question of vision. Two opposed possibilities soon emerged. In one, the eye is active and emits rays that touch the object. In the other, the eye is a passive receptor of rays coming into it from objects. The ancient Greeks considered both seriously.

Plato favored the active view. He depicted the eye as containing a gentle fire that streams outward through the pupil and contacts the outer fire of daylight. Then these inner and outer fires coalesce to form a stream that then can contact an object, producing the sensation of sight, as if a thread of perception flows back into the eye. At night, the visual stream from the eye does not encounter a kindred fire outside and hence is quenched, cut off.¹⁶ Similarly, Euclid and Ptolemy based their mathematical optics on the geometry of rays emerging from the eye. As late as 1280, John Pecham interpreted this to mean that these rays then return to the eyes “as messengers,” rather like

radar.¹⁷ Lest all this seem too primitive, it is worth remembering that modern studies of vision have emphasized how active the eye is in visual processing, especially in its complex scanning motions. And we still speak of feeling a hard stare or looking daggers, as if they really emerged from the eye. The active quality of *seeing* is crucial to human vision, particularly in the visual arts. Indeed, the Latin word *lux* means light that is actually perceived, as opposed to the illuminating source, *lumen*. Thus, when God initially said “Let there be light (*Fiat lux*),” He was not creating a source of light (the sun was only created on the fourth day) but calling forth light as the primal act of *seeing*.¹⁸

The passive view began with Empedocles, who thought that all objects constantly send out effluences or little films, which then are received by the eyes.¹⁹ This view was taken up by the early Greek atomists, who interpreted the films as atoms coming from the surfaces of bodies. Their Roman disciple, the poet Lucretius, explained vision as the reception of *eidola*, meaning “little images,” which make up “a sort of outer skin perpetually peeled off the surface of objects and flying about this way and that through the air.”²⁰

Whether we follow the active or the passive account of vision, it is hard to understand the appearance of the sky. If vision involves a ray from the eye meeting the object, what is the object seen in the sky? At the very least, it is not like any object seen on earth. A similar difficulty plagues the passive view: from what object come the “little images” of the sky? And how does the eye then make sense of them?

Plato’s student, Aristotle, continued the dialogue about these views. On one hand, Aristotle was critical of those whom he

calls “the ancients.” He rejected as irrational the notion that vision results from rays issuing from the eyes, for then “why should the eye not have had the power of seeing even in the dark?”²¹ Clearly, he was not persuaded by Plato’s attempt to have the inner fire meet the outer. On the other hand, Aristotle also rejected what he calls the “absurd” theory that colors are emanations from objects, since it neglects the role of the eye in vision.

Rather than making the eye purely active or passive, only sending out rays or only receiving them, Aristotle concentrated on what lies *between* object and eye.²² Light itself is a state of activity, “the activity of what is transparent,” of the in-between medium, when it is excited by the mutual influence of the object and the eye. Here, his word for activity is *energeia*, the vivid intercourse with the world that he calls “soul.” In a powerful metaphor, he called on eating as the primal function of soul, whether in the literal chewing and digestion of food or the more subtle act of consuming involved in vision or hearing. In each case, the soul takes in something from the outside world and transforms it into itself. Mysteriously, I consume and destroy my lunch, which seems so utterly unlike my body, yet which can be incorporated into me. Similarly, through sight I take in objects outside me, somehow assimilating their alien being into *my* seeing. As I see an external object, it is now somehow *inside* me, if not literally, at least in some sense.

In both cases, Aristotle also judged that this profound transformation of the alien into myself occurs through the mediation of a transparent zone *between* the inner and outer world. He thought that seemingly empty space is really the venue in which what we call color and light emerge, as that space is more

or less energized through the influence of the object seen. In this, Aristotle may have anticipated the concept of light as a *field* that emerged fully in the nineteenth century in the work of Michael Faraday and James Clerk Maxwell.²³

Aristotle did not consider that his theory could be given mathematical form, because he judged that the unchanging forms of mathematics cannot describe the changing physical world or the dynamics of the soul. Yet he did apply his ideas to physical phenomena qualitatively. His treatise called *Meteorologica* was the beginning of meteorology, from *meteora*, meaning high, raised up, sublime, hence elevated natural phenomena. In this treatise Aristotle considered the causes of wind, rain, lightning, thunder, as well as of earthquakes, comets, and what we call meteors. He also devoted considerable attention to the rainbow, explaining it as reflection from small drops of water. These extraordinary or variable phenomena drew his attention, but the blue sky itself did not.²⁴

Nevertheless, among the works traditionally attributed to Aristotle is a short treatise *On Colors*, though probably written by one of his students. In that work, the question about the sky's color seems to emerge for the first time. The author begins with the assumption that "water and air, in themselves, are by nature white," but notes also that "water and air look black when present in very deep masses."²⁵ He begins to connect this with other phenomena in the sky, such as its purple color at sunrise or sunset, which he attributes to a blending of feeble sunlight with thin, dusky white. In general,

we never see a color in absolute purity: it is always blended, if not with another color, then with rays of light or with shadows, and so it assumes a tint other than its own. . . . Thus all hues represent a threefold mixture of light, a translucent medium (e.g., water or air), and underlying colors

from which the light is reflected. . . . Air seen close at hand appears to have no color, for it is so rare that it yields and gives passage to the denser rays of light, which thus shine through it; but when seen in a deep mass it looks practically dark blue.²⁶

Thus, the sky is blue because it lets through the surrounding darkness, a notion close to Plato's idea that I have called the darkness theory. Aristotle's student finds confirmation in the deepening blue of the sky at nightfall, "for where light fails, the air lets darkness through and looks dark blue," though air, by itself, is "the whitest of things."

Though much about this explanation will later be criticized and revised, it makes several crucial steps. First, this is the earliest text that recognizes that there *is* a question, that the blueness of the sky needs explanation. This is no small matter, for an unasked question finds no answer. Second, this account attributes the color of the sky to the interaction between the air and outside influences, as opposed to attributing the color to bodies floating in the air, but not the air itself. This powerful assertion will remain in doubt for almost two thousand years.

Aristotle himself would probably have found his student's explanation puzzling, if not contradictory. Aristotle had argued that darkness was not the *presence* of something, but the *absence* of light. This follows from his basic concept that light is a state of energized activity of a medium, so that darkness is the lack of that activity. How, then, can the outer darkness shine through the atmosphere? Also, the air seems passive, almost irrelevant, in this explanation, which puts the onus on a paradoxically potent darkness.

In this way, Aristotle and his student came close to identifying the sky's blue with the interaction of light with air. Their hesitation is understandable, for if air is truly transparent, it is

hard to understand why it turns *blue*, rather than some other color. Hence, they needed the darkness of the night sky to mix with the white of the air. Indeed, Aristotle himself had speculated that what we call the different colors are really formed by various mixtures of minute quantities of black and white, perhaps arranged in simple ratios like 3:2, such as characterize the consonant intervals of music. This ingenious theory goes below the threshold of visible size to provide what we would call a microscopic basis for color, one that would explain the properties of the light-bearing medium. In hindsight, his musical theory of black and white building blocks may seem a kind of atomic theory.²⁷

However, Aristotle definitely rejected the idea of atoms flying around in the void, which particularly troubled him. How can *nothingness* exist without paradox and contradiction? How can nonexistence exist? Instead, he argued that the cosmos is continuous and cannot have any void spaces. If so, there are no fundamental microscopic structures whose size or properties might explain the sky's blueness.

The surviving writings of the earliest Greek atomists are too fragmentary for us to know whether they puzzled over this question or had developed their theory enough to address it. The earliest of them, Leucippus, wrote two centuries before Aristotle and left only one fragment: "Nothing happens at random; whatever comes about is by rational necessity," presumably because of atoms in motion.²⁸ If so, surely the appearance of the sky also comes about through atoms. Lucretius sang of atomic theory as a remedy for human fear and superstition. He took particular care to show that "the sky in all its zones is mortal," demystifying the realm of Zeus and dissolving his thunderbolts into atoms. Lucretius is one of the few ancient

authors who refer explicitly to “the blue expanses of heaven” as he explains different clouds through their underlying atoms.²⁹

Yet Lucretius did not address the cause of the sky’s color (though he wondered why thunder could come out of a blue sky) and his explanations of thunder and lightning as clashing atoms remained quite schematic. To gain explanatory power, the atomic hypothesis required deep transformation. Even so, it proved to be crucial.