# The Moon & the Western Imagination

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*To Kyle and Cameron,*
*without whom the heavens would be empty*

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Thou shalt draw down the Moon from heaven . . .
For whilst thou seest the lunar disc display
Such rocks and ocean depths unfathomable,
What powers prevent thy sight of worlds celestial
From tracing all their semblance to this earth?

Jeremiah Horrox, "The Transit of Venus," 1640

Aye, pardon us, O moon,
Round, bright upon the darkening!
Pardon us our little journeys endlessly repeated!

William Carlos Williams, "A la lune," 1914

# 4

# The Moon and Medieval Science

## Text and Images before the Twelfth Century

### THE MOON AND THE SEVEN LIBERAL ARTS

In the last years of the Roman Empire, and thus at the brink of the Middle Ages in Europe, several works involving astronomical subjects were written that set the course of knowledge in this area for eight hundred years. Ptolemy's writings were not among them, nor were those of Hipparchus, Archimedes, or Plutarch. Nearly the whole of Hellenistic physical science slipped beyond the reach of what is commonly called "the West." The Romans had found little use for its astronomy, with its difficult, mathematically demanding thought. Their taste was for a more simplified, descriptive portrait of the heavens that could be used in weather prediction, calendar making, and astrology. The texts of Greek science journeyed eastward, first to Byzantium, and then, under pressure of persecution, to Syria in the caring hands of Nestorian and Monophysite Christians, finally to rest in the appreciative libraries of Islam.[1]

Early medieval astronomy among the Latins, meanwhile, was derived from several major texts. These works mainly dealt with planetary movements or with more general celestial (stellar and planetary) phenomena. The first group included three texts in particular: *Commentary on the Dream of Scipio* by Macrobius (fourth century A.D.), *Commentary on Plato's Timaeus* by Calcidius (fourth century A.D.), and most importantly, *The Marriage of Philology and Mercury* by Martianus Capella (late fifth century A.D.). Celestial astronomy was represented by Pliny and Aratus, whose works were discussed in earlier chapters.[2] If we think in terms of the "liberal arts" and the importance they acquired since the Carolingian era, the most influential work would have to be the brief encyclopedic handbook, *The Marriage of Philology and Mercury.* This book was written in a mixture of styles only a decade or so after the final collapse of Rome, a context that adds a touch of irony to the literary qualities and intent of this work, proposing as it does a flowery celebration of knowledge and its assumption to the heights of heaven.[3] Writing at the threshold of the Dark Ages, Martianus holds forth on the seven *artes*—grammar, dialectic, rhetoric, geometry, arithmetic, harmony (music), and astronomy—as if the gates to final wisdom and the path to divinity had finally opened.

*The Marriage of Philology and Mercury* is divided into two basic parts. There is an allegorical prologue announcing the wedding of the god Mercury (eloquence) to the maiden Philologia (learning), whose seven slave attendants introduce themselves in the second part through speeches that summarize their respective "art." In contrast to the exaggerated, baroque language of the first two books announcing the marriage, each of the following speeches is a concise, straightforward epitome of its subject. In the case of astronomy (book VIII), for example, scholars agree that Martianus's treatment represents "the most orderly and comprehensive treatment of the subject by any Latin manuscript extant."[4] It presents a discussion of the planets and fixed stars, the ecliptic, constellations, and eclipses, focusing above all upon celestial motion. This is obviously the legacy of Greek mathematical astronomy reduced to textual description. Martianus, however, has not a word to say about the substance or nature of any of the planets, only their geometric movements.

In the allegorical prologue, another type of astronomy can be found:

> Then the bearers picked up [Philology's] palanquin and with great effort carried her aloft. Borne up by their buoyancy they rose

126,000 stades, and completed the first of the celestial tonal intervals; then the maiden entered the circle of the Moon, and in those vapors suitable to a goddess . . . she saw a soft spherical body composed with the smoothness of dew from heaven, reflecting, like a gleaming mirror, the rays of light that fell upon it. In it there appeared the sistra of Egypt, the lamp of Eleusis, Diana's bow, and the tambours of Cybele. Changing in color, and threefold in form during its cycle, it shone with awesome majesty. Although it was thought to be horned and rough, yet when it emptied itself it showed, according to its season, a cat or a stag, or any of four appearances.[5]

In a few short sentences, Martianus evokes an entire tradition of lunar imagery lying outside the writings of poets, astronomers, and popularizers and mixes it with one of the most ancient conventions of all (femininity, moistness). In the face of the Moon itself, he tells us, there are several appearances that resemble animals, objects, even musical instruments. The sistra (a curved metal rattle used at Egyptian festivals), a lamp or bow, the tambour (a type of drum), a cat, and a stag can all be seen in the patterns of light and shade on the lunar surface. Such visions hail from prominent mystery cults in Egypt, Babylonia, Greece, and Rome,[6] in particular those associated with Isis, Cybele, Ceres, and Diana, and had probably evolved into popular folklore by the time Martianus wrote of them.

Until now, the discussion has not included these types of lunar images because they were not mentioned by the Greek philosophers or astronomers, including Plutarch, at least not in the writings that survive. These images reveal a high degree of close observation of the Moon's surface appearance. The figure in the Moon was given other aliases during antiquity and the early Middle Ages. Folklore records not only the cat and stag but also a rabbit, a reclining woman or girl, and a pair of young children with a pole lodged between them.[7] Astrologers claimed the ability to divine future events, particularly those concerning weather, pregnancy, and mental condition, by noting the exact positions of dark and light on the lunar surface (positions, of course, that never changed). "Scrying" the Moon, as it was called, even included reading earthly happenings by the figure that appeared in a reflection of the lunar face on a pond, stream, or lake.

None of these images or aspects of the lunar imagination, as visual as they are, appear to have been recorded in the artistic works that remain from late antiquity or the medieval period. One reason for this may have been the unwillingness to portray a body ripe with omen and magic for fear of ill effect or reprisal. The question, however, still remains: What types of drawings of the Moon *did* exist during the Middle Ages, and what do they indicate about the history of observation and the development of scientific illustration?

## FIGURES DRAWN: THE PAINTINGS AT DURA AND EARLY SYRIAC GOSPELS

Some of the very earliest painted images of the Moon that remain in existence, apart from allegorical works depicting Selene and Luna, appear in illustrated literary texts of the fifth century A.D. Possibly the oldest of these manuscripts is the *Vergilius Vaticanus,* an illuminated version of the Aeneid that includes a scene of the sack of Troy, showing in brilliant color the city walls, Trojan Horse, attacking Greeks, and in the background, a ship pulled up on the shore beneath a crescent Moon and several gilded stars.[8] Inclusion of the Moon appears to have been done simply for the sake of background and suggests that such use was common or at least well established.

Within Jewish and early Christian society, on the other hand, the lunar orb took on iconic uses, with the oldest known images appearing in sixth-century religious art of the Near East. Perhaps the most striking example is included among the magnificent wall paintings at the Dura synagogue in southern Israel, preserved by a particular, if tragic, set of circumstances. Dura was a small Roman military outpost along the eastern margins of the empire. About A.D. 256, this largely Jewish settlement was attacked and destroyed by an advancing Persian army. In a desperate attempt to stave off the inevitable, the inhabitants shored up the weakest wall of the town by filling with earth the buildings lined alongside it, including the synagogue with its newly painted interior. The attempt proved futile; Dura was left a buried and unknown ruin for more than fifteen hundred years. Not until the twentieth century was the town excavated and the beautifully preserved wall paintings brought to light once more, at which point they became the subject of intense and careful study, with profound results for the history of Jewish art, literature, and culture.[9]

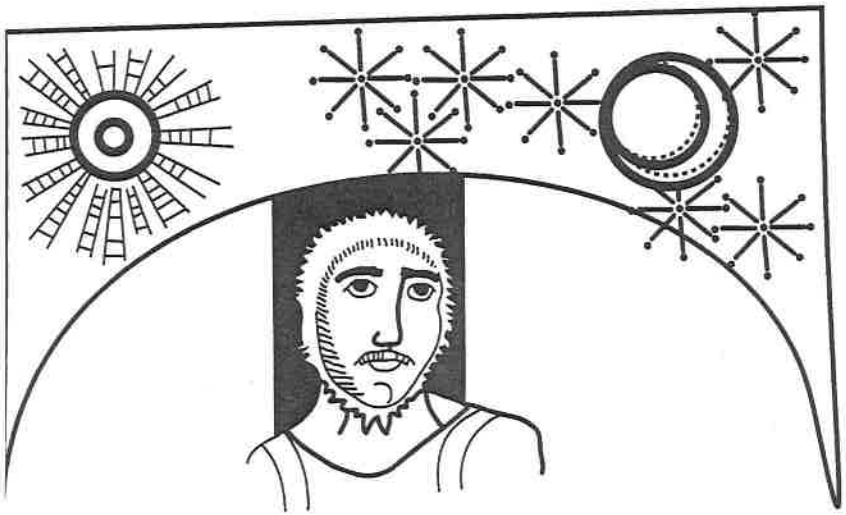


*Figure 4.1. Sketch of the upper part of a wall painting at Dura synagogue, dated about A.D. 256, showing the head of a man (Moses?) and above it the Sun, seven stars (Pleiades?), and a crescent Moon, all in stylized fashion. Redrawn by Floyd Bardsley.*

Painted on one of the wing panels are four portraits of unknown figures, possibly Moses (the upper two figures), Ezra, and Abraham.[10] These are the only portraits in the entire series of paintings and are thought to depict important figures. One portrait shows a man with white hair and beard wearing a Greek robe; above his head stretches an arc of the heavens containing the Sun on the left, seven stars, and the crescent Moon on the right. A rendering of the upper part of this image is shown in figure 4.1 and should be compared with the clay tablet shown in figure 2.1.

The similarities in the depiction of the stars and crescent Moon are striking. It is as if a thousand years had yielded no advances in portrayals of the heavens. The artists at Dura, it seems, employed an image pattern that was traditional, well established, and easily understood by the populace at large. To say even this much is speculative; yet there is at least the implication that the basic arrangement and style of figures 2.1 and 4.1 represent a pattern that had remained stable for centuries and had been copied on numerous occasions. This is also suggested by certain sculptural works that offer astrological predictions and include identically pointed stars, a crescent Moon, and one or more allegorical versions of the Sun and planets.[11]

The image in figure 4.1 in particular recalls an important and much used commentary on the Old Testament, by the Hellenistic Jewish scholar Philo Judaeus (ca. 20 B.C.–A.D. 50), in which the following lines occur:

> He [Moses] gathered together a divine company, that is the elements of the universe and the most effective parts of the cosmos, namely the earth and heaven. . . . In the middle between these he composed hymns using every musical mode and every type of interval in order that men and ministering angels might hear. . . . The angels would also be strengthened in their faith if a man clothed in his mortal body could have a power of song like the Sun, Moon, and the sacred choir of other stars, and could attune his soul to the divine instrument, namely the heavens and the whole cosmos.[12]

Moses, it appears, is at the end of his life, about to enter the ranks of the ethereal. He sings the "perfect song while yet in his body" and (in lines that follow the above passage) expresses his love and concern for his people, scolds them for their sins, and gives them hope for their future. His voice is "attuned" to the "music of the spheres," filled with the force of heaven. He sings the Platonic harmony of harmonies that will bear to the Israelites a depth of religious faith and classical virtue worthy of the angels.

When Moses dies, the Old Testament tells us, another great leader steps forward, the warrior Joshua. The Lord sends Joshua to lead the armies of Israel across the River Jordan and there establish a final homeland. In the midst of a great battle in the valley of Ajalon, the Sun begins to set while victory remains undecided. As he sees the land darkening, Joshua calls out to God for aid:

> "O Sun, stand thou still upon Gibeon;
> And thou Moon, in the valley of Ajalon."
> And the Sun stood still,
> And the Moon stayed,
> Until the people had avenged themselves
> Upon their enemies.
> —Joshua 10:12–13

There is no small poignancy in thinking that such words may have inspired the artist at Dura, perhaps only days before the Persian army

descended upon the town. At the same time, there are difficulties with this interpretation: there are no stars mentioned in the account of Ajalon, and Joshua was not a man whitened by age but was vigorous and in his prime. Could it be that the artist wished to combine more than one invocational theme in his image? The question must remain unanswered. What is important is that an ancient model of the heavens was borrowed for a very specific religious purpose, one that may well have altered its passage into the future.

This is suggested by two other early works in which the Moon appears in painted form. One of these is among the oldest known manuscripts in Syriac, the Rabbula Gospels, dated A.D. 586, so named because they were written and illuminated by the bishop Rabbula. The codex contains richly colored illuminations said to be derived from earlier wall paintings or mosaics in Palestinian and Syrian churches. Among the most striking of Rabbula's images is a full-page depiction of the Crucifixion and Resurrection. In this miniature, over each arm of the cross and above a valley between two towering and crudely drawn mountains, stand the Sun and Moon, this time with the Moon on the left in crescent phase, resting in the center of a dark disk. A Syriac Bible of the next century contains the portrayal previously discussed as a possible interpretation for the painting at Dura: Joshua at Gibeon, painted in full battle dress, sword in hand, pointing upward to the Sun that shines down on the left while the crescent Moon hangs on the right.[13] The body of Joshua has a slight Hellenistic sway to it as well as skillful shading, once again implying the use of existing models. Unlike the Rabbula Crucifixion, there is little complexity in this image. It is merely a literal rendering of the story about Joshua at Ajalon, suggesting that use of the Sun and Moon as iconographic elements was common practice by this time.

## ICONOGRAPHY OF THE MOON IN EARLY CHRISTIAN ART

Associating the Sun and Moon with the dying Christ defines an artistic motif that continued unbroken throughout the entire medieval period, during the Renaissance, and even into the sixteenth century. Images of the solar disk and crescent Moon above the arms of the cross in representations of the Crucifixion can be found in hundreds of works, not only in illuminated books, but also in ivory carvings, chasubles, reliquaries, bishops' robes, tabernacles, frescoes, and paintings; i.e., in nearly every genre of Christian art. Inherited from antiquity, the time of the tablet shown in figure 2.1, this motif constitutes one of the oldest iconic threads within the greater weave of Christian art.

The meaning of this association is not clear. Some evidence suggests that the Moon, because of its link with corrupted matter, inconstancy, and the terrestrial sphere, was present in images of the Crucifixion to symbolize the mortal, earthly side of Christ's nature. Such an interpretation is implied by traditional connections between the Virgin Mary and the Moon, based on commentaries concerning the vivid and dramatic imagery in *Revelation* 12:1–4, which reads, "A great and wondrous sign appeared in heaven: a woman clothed with the Sun, the Moon beneath her feet, and on her head a crown of twelve stars. She was about to give birth and in the agony of her labor cried out. Then a second sign appeared in heaven: a huge red dragon with seven heads and ten horns and seven crowns on the heads. With his tail he swept a third of the stars out of the sky and flung them to the Earth."

From as early as St. Irenaeus (second and third century A.D.), commentators spoke of the woman either as the Virgin Mary or the Holy Mother Church, with the other portions of the vision attracting a wider array of associations (e.g., the dragon as Satan, a host of false churches or unbelievers, or the Roman Empire). An especially influential commentary, produced in the sixth century A.D. by Pope Gregory the Great, favored the choice of Mary as the symbolized presence and said that the Moon lay crushed beneath her feet, representing "all fallen, mutable, and earthly things."[14] Taken together, the Sun and Moon in images of the Crucifixion are therefore likely to encompass good and evil, divine and fallen, sacred and profane, immortal and mortal.

The Crucifixion, though the main setting for nonscientific images of the lunar orb in medieval Europe, was not the only one. Alongside the "sullied" notion of Pope Gregory the Great, there was a contrasting, favorable association between the Virgin Mary and the Moon, revealed by the inclusion of the lunar crescent in some paintings of the Annunciation and the Coronation of Mary. Such associations appear to be much more typical of the later Middle Ages, from the thirteenth century onward, and may well be related to the introduction of Aristotelian ideas and the influential commentaries on them by authors such as Averroes. As interpreted by the Arabs, Aristotle believed

in a crystalline lunar sphere, set aglow by the Sun's light and made of a single, homogeneous substance whose dark and light patches were caused by denser or more rarefied conditions. The suggestive purity of this interpretation, coupled perhaps with the ancient connection between the Moon and notions of womanhood, helped further the association with the Virgin Mary, a link that became especially common and debated in the later Renaissance and early seventeenth century.[15]

These connections strongly suggest that the oldest tradition of the Moon as painted image came not from science or philosophy but from literature and religion. These were the realms, after all, in which the lunar body had long played an important role and had drawn to itself the greatest spectrum of interpretive imagery. It is no surprise that this would remain the case for some time.

## CAROLINGIAN ASTRONOMY: TEXTS AND AESTHETICS

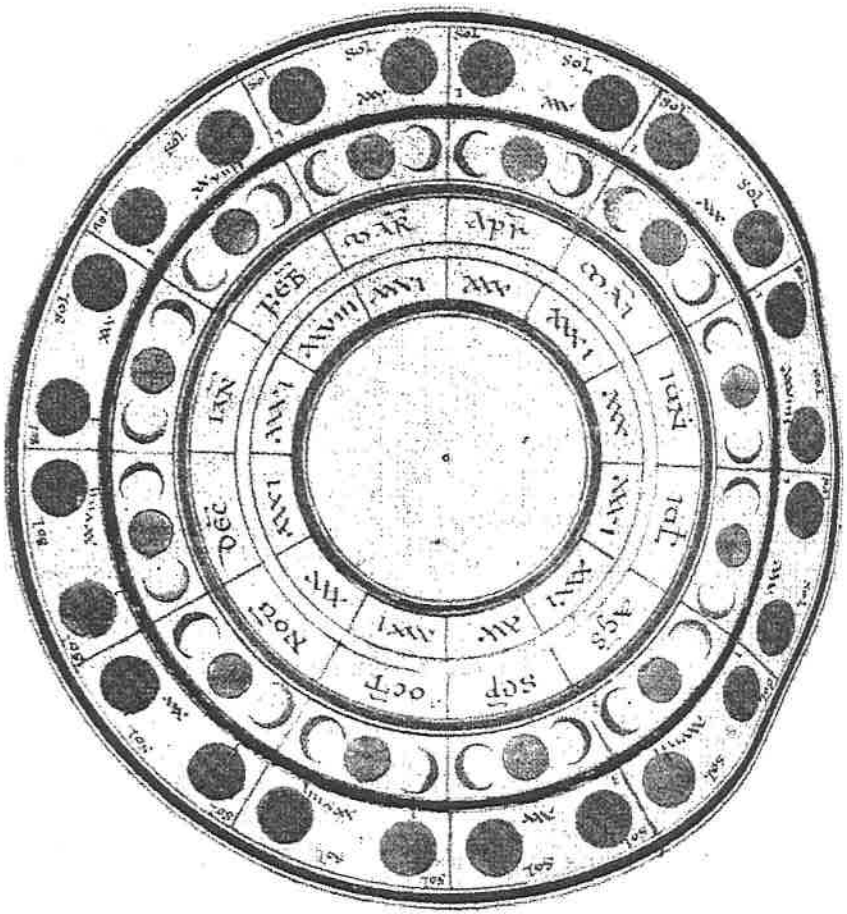
Beginning with the Carolingian revival of classical learning in the eighth century, medieval authors interested in the heavens regularly turned to Martianus Capella, Pliny, and Aratus. They also consulted the works of Cassiodorus, Isadore of Seville, and most importantly the Venerable Bede, whose *De rerum natura* (On the nature of things, ca. A.D. 703) and *De temporum ratione* (On time reckoning, A.D. 725) laid out the celestial hierarchy in Christianized detail and injected a high level of arithmetic calculation into uses of the heavens for calendrical science. As reflected in the number of surviving manuscripts, however, the Carolingians preferred Martianus's *The Marriage of Philology and Mercury* (perhaps the primary textbook of the entire succeeding medieval period), Pliny in a unique form, and illustrated versions of Aratus. Pliny gained influence through a collection of excerpts from *Naturalis historia* concerned with the planetary orbits and motions. These passages were selected, partially rewritten, and assembled about A.D. 809 for use as a teaching aid and a brief, theoretical reference.[16] *Phænomena* of Aratus (both in Cicero's translation and in that of Germanicus Caesar) was resurrected in beautifully illuminated manuscripts, of which there are a fair number remaining today, some bearing among the most striking artistic images painted during the entire early medieval period.

The Carolingian revival marked a strong return to Roman learning in particular (due to the constraints of Latin) and among the sciences, to astronomy above all. A pronounced effort of the late eighth and ninth centuries was to recover and solidify such learning by building "workshops of knowledge" (a phrase identified with Charlemagne) in the form of cathedral schools that would then serve as essential sources of strength for the Church and a new Holy Roman Empire by becoming centers of literary and artistic endeavor, where manuscript copying, collecting, and study especially would occur. This emphasis on the power of words and language—a hallmark of Carolingian achievement[17]—helped enforce a hierarchy of image making, whereby drawn and painted images were viewed as secondary to writing and reading. Inspired by the thought of St. Augustine, St. Gregory, and others, *Libri Carolini* (Caroline Books) expressed a central tenet of the times in stating that words and images embodied knowledge in different ways—words by their direct and "undefiled" transfer of truth, images by their ability to act as narrators and teachers to the illiterate and by their powers for conveying beauty, skill, and revelations of divine order. As one recent scholar has commented, "It is within the wary acceptance of the didactic value of pictures and the conviction that writing was more reliable, more truthful and unambiguous, that Carolingian book painting has to be seen."[18] This is true not only of book painting, however, but of all forms of scientific illustration.

Within this framework, the idea of "observation" was suspended, neither lost nor liberated, but left on the wayside. Naturalistic portrayal of the physical universe appeared only where classical models were closely followed.

## ASTRONOMICAL ILLUSTRATIONS: MAJOR TRENDS

Prior to the middle of the eighth century, the major astronomical work to regularly bear diagrams or illustrations was the *computus*. This type of text had the primary function of using planetary cycles to calculate the specific dates of important holy days (especially Easter) and the seasons. Bede, drawing on Pliny and other authors, had set the course for this genre in the middle seventh century, expanding it to embrace the arithmetic of the heavens as a whole, including the zodiac and planets.[19] Before Bede, the computus was a bare-bones document, meant to serve purely practical uses without diagrams.



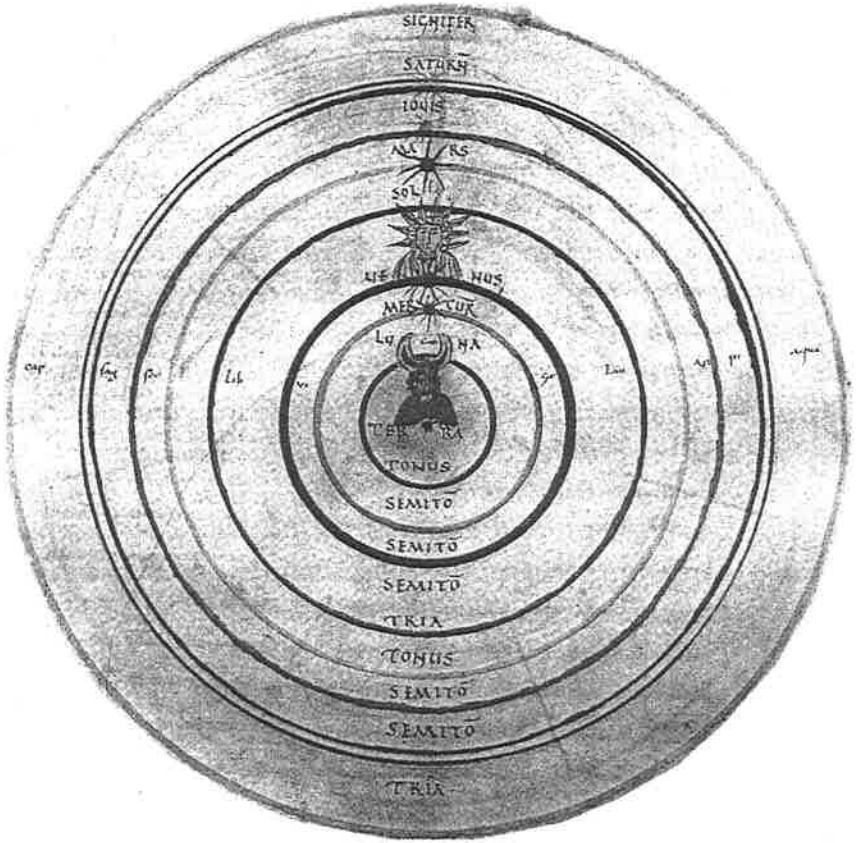



*Figure 4.2. Images from the Hildebald manuscript, dated between* A.D. *798 and 805 and archived in the cathedral library in Cologne, Germany (Cod. 83). The Moon is depicted in various forms, including classical personification (the goddess Luna), circular orbits, and phase diagrams.*

From Bede onward, however, new types of imagery were employed: circular charts, diagrams showing the arrangement of the celestial bodies, drawings depicting the orbits of the planets and the phases of the Moon, and actual illuminated paintings of the constellations and planets in personified form (fig. 4.2). This tendency to include illustrations expanded considerably in the late eighth and ninth centuries, when it became common practice to produce sourcebook-type compilations, i.e., astronomical manuscripts made up of selected passages from a wide range of different authors.

One such text, known as the Hildebald, is a multibook computus displaying a magnificent abundance of diagrams, apparently collected from several versions of Bede's *De temporum ratione* (On the logic of time) and other books.[20] The Hildebald manuscript was produced between A.D. 798 and 805 and was quite likely used by scholars in Charlemagne's court at Aachen. By almost any standard, it is a remarkable and visually magnificent work. It provides nothing less than a grand combination of existing types of astronomical illustration: geometric diagrams, Sun/Moon orbit and phase cycles, intricate illustrations of planetary apsides and latitudes, drawings of the five terrestrial zones, artistic paintings of the constellations, and more.[21]

As noted with regard to Martianus and the Moon, we find in the Hildebald computus more than one species of "astronomy." There is an astronomy of arithmetic calculation, of decorative order and pure geometry, and of myth. Such diversity acts to contradict any unified vision of the universe, any single "view." Each type of image, of course, bears its own internal logic and cognitive demand; it calls upon the reader in a particular way. Arithmetic diagrams and tables posed the universe as ruled by numbers; geometric illustrations offered it as a representation of engineered order and fixed spatial relations, reminiscent of gears in a mechanical device; allegorical figures of the planets proposed that one see the skies in classical aesthetic terms, with the entire Carolingian effort of *renovatio.* The bringing together of all of these "astronomies" reflects the eager and often uncritical revival aspect of the Carolingian intellectual movement.

How does the Moon appear as an image in the Hildebald manuscript? Figure 4.2 provides a sampling that corresponds to each of the different astronomies mentioned above. We see the Moon reduced to the circularity of its orbit, expanded into its succession of phases, and rendered into the form of a goddess. All of these types of images existed in antiquity. What is new here is their inclusion within a single work. Carolingian astronomy, in other words, could be a kind of collector's cabinet. Its contents, however, were more limited than those of antiquity: it shows no interest in speaking of the actual appearance of the lunar orb or its composition. The "spottedness" of the lunar surface was not a subject of discussion beyond the continual rehearsal of Pliny's characterization that this constituted "merely dirt from the earth taken up with the moisture." It is ironic that the most naturalistic element offered by any of the images found in the Hildebald treatise—that of earthshine (light reflected from the Earth to the Moon, faintly illuminating the lunar disk during the crescent or gibbous phase)—appears in the painting of the mythic figure Luna.

## PLINIAN DIAGRAMS AND THE TRADITION OF MATHEMATICAL HEAVENS

Plinian geometric illustrations carried forward the simpler traces of the tradition of Hellenistic mathematical astronomy. Again, this was a tradition that was not much interested in observing, studying, and depicting the lunar surface but instead in describing celestial movement. Even questions about why the planets change size and color, for example, were answered within this tradition through variations in latitude and the angle of the zodiacal circle. The concept of Venus or the Moon, as "other worlds" in the physical sense, does not attain a following at this time.

At first blush, the range of diagrams in the Plinian handbooks seems considerable. There are various types of concentric drawings depicting planetary order and the harmonic intervals between orbits. There are complex circular illustrations showing planetary apsides and latitudes, with up to thirteen concentric circles representing the interval degrees of the zodiac, over which are imposed the different eccentric orbits for the planets and the Sun. Such diagrams are difficult to read; at their worst, they become manneristic and suggest that pedagogy has been left behind in favor of a certain infatuation with visual relationships on the page, with the sheer power of drawing itself. At this point, such figures no longer illustrate the order of the solar system. Instead they express the impossibility for any single diagram in this tradition to include all planetary motions, and therefore the inevitability that such a diagram would eventually move from the realm of "science" (knowledge) into that of aestheticism. As early as the later ninth century, this seems to have been realized because new rectangular drawings were invented to isolate and graph more simply the position of each planet through time.[22]

The mathematical cosmos had gained a number of forms by this time, both in image and in text. This development directly linked medieval Europe to antiquity by showing that the real work of astronomy was to comprehend the planets and stars through their movements, positions, and cycles. The absence of the grand Ptolemaic conceptual scheme in early medieval Europe did not especially matter in this regard. Such absence prior to the twelfth century has been often lamented as a sign of the low level of astronomy at this time. The heavens, however, were densely mathematical in a variety of ways. The skies were embodied in arithmetic calculations and the wholesale concern with time reckoning, which was primarily fixed upon the Moon and was central to European Christian culture from Gregory of Tours (sixth century) onward. On the textual side, too, a mathematical view prevailed. This is apparent in Bruce Eastwood's characterization of early medieval astronomy as a "series of discrete definitions of terms which emphasized

observation [especially the fixed methods of observing and recording planetary motions], identification, and occasional tracking of celestial bodies."[23]

## ARATUS IN THE MIDDLE AGES: LITERARY ASTRONOMY RECLAIMED

It is difficult today to think of the beautifully painted miniatures adorning Carolingian versions of Aratus's *Phænomena* as "science." They instead appear to be the precious remnants of a once magnificent "art," that of book illumination. Emerging from an ancient song about the wheel of the heavens, these figures are among the most powerful and convincing testaments to the urge for *renovatio* during this period. As one scholar has written, they "might have stepped out of a Pompeian mural . . . to transmit to posterity the genuine effigies of the pagan gods and heroes that had lent their names to the celestial bodies."[24]

Of the various *Aratea* that have survived from this time (doubtless a small sampling of a much larger corpus), two in particular stand out as unique masterpieces. One of these is the Leiden *Aratus (Codex Vossianus Latinus 79)* archived in the university library at Leiden, dating perhaps from the early ninth century.[25] The miniatures that decorate this manuscript appear to be copies of much older models; this can be seen in the nakedness of many of the human figures used to depict constellations, their sophisticated balance and proportion, and their mixture of realism and stylization (fig. 4.3). These figures are solid, wonderfully shaded and colored, and full of exquisite detail, with the stars portrayed as small gold spots (many in the shape of diamonds) that do not in the least detract from the allegorical image. Although the purported center of interest, these stars are not much more than an afterthought: little concern has been given to the accuracy of their position and none at all to their relative brightness. True to Aratus, this is astronomy in the service of art, a literary astronomy illustrated in a manner loyal to the poetic text from which it stemmed.

Any hope of finding in such illustrated manuscripts a drawing of the Moon as a planetary body is therefore in vain. The closest one comes is in the final image of the Leiden *Aratea,* which is a map of the solar system, apparently the oldest known to exist, with the planets arranged as they would have

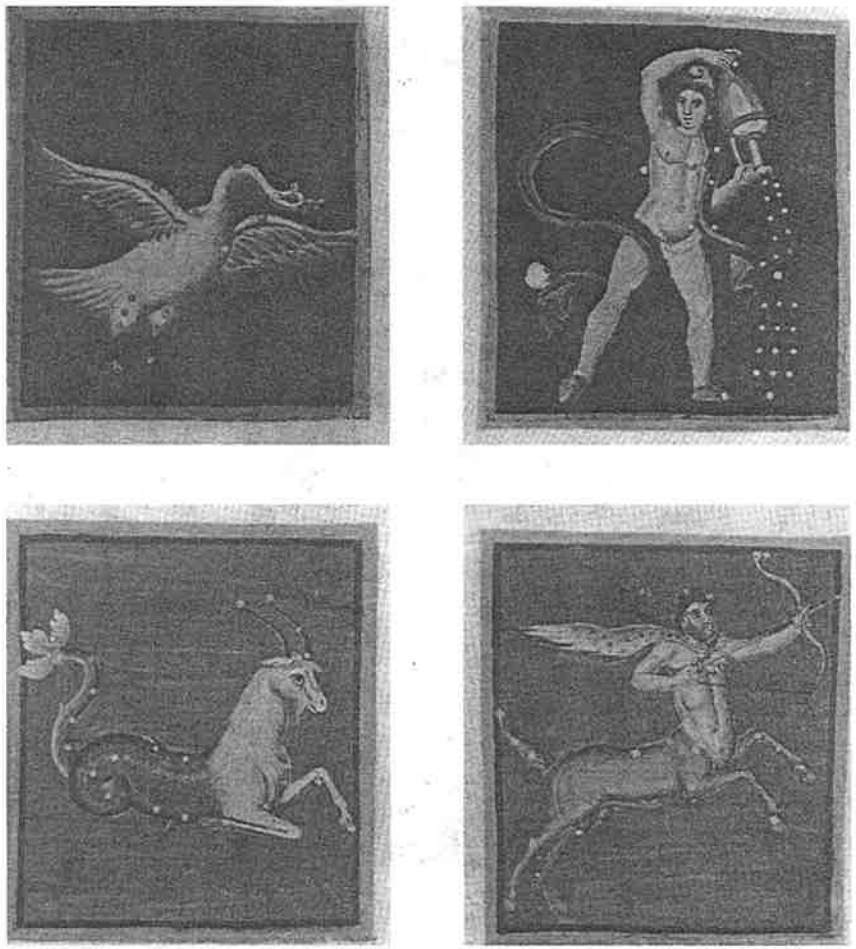


*Figure 4.3. Images of the constellations from the Leiden* Aratea, *dated eighth–ninth century. The figures include (clockwise from the upper left) Cygnus, Aquarius, Capricorn, and Sagittarius.*

appeared on March 28, A.D. 579.[26] Figure 4.4 reveals that the complexity of this diagram vies with that of any of the Plinian drawings noted above. It depicts the planetary orbits not as perfectly centered upon the Earth but as eccentric in shape, with Mercury and Venus actually orbiting the Sun—the solar system as depicted by Martianus Capella. Each planet, zodiacal constellation, and month receives its allegorical figure, mostly in the form of medallion-like images, with Luna shown in her chariot drawn by two oxen. To the unwary observer, Mercury, Venus, and the Moon might seem to

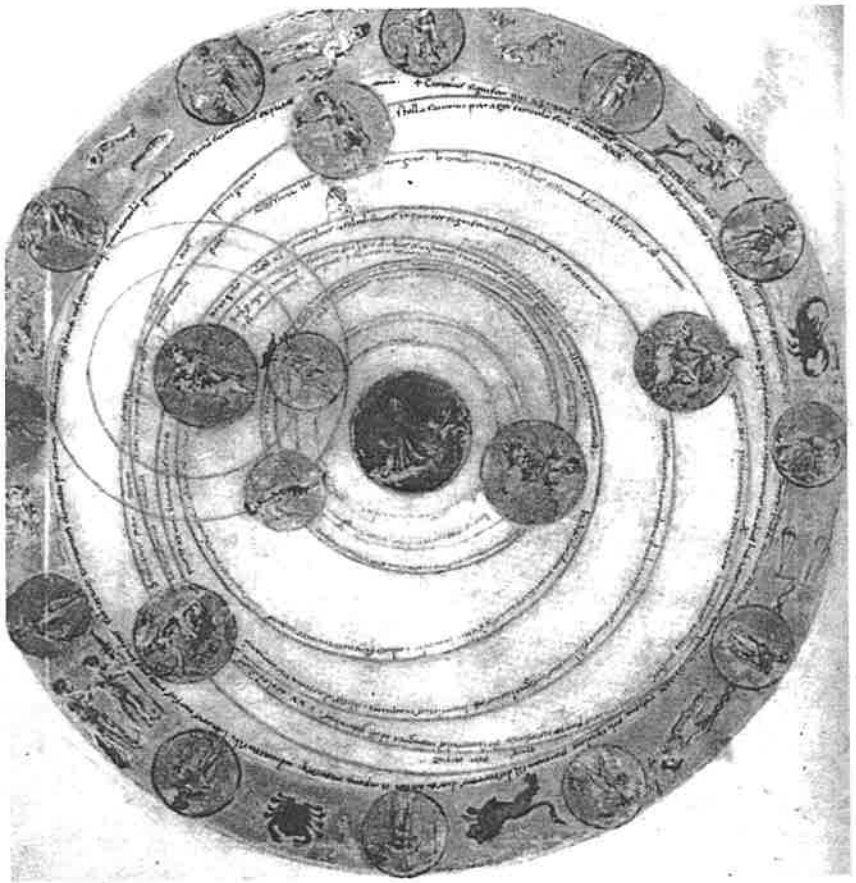


*Figure 4.4. The solar system and zodiac from the Leiden* Aratea. *The figure depicts geometric orbits with medallions holding allegorical figures for each planet. The Earth sits in the center; the Moon appears on its immediate right; the Sun lies to its left, circled by Mercury and Venus.*

occupy each other's orbits. Moreover, the months are placed in the wrong order with respect to the signs of the zodiac (one runs clockwise, the other counterclockwise). There appears to have been too much information packed into this one figure for the artist (or copyist) to keep accurate track of everything.

There is one other aspect to this early map of the solar system that requires mentioning because it brings us to the very heart of the question regarding scientific illustration. Pliny, as it happens, is present in this map in more than just echo. Around the circle of each planetary orbit are quotations from *Naturalis historia* regarding perigee, apogee, and astrological exultation. The diagram was not considered finished or complete without significant use of text. This is because, unlike the miniatures, it was intended as a pedagogic aid for learning the fixed and prescribed order of the heavens, not their mythology. For Carolingian scholarship, images were not sufficient in themselves to convey the actual science of astronomy.

The ultimate example here is a second Aratus masterpiece from the ninth century, this one apparently written in France and then transported to England, where it became a model for similar versions down through the twelfth century.[27] In this illustrated manuscript, the body of each constellation is literally made up of words, a selection of passages from the *Astronomica* of Hyginus, a second-century A.D. Roman author. Under each image is given the relevant passage from Aratus's poem in the translation by Cicero. The extracts from Hyginus treat the number of stars, their names, relative brightness, and general position. They are written, moreover, in an antique script known as *capitalis rustica,* a deliberate call upon Roman-derived, antiquarian calligraphy. This unique method of portrayal offers the "authentic" science of Hyginus (such as it is), by showing the bodily substance of each constellation, captioned by the "literature" of Aratus/Cicero. As with other Aratus versions, very little attention has been given to the drawings of the stars themselves. They are simply sprinkled here and there like so many grains of gold, but their overall arrangement is just careful enough to suggest to the celestial *illiterati* the figures of their respective namesakes.

## THE MEDIEVAL MOON AND SCIENTIFIC ILLUSTRATION

At this early stage in the history of European science and art, text and image are not yet separable as modes of expression. Browsing through whatever herbals, bestiaries, lapidaries, or other technical manuscripts we might find from this period, we see drawings of great beauty invaded by words at nearly every turn. Plants grow and twine upward out of their own written names; beasts of the forest or jungle pose like statues upon the stage of their description; medical guides unravel every nerve or artery with a caption or poetic couplet; the universe spins and the planets hang upon wirelike circles and eccentrics over which revolve letters, numbers, names, and dates. Illustrations

are not trusted to do things on their own, nor were they for a long time to come.

The privileges granted to writing and the antiquarian impulse in Carolingian thought ensured that the Moon, drenched as it was in classical myth, would be portrayed most often in allegorical fashion. This took place well outside the precincts of technical expression and resulted in fascinating combinations of Christian and pagan imagery. In Bibles prepared and illustrated at this time, for example, personifications of Sol and Luna are fairly common. A particularly striking example is an ivory carving of the Crucifixion, executed about A.D. 870 and later set into a book of Pericopes for Henry II of England (early eleventh century). The image shows the Sun and Moon not as disk and crescent or as orbs borne by angels but as pagan gods in their respective wagons, being drawn by rearing steeds (Sun) or stolid oxen (Moon).[28] If such artworks were instrumental in reviving pagan allegory and symbolism about the heavens, no less was this true for literature. Images of the Moon as an emblem of love, past life, change, and inconstancy, fixed in written expression from the beginning, again became current: "As the Moon grows in light to full circle, yet soon vanishes in ever changing movements, so too the kingdoms of men grow and pass away."[29]

As an image for the imagination, the Moon remained richly variable. It could be associated with a pagan goddess, the Virgin Mary, the profane on Earth, the fleeting qualities of pride and human life, and the science of the skies. A metaphor as well as an allegory, the lunar body drew to itself ingenuities of portrayal that crossed the borders of many disciplines. This would not change, but it would undergo important alteration, particularly in the wake of Arabic science and its pivotal influence upon Europe.

# 5

# The Later Middle Ages

## From Symbolism to Naturalism

### Continuity and Change in Lunar Imagery

The late Middle Ages mark a crucial period in the history of the Moon on Earth. New versions of the lunar orb and new discussions of its reality emerged in European thought and came to exist alongside those of the past. The twelfth to fourteenth centuries define the time when the physical makeup of the lunar body, including the "spots" on its surface, first came into sustained intellectual view. This took place at a time when symbolic predispositions toward material reality began to give way to, or be deeply modified by, a true naturalism based upon an empirical appreciation of the beauty, form, and concreteness of earthly phenomena. This overall trend would not reach its culmination until the early fifteenth century, most impressively in the art of Jan van Eyck. But its existence before that time is clear, and its outlook constituted a truly profound change over previous centuries.

Within astronomy itself, the main genres of illustration evident at the close of the Carolingian *renovatio* continued largely without interruption. Yet from the late twelfth century onward, with the full introduction of Greek

and Muslim learning through translations from the Arabic, the balance between a "scientific" and a "literary" astronomy, between Plinian-type diagrams and allegorical pictures, came to an end. Greek-Muslim science (for this is what it was) effectively meant the demise of a literary-allegorical astronomy. At the same time, it brought with it a new division of the heavens into mathematical-theoretical and physical-philosophical halves, exemplified by Ptolemy on the one hand and Aristotle on the other. Once these authors were established within the new university system and adopted by schools and authors elsewhere, there was little room within astronomy proper for the high artistry of the Leiden *Aratea.* Illustrated versions of Aratus's poem, Martianus Capella's textbook, and the Plinian extracts continued to be produced, even after the introduction of printing. Yet serious students of astronomy had long abandoned such works by this time (or else used them sparingly) in favor of new texts that dealt more directly with geometric theories and the actual substance of the celestial bodies.

This general trend was itself aided by larger developments in medieval aesthetics. From the twelfth century onward, a new outlook on the natural world gained strength, inspired by a complex mix of Aristotelian ideas and gothic theology. Greek-Muslim thought helped urge influential writers such as Hugh of St. Victor to adopt the classical notion of the visual world as a source of true knowledge and to argue for the spiritual benefits received through appreciation of the realities of God's creation. Such notions, writes David Summers, "gave the deepest possible justification for an art appealing first of all to sense, because on such a view it is possible to ascend from the pleasing qualities of objects to the real presence of divine grace."[1] Art thus became a means to express divine harmony and order in its material manifestations. The centrality of art in European society grew, even as it looked outward to the nonhuman universe of forms.

The move toward more realistic portrayal of natural phenomena affected a wide array of expressions, from the ornamental borders of gothic manuscripts to the sculptures adorning the great cathedrals. The focus was clearly on organic nature first, on plants, animals, and humans most of all. Although by the fourteenth century this focus had widened to include many phenomena of the physical universe, it did not yet mean the complete end of literary-allegorical representations. The late medieval Moon retained something of its ancient iconographical substance, at least in part and for a time.

## THE MAN IN THE MOON APPEARS

During the several centuries after Charlemagne's death, lunar depictions remained similar to those already discussed but with some important modifications. In astronomical treatises and in illustrations of biblical or literary texts, the goddess Luna began to shrink, indeed to change gender. From her full-scale form as a standing figure, perhaps borne by an ox-drawn wagon, she was scaled down to a head medallion, especially in Plinian-type diagrams, or to a man-in-the-Moon face with distinct male characteristics. The latter development appears to have been related to the increased amount of Crucifixion imagery, which, as noted previously, was commonly adorned with the Sun and Moon (each as a face within a disk) above the arms of the cross. By the twelfth and thirteenth centuries, this man-in-the-Moon image had become a standard icon in a wide range of new media, including woodblock prints, stained glass, fresco paintings, and more.[2] As before, the crescent phase was preferred, with the face given in three-quarter or full profile. By the later fourteenth century, these faces had entirely replaced the pagan god and goddess Sol and Luna in Plinian and other illustrations of the solar system.

The ubiquity of this facial imagery can be demonstrated by two crucial examples. In art, there is Giotto's famous fresco *The Last Judgment,* painted in the Arena Chapel in Padua. This painting depicts God the Father sitting in judgment and surrounded by angels, above whose heads hover the Sun on the left, painted in gold, and the Moon on the right, ashen in color with a distinct face on its crescent portion. Giotto did not entirely follow convention: his Sun is faceless and he did not confine the lunar face to the darker, concave portion of the crescent. Instead his image shows a gray, charcoal-like visage whose features vaguely suggest that they were based on the distribution of "spots" on the lunar surface. No verification of this can be made, however, given the lack of documentary evidence.

Among astronomical treatises, the second example was one of the most widely used textbooks between the thirteenth and sixteenth centuries. The two drawings of figure 5.1 are from a 1488 printed edition of John of Sacrobosco's *De sphaera* (On the sphere) and are meant to depict lunar and solar eclipses. Originally written around A.D. 1250, this brief work was a simplified introduction to spherical astronomy (planetary motions) and became a

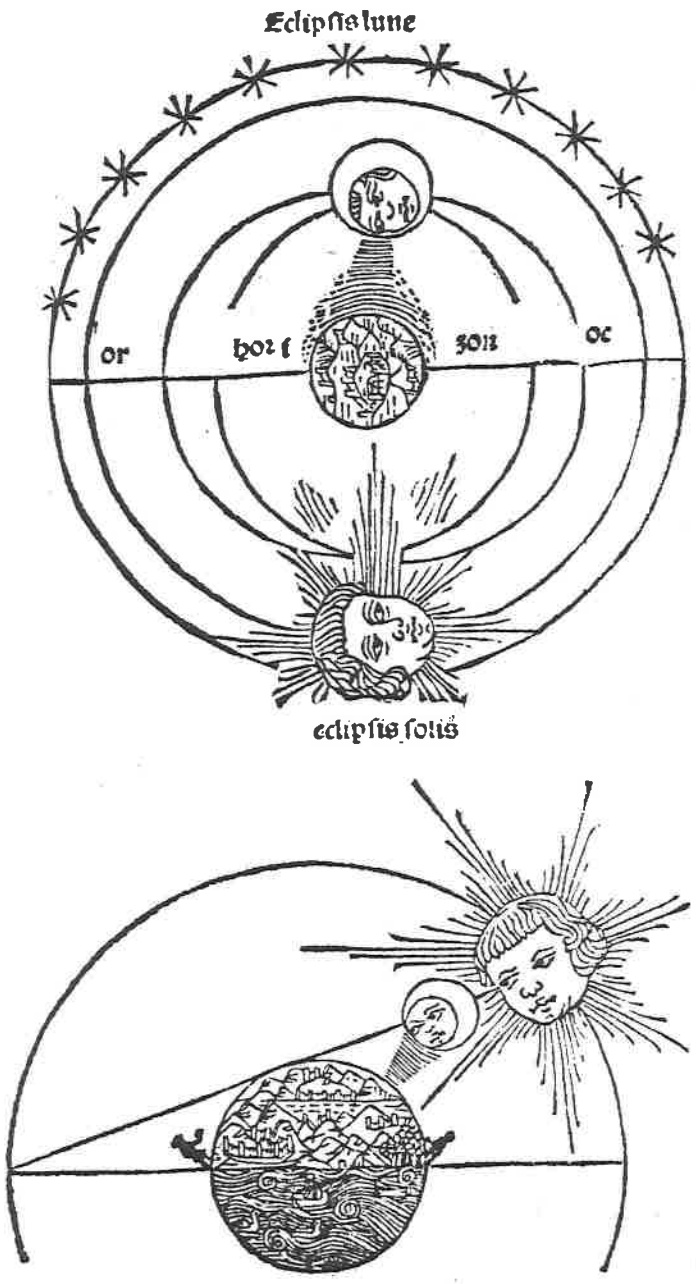



*Figure 5.1. Drawings from a fifteenth-century edition of* De sphaera *by John of Sacrobosco (thirteenth century), meant to illustrate lunar and solar eclipses.*

standard source in university courses down to the time when Kepler was a student in Tübingen. Earlier manuscript editions prove that the drawings of figure 5.1 are modeled on older versions, except that they give hair to the solar and lunar heads in naturalistic fashion. This not only departs from the strict allegorical tradition, but it also casts a degree of comical irony on it by literalizing the man-in-the-Moon image as a (decapitated?) form. The point, however, is clear: Giotto and Sacrobosco are neighbors beneath the light of the same lunar image.

For reasons as yet unknown, the face given the Moon was mostly male. This is difficult to explain, given the myriad connections between woman and the Moon, so much a part of Greek, Roman, and medieval culture and at least hinted at by the personification of the lunar orb in the form of a female goddess. Why were such associations erased at the level of representation? Evidence suggests that misogyny played no role in this change. Rather, a merger of ancient Greek and biblical folklore may have been involved, a complex transfer of the ancient notion of the Moon as a place of purgatorial atonement to biblical tales of punishment for sins committed. European folklore contains a number of versions of a tale based on the biblical story related in *Numbers* 15:32–36, in which a man who refused to rest on the Sabbath and instead gathered wood to sell was seized, bound, and stoned to death. Popular tellings have the man banished to the Moon, along with his sticks, which he continues to carry on his back. In some renditions, the offender is given a choice of whether to serve his exile on the Sun or on the Moon and he chooses the latter. In still different versions, the man is caught stealing cabbages on Christmas Eve; he and his booty are conjured to the Moon, where he can still be seen. Other European legends with medieval origins pose the man in the Moon as Judas or Cain burdened with a bundle of thorns, punished for his crimes by expulsion from Earth. The Cain image even gets a brief mention in Dante's *Divine Comedy* as a recognized folk belief (*Paradiso,* Canto II). Perhaps such stories also account for the tired and troubled expression so often given to the man in the Moon in medieval and Renaissance imagery. By the fifteenth century, the face had become an artistic cliché. So standard an image was it that even after Galileo's telescopic portraits of the Moon appeared in 1610, and painters in Italy and elsewhere began to depict the lunar body as a crystalline or cratered sphere, the man in the Moon continued to appear in serious works on astronomical and meteorological subjects.

## A NEW SUNDERING OF THE HEAVENS

The massive influx of Greek-Muslim thought into Europe through translations mainly from the Arabic formed what has become known as the Twelfth-Century Renaissance,[3] one of the most crucial episodes in medieval intellectual history. At the same historical moment that the building of the great Gothic cathedrals took place, the foundations of modern science and the beginnings of the university system in Europe were solidified. It was at this time that the works of Ptolemy, Aristotle, Archimedes, Euclid, and others were introduced to Latin culture. These authors, however, did not come into Europe as they had left Greek culture more than a thousand years before. They had been copied, edited, corrected, partially rewritten, and illustrated by generations of scholars in Islam, who had absorbed their contents, debated their implications, and nativized their learning to a very different, evolving culture. What the West inherited was a much more complex alloy of Greek and Arabic learning. Along with Ptolemy came al-Farghani, al-Battani, Thabit ibn Qurrah, and al-Sufi. Aristotle and his version of the heavens went hand in hand with the commentaries of al-Kindi, al-Farabi, Ibn Sina (Avicenna), and Ibn Rushd (Averroes). Euclid was accompanied by the advanced trigonometry of al-Kwarizmi (whose name has succeeded to the present in the form of "algorithm"). And Archimedes arrived with interpretive companions too numerous to mention.

The effects on European astronomy were momentous. Change did not occur suddenly or dramatically; the basic position of medieval astronomy in society, its service to problems of enduring interest in a feudal, religious setting (calendar reform, time reckoning, seasonal predictions, and determination of holy days), did not vanish. What Greek-Muslim astronomy did, first of all, was to vastly improve the methods to achieve these tasks. It did something else as well, something of considerable relevance to our discussion of the Moon. The simultaneous introduction of Ptolemy and Aristotle effectively sundered the heavens in a new manner. Here we should recall the scheme of Geminus in the first century B.C., who wrote that it was the work of physics "to consider the substance of the heavens," and that of astronomy to study the "arrangement of the heavenly bodies . . . as well as their movements." Importing the basic texts of Greek-Arabic science and philosophy meant importing this ancient division, which had remained intact. As a result, the main current of astronomical study and observation turned toward the mathematical heavens, whereas philosophy and physics took over cosmological reflection, as well as discussions of planetary substance. Ptolemy's *Almagest,* for example, which was too difficult for the majority of students and scholars, was digested into two widely used introductory texts, John of Sacrobosco's *De sphaera* and the anonymous *Theorica planetarum,* both of which came with illustrations (fig. 5.1). These works appeared in the thirteenth century and effectively replaced Pliny and Martianus as the central textbooks of astronomy.

## RISE OF THE LUNAR SURFACE: A SAMPLING OF IDEAS

If *De sphaera* and *Theorica planetarum* were uninterested in the planets as actual physical bodies, such was not the case for Aristotelian cosmology and its commentators, of which there were soon an abundant number. These commentators were the ones who brought the "spottedness" of the Moon into discussions about the heavens. Plutarch's work on the lunar body does not appear to have been widely available before the Renaissance. Instead Latin writers drew upon Islamic authors, especially the twelfth-century philosopher Averroes, who in turn received much inspiration from the tenth- and eleventh-century scholar of Arabic science, al-Haytham (about whom we will have much more to say below).

One Latin writer who tackled the question of the Moon's "spottedness" was Alexander of Neckam (A.D. 1157–1217), reputed foster brother to Richard the Lionhearted and scholar of Greek and Arabic natural history. In his work *De naturis rerum* (On the nature of things), named after the tradition of works by Lucretius, Isidore of Seville, and Bede, Neckam informs us that some thinkers believe the Moon to be covered with mountains and depressions, whereas others interpret the dark areas as portions characterized by "greater obscurity." His own view was that the lunar spots were intended by God as a sign of original sin stained upon the heavenly bodies: only "when all the planets and stars shall stand as it were justified, our state too will become stable, and both the material Moon and holy church will be spotless before the Lamb."[4]

A very different type of image, bleached of such symbolism, was proffered slightly later by the consummate scholar of the late European Middle Ages, Albert the Great (A.D. 1193?–1280). Albert believed that the Moon was smooth and spherical, its dark areas caused by variation in the density or lightness of the lunar substance. This was the standard position of the Peripatetic school of Greek natural philosophy founded on the ideas of Aristotle. Albert, however, did not stop there, but offered a descriptive image for the lunar maria. Images of this type, as we noted earlier (see chapter 4), were known from antiquity: the apparent figure in the Moon had been seen as a cat, stag, lamp, drum, etc. In his *Meteorologica,* Albert produces a much more complex figure. Those, he says, who have closely observed the lunar disk in the early hours before dawn can discern a lion with its head on the east and on its back something resembling a tree trunk that thins to the west. Leaning against this tree, a man stands with his feet pointing toward the back end of the lion. Impressionistic as it is, the image indicates a high level of observation—indeed, it is complex enough to suggest that Albert may have sketched this arrangement of figures. Because Albert says nothing about the meaning of his image, it was probably a likeness, used for purposes of visualization and memory, stripped of mythic and religious connections. This type of secularism was new.

As noted, both Alexander of Neckam and Albert the Great were influenced by the writings of Arab natural philosophers. The most important of these with regard to the Moon and planetary astronomy was Ibn Rushd (A.D. 1126–1198), known to the Latins as Averroes, the most notable of the many commentators on Aristotle. Averroes, it appears, took some pains to derive a consistent theory of the Moon's substance and true nature from the various, partly contradictory statements found in Aristotle's work.[5] This was no easy task. Aristotle, as stated earlier (see chapter 2), had variable things to say about the Moon, noting that it "participates" in the Sun's light and is "as it were, a second and smaller Sun," yet it is also the origin of certain "creatures of fire" (such as the salamander) of terrestrial affinity.[6]

What does Averroes make out of this seemingly dual attribution? The Moon, he says, is similar to the Sun in an analogical sense, not a literal one. The relationship with the Earth, however, is more complicated. "The Moon has a relation with the terrestrial nature, because it is not luminescent"; those portions of the Moon "that are translucent, that do not glow by themselves . . . [have] a relation with the nature of water and air,"[7] which represent the nonluminous parts of the Earth. But what of Aristotle's stated link between the lunar substance and the element of fire? Different portions of the lunar surface have different natures, Averroes states; those more "translucent" and "obscure" bear a relation to the Earth, whereas those that are luminescent possess a nature in concert with that of fire and the stars. The Moon is thus, as in so many other formulations, a mixture of higher and lower matter, incorruptible celestial substance and imperfect "sublunar" material. The true essence of the lunar body, however, lies in light and visibility. Averroes makes this plain in an interesting way, drawing on a long tradition of Islamic deduction reaching back at least to the tenth-century polymath, al-Haytham. "It has been demonstrated," wrote Averroes, "that if the Moon acquires the power of lighting up from the Sun, it is not by reflection. . . . The Sun renders it luminescent first and then the light emanates from it in the same way that it emanates from the other stars."[8] A fluorescent lunar body allows Averroes to maintain further that the Moon is not rough and mountainous like the Earth, but smooth and perfectly spherical, as Peripatetic theory had stated. It is not a mirror, nor is it another Earth. It is a celestial ball of variable composition, whose dark areas define "portions of the surface . . . that do not receive the light of the Sun in the same way that other portions do."[9]

This is as far as Averroes goes. It is farther than Aristotle but way short of Plutarch. The Moon remains for "The Commentator" (as Averroes was known) a philosophical object more than a true physical one. Its surface is little more than the abode of certain essences, and in describing the nature of these, Averroes dispenses with any further interest in the observable features of the Moon.

## AL-HAYTHAM: AN OVERLOOKED MASTERPIECE ON THE SUBSTANCE OF THE MOON

Averroes claimed that his ideas on the Moon's ability to illuminate itself came from a near contemporary, the twelfth-century Hebrew scholar Abraham ben Ezra. It is clear, however, that both Averroes and ben Ezra drew their concepts on this topic, at least partly, from one of the greatest Islamic

scholars of the sciences, al-Hasan ibn al-Haytham (A.D. 965–1039). Many volumes have been written about al-Haytham's contributions to science, especially in the areas of optics, mathematics, and astronomy.[10] It is said that, in addition to many other achievements, he was able to merge the deductive, often circular logic of Aristotelian natural philosophy with a far more inductive, experimental, and mathematical study of phenomena.

Al-Haytham wrote a great deal on the nature and behavior of light, and he applied his research to several treatises on the heavens. He wrote two works on the Moon, *On the Light of the Moon* and *On the Nature of the Marks Seen on the Surface of the Moon*. The latter work is the only true successor to Plutarch's famous dialogue prior to the Renaissance, a length of some fourteen hundred years. The book's German translator, Carl Schoy, characterizes al-Haytham's study as "the first significant step forward [since antiquity] toward a proper understanding of this lunar sphinx," and he is surely right. But Schoy, however inadvertently, is also partly correct in noting that al-Haytham's book has its limitations because its conclusions were "arrived at purely through optical considerations—since, at base, [to him] it was all a problem of optics through and through."[11] A problem of logic, too, we might add. When we read through this brief treatise, we find more than half of it devoted to debunking existing theories about the lunar "markings" and the remainder focused upon discerning the nature of these markings on the basis of extended deduction from a thin stratum of observations. At its outset, the work promises something unprecedented:

> If one were to carefully observe and consider the surface markings [of the Moon], one finds them to be of constant disposition, revealing no changes in themselves, neither in their form, their position and size, nor in their respective types of darkness. Superstitious men, and those who should not be taken seriously, have proposed their own, divergent opinions on this matter. Certain people hold that the spots belong to the lunar body itself; others believe that they exist apart from it, namely between the lunar body and the eye of the observer; still others conceive that they offer an inverted image [of the Earth], since the lunar surface is smooth and reflecting. . . . There are also those who maintain that the form of the earthly oceans can be seen there, in mirror image, while others say that it is mountains and mountain ranges of our Earth that are reflected. Finally, there are some who believe that what is seen defines a [unique] form outlined by reflected rays falling upon the Earth. (pp. 1–2)

Al-Haytham's treatise is, therefore, like Plutarch's, a catalogue of existing ideas about the lunar surface. Also like Plutarch, this author intended to dispense with most of these ideas. Whereas the Greek author selected one particular concept for applause from among the many discussed, al-Haytham had his own to propose. Doubtless Arabic scholars were directly and indirectly influenced by Greek ideas on the Moon; some of the beliefs discussed by al-Haytham (e.g., the Moon as a reflecting sphere) were current in Hellenistic philosophy and can be found in Plutarch's own work. Does this mean that al-Haytham used Plutarch as a source? The possibility certainly exists. A similarity in titles alone might suggest as much. Beyond this, however, some of the same reasoning and evidence appear in both works. Yet the conclusions reached by these two authors about the nature of the lunar "spots" are entirely different and, in fact, mutually exclusive. In matters of style, too, Plutarch and al-Haytham share very little. Whereas the Greek author chose a dialogue format and thus could include a range of specific rhetorical voices as well as humor, literature, myth, and philosophy, al-Haytham (if we are to accept his translator's version) wrote in a consistently flat, no-nonsense style entirely reminiscent of Aristotle. His book is much briefer (a mere thirty-four pages in its published translation) and less entertaining. Here lies a crucial point: it is distinctly *not* a literary science that interests al-Haytham, but a philosophical and observational one. The Moon to this author is not a subject for imaginative flights of fancy or folly; it is a very real object whose essential nature must be discerned from the workings of clear-sighted logic.

What were some of the specific "theories" that al-Haytham sought to debunk? First mentioned and apparently among the most popular were those that posited some intervening substance in space itself, whether between the Moon and the Earth or the Moon and the Sun. Such a substance might include a certain "moistness" or a series of "vapors" drawn up from the surface of the Earth (again, a Greek idea, which is also found in Pliny). Alternately, denser or more "opaque" areas hovering between the Moon and

the Sun were thought to partially block out the light received by the lunar surface, thus creating the appearance of "spots." These theories, therefore, were based on the idea that the Moon shines mainly by reflected light. A second group of hypotheses proposed that the Moon is covered by a thin, transparent layer and that either this layer is itself spotted or else acts as a complex stratum in which the light from the Sun and the light from "behind (within?) the Moon" mix and partially cancel each other. Al-Haytham also discusses and discounts the concept that the Moon's appearance is due to topographical roughness that throws shadows on what is otherwise a smooth and crystalline surface. Such roughness, he states, was thought by some to result from elevated terrains, such as mountains, and by others from low areas, such as cavernlike holes.

Considered closely, these theories do not merely represent different accounts of an identical observation. To see the lunar maria as "clouds" out in space, as pure reflections of earthly oceans, as embedded "darknesses" in a translucent film, or as shadows cast by mountains or valleys requires a difference in specific cognitive emphasis. This diversity in cognitive style tells us that there were no standards at the time, as in antiquity, for observing the Moon. No central guide existed for making sense of the seen. Such guides *were* present with regard to the motions of the planets and the Sun, the visual order of the constellations, and the geometric relationships of the solar system. These guides were mathematical and, in the case of the constellations, also allegorical. They did exist, however, and helped to standardize perception. This was not true of the Moon. Lunar perceptions remained diverse, unsettled, even fanciful up to the time of Galileo. As we shall see, it was not the telescope per se that finally, after so many centuries, set down the basic rules of the Moon's visual reality; it was Galileo's own magnificent use of this instrument to produce convincing images of witness that established a true perceptual rhetoric for the lunar surface.

Galileo, in a manner of speaking, recreated the Moon in the image of the Earth in an entirely literal fashion. Any of the visual concepts that al-Haytham discussed might also have been tied to terrestrial realities, such as clouds, glass, crystal, or translucent stone, all of which could have been used to support the perception of the lunar surface as embodied light. As for the vision of mountains and caves on the Moon, obviously it is the Earth itself that is used as a perceptual model, just as it was in Plutarch's day. Yet none of these concrete, everyday analogies are invoked in al-Haytham's text. Everything remains on a more elevated, philosophical plane. In writing of the lunar surface-as-landscape theory, for example, the author never uses terms such as "hills," "valleys," "mountainous," or "rolling"; he speaks only of "roughness" *(Rauheit)* or "unevenness" *(Unebenheit)*. The only comparison made is an indirect one between the Moon and a certain type of optical "body."[12] This lack of earthly comparisons is just as true for Averroes, whose work appeared several centuries later. This point may seem minor, but it gains much meaning when compared with later discussions of the lunar surface during an era of increasing naturalism in art and science in Europe.

Without going into detail, al-Haytham dispatches most ideas about the Moon on the basis of two fundamental principles. The first of these stems from observation and was also used by Plutarch: the spots on the Moon cannot be pure reflections, or the result of space vapors, or anything similar because they would naturally change shape, size, and location at different times of the lunar cycle and from different positions on the Earth. The "spots" on the Moon never vary, therefore none of these theories can be correct. Al-Haytham's second principle, however, is one he deduced from optical considerations of the Moon's light and origin, as put forth in his earlier work *On the Light of the Moon*. This principle denies that the Moon shines by reflected light alone, maintaining that its luminosity is due to a combination of reflection and the native capacity of the lunar material to absorb and emit, or "give back," a certain quantity of light received from the Sun. "The Moon," writes al-Haytham, "becomes self-illuminating when struck by sunlight" (p. 11). "That light produced by each point of emanation is called 'secondary light,' while the light reflected from the smooth body [of the Moon] is called, analogically, 'primary light.' Secondary and primary light are produced together, when the smooth body is reflecting in the line of sight" (p. 13). It is this idea of a self-illuminating Moon that Averroes adopts in his own treatise, although taking it to a more extreme position.

How, finally, does al-Haytham explain the markings on the Moon? First, he concludes on the basis of the theory just noted that differences in the light given off by lighter and darker areas of the Moon indicate that "the body of the Moon [must] be entirely different in those places where spots occur" (p. 20). More specifically, "the entire lunar body possesses the power to absorb light; only in the places where spots occur is this power incomplete, and this

because of some impediment" (p. 30). The origin of this impediment, we are eventually told, is that the Moon, like other heterogeneous bodies, contains certain areas characterized by an increased "density" *(Dichtigkeit).*

At this point, the treatise ends. In modern terms, we do not seem to be left with much; but in fact, the author had gone beyond most of his contemporaries. The secret of the Moon's spots, he implied, the answer to this ancient "lunar sphynx," was not to be found in phenomena of light after all but in the nature of the Moon's physical substance. Hints of the idea of "dense" and "rare" lunar substance existed in antiquity and were certainly later found in the writings of Arab scholars such as Ibn Sina (Avicenna). Al-Haytham, however, gave this concept one of its first major articulations. In this regard, something else this author says is also noteworthy: "If what we perceive in the lunar surface is only reflected light, then it can be maintained that the spots on the Moon represent nothing other than physical irregularities in this surface, which hinder the reflection of light" (p. 11). Inverted, this argument states that the Moon must have a significant topography if it can be shown to shine by reflected light.

What we find lurking in al-Haytham's little book is very similar to what we saw in Plutarch's much larger one: an essential interest that strikes near the heart of the lunar appearance, extending itself into questions and statements about the actual physical reality of the Moon. Granted, Plutarch is more explicit; his "mountains flaming bright" affect our imaginations deeply and immediately. Both authors, however, succeed in drawing the reader's attention to the lunar surface itself. This is where al-Haytham's narrative finally lands us, despite its philosophical-optical baggage. His text even resembles the very body he wishes to investigate: thick and opaque in some parts, brilliant and unobstructed in others. If Averroes refused to acknowledge any debt to him, it was perhaps to avoid any direct comparisons.

## THE MOON OF THE FOURTEENTH CENTURY

By the early 1300s, the ideas of Aristotle and Averroes were in wide circulation throughout European intellectual culture and commanded enormous, if sometimes conflicting, allegiances. Although it does not appear that fourteenth-century Scholastic philosophers knew of al-Haytham's work on the Moon (there seem to be no Latin versions of it), they nonetheless repeated much that was in it through their debates and discussions on Averroes. Contrary to what has often been said, however, European authors did not merely repeat The Commentator's words. One example of this, as well as a sign of how generally known were Averroan concepts, is the discussion of the lunar substance that appears in two works by Dante, his *Divine Comedy* and the unfinished *Convivio.* In both works, Dante mentions that it is a widely held belief that the dark portions of the Moon represent "rarer" material and the light areas "denser" material, which is a complete inversion of Averroes's own position.

Not content with this explanation, Dante has Beatrice refute it in the *Divine Comedy* by proposing an actual experiment along Aristotelian lines (involving mirrors and a candle to show that a reflected image does not become darker with distance) and then replaces the dense/rare idea with a diffuse, Neoplatonic scheme dependent upon angels governing each of the planetary bodies and a single "mover" who is variably expressed in them.[13] What is significant about Dante's scheme, however, is its proposal that the Moon is made up of more than one substance: "[T]he which in quality, as well as quantity, may be observed of diverse countenance." This was a much more radical departure from reigning interpretations of Averroes, which preferred a more or less homogeneous lunar body. It was also not well accepted within the precincts of Scholastic philosophy, even among such influential and innovative thinkers as John Buridan, Nicholas Oresme, and Albert of Saxony.

John Buridan (ca. A.D. 1300–1358) wrote a treatise on Aristotle's *Metaphysics,* in which he also commented directly upon Ptolemaic astronomy, following Averroes's denial of the existence of epicycles. Buridan speaks only briefly of the Moon and its appearance, when discussing whether an epicycle should be assumed for its motion. It should not, he writes, "because then it would follow that in the spot of the Moon which appears as if it were an image of a man whose feet always appear to be below [or toward the bottom], the feet would sometimes appear above [in the upper part of the Moon]."[14] This image is less complex and was probably much more prevalent among scholars than that of Albert the Great. Yet it shares with his notion a more

purely descriptive component. Nothing of this attempt to identify a figure in the pattern of light and dark on the lunar surface exists in the work of Averroes. Buridan and Albert both treat the Moon as a single body with a single substance but also speak of it as a picture to be painted in words.

Between A.D. 1370 and 1377 Nicholas Oresme translated Aristotle's *De caelo* into French, giving it the title *Le Livre du ciel et du monde* (Treatise on the heavens and the universe). In this work he included a commentary in which he made many statements about the Moon. Oresme mentions Albert the Great's lion/tree/man image, yet he also cites Averroes in many instances. He states definitively that "[t]he moon is a perfectly polished . . . transparent and clear body such as crystal or glass."[15] Its "spot" or "shadowy figure" results because different parts of the lunar substance are "transparent and clear" to different degrees, the optical equivalent of "dense" and "rare." The author also spends some effort refuting competing ideas about the Moon's surface, especially the classical notions that it is a mirror of the Earth or obscured by "heavy vapors" lying between the Earth and Moon that are attracted by the "cold body" of the latter. (This was a popular idea among Islamic scholars of Greek science.) At some point, however, Oresme makes a curious comparison: "It should be noted that, in the case of an alabaster stone, those veins or sections that are most clear and through which one can see almost as clearly as through crystal seem darker and less white than the other parts; the same is true of parts of the Moon. Thus the clearer some parts are, so that the Sun's penetration is deeper, the darker those parts appear" (p. 459).

A piece of terrestrial rock, an ornamental one at that, becomes a model to explain the nature of the lunar surface. In these few lines, Oresme introduces a new world of immediate, visual evidence that one can physically hold before the eye. For the first time since antiquity perhaps, literal pieces of the Earth are proposed as the key to the nature of the Moon. Oresme's work has more than a few concrete analogies: the fixed stars are said to move "like a nail lodged in a ship" (p. 453), and the heavens cannot be divided "as one divides a wooden log" (p. 455).

One last fourteenth-century author who deserves mention here is Albert of Saxony (ca. A.D. 1316–1390), whose work, *Questions Regarding the Heavens and Universe,* addressed the problem of lunar substance in a manner that, at first, seems an almost word-for-word citation of Averroes:

> The Commentator issues [an] opinion, which I believe to be true. The spot [on the Moon] issues from the diversity of the parts of the Moon. . . . The parts in which the spot is seen are the rarest, which renders them least capable of glowing. The parts next to them are the densest, and because of it, they glow most. . . . The Moon is simple in substance, in fact, but that would not prevent it from exhibiting differences in density and rarity between its various parts.[16]

Like Dante's protagonist in the *Divine Comedy,* Albert of Saxony reverses Averroes on the lunar maria and their cause while upholding the idea that the Moon's substance is "simple," i.e., homogeneous. Albert is less in touch with the growing preference for the concrete than are his relative contemporaries, John Buridan and Nicholas Oresme. His Moon is very much a Scholastic orb, unmediated by the new comparisons and analogies that seek to explain it in entirely familiar terms and that would continue to gain force in the century that followed.

## THE RISE OF NATURALISM: ART AND SCIENCE UNITED

Late medieval art began a profound shift in its aesthetic priorities with respect to the natural world. In the place of stylized, wooden, or gestural portrayals, expressive of an art that served as didactic surface, a new type of realism intruded. By the mid-thirteenth century the capitals of cathedral columns in France; the margins of French, German, and English book manuscripts; and the illustrations of most herbaria and other scientific works displayed the closely observed features of plant species, insects and birds, known and mythical animals, and Christ with wounds that gushed or flowed.

The ascent of naturalism has been a topic of frequent scholarship ever since the early decades of the twentieth century.[17] This ascent appears to have begun in sculpture and progressed from there into painting, book illumination, and other expressions. So striking is this change from previous Romanesque styles, so eager is it for the world of appearances, that it has often inspired flights of exaggerated discovery: "The thirteenth century sculptors sang their *chant de moi,*" writes one well-regarded authority. "All the spring delights of the Middle Ages live again in their work. . . . The [late medieval

period], so often said to have little love for nature, in point of fact gazed at every blade of grass with reverence. . . . It was these breeders in stone, these Burbanks of the pencil, these Darwins with the chisel, who knew nature and had studied botany and zoology in a way superior to the scholar who simply pored over the works of Aristotle and Pliny."[18] The truth, however, requires that this observation be amended. Not only were these early naturalists steeped in the writings of Pliny, but they were also probably acquainted with the herbals and bestiaries of Arabic writers, the writings on animals by Aristotle, and the physiology of Galen, all so recently translated and so clearly superior to similar works by earlier Latin authors.

The new feeling for natural detail came from many things, not all of them well understood. Beginning mainly in France, it was tied to the burgeoning court of Paris, with its growing love of learning and finery. The medieval world had become a vastly larger place than it had been in the time of Charlemagne, spurred forward by the growth of towns and international commerce, the rise of the artisan classes, the spread of literacy, the advent of pilgrimages and crusades, and technological advancements.[19] A potent new mobility had been added to European society by the late twelfth century—mobility of objects, goods, currency, persons, books, languages, words, and images. Partly as a result of these expanding circulations, an eager materialism became inevitable. It was aided by religious reforms such as those of the Franciscans, who saw and praised God in the "littlest of things." No longer was the physical world a storehouse of symbolic images, "an aesthetic expression of ontological participation" in the play fields of the divine.[20] While retaining such universality of the *tableau sacré,* it had also become an atlas of objects, a "book written by the finger of God," as noted by Hugh of St. Victor (A.D. 1096–1141).[21]

No more remarkable example of the new piety of naturalism exists than in a text by this same author comparing holy meditation with green wood catching fire. Hugh's description of the flame's struggle with the log, the clouds of swirling smoke, the quality of flickering light, and the progress of combustion itself go on for more than a page. They are delivered in a vivid, dramatized prose; the author is not merely describing things for us, he is telling a story, painting a picture. His observations bear us along, beyond the edges of any original comparative dimension, into a scene of wholly material process.

> If the fire first seizes hold of the green wood with difficulty, it soon does so with ever stronger gasps, flaring up against the exposed pith. One sees how the thick, dark clouds of smoke rise and envelop the yet measured glow that barely shines within, until, gradually, the flames more fully awake, smoke and darkness disappear, and the pure glow of fire emerges into the foreground. Now the victorious flames take command and spread themselves over the entire burning mass, like a funeral pile . . . flickering here and there, penetrating and shooting forth from the victim material. Only then, when it has penetrated the innermost portions and drawn all into its power, does the fire grow quiet . . . and every sound softens. The raging and devouring flame becomes still and peaceful, having forced all to submit and be incorporated into its sympathy, finding nothing any longer that might be alien or opposed to itself.[22]

Reading such words, we sense a mind caught up in its own ability to observe, record, and dramatize, a mind in love with the narrative production of images.

Between the middle thirteenth and late fourteenth centuries, the regional base of the new naturalism shifted from holy to secular workshops. Commissions offered by and through the Church were no longer the staple of artists and illustrators everywhere; many now found patrons in the court of the French kings and later in the metropolitan centers that bloomed under the wealth, power, and taste of the brothers of Charles V. These dukes of Berry, Burgundy, Anjou, and Orléans acted as the benefactors of the burgeoning arts and sciences and did so in sumptuous fashion. The greatest artists of this period, up through the first several decades after 1400, were Flemish and Dutch by birth and often by training. The most famous are Claus Suter from Haarlem; the Limbourg brothers from Guelders; Melchior Broederlam from Ypres; the Master of Flémalle and Jan van Eyck, both from the Netherlands. All of these artists took the "return to nature" greatly beyond anything previously conceived. They produced a scholarly art, steeped in textual sources (not only the Bible but also the works of Pliny, Discorides, Aristotle, and Galen), that was also worldly in the most immediate sense. Quite suddenly the artistic capacities of antiquity, for so long the standard model of *renovatio,* were left behind. For the first time, it appears, artworks

became the stage for revelations of visuality and displays of collected observation. Stone, tempera, and oil were transformed from tools to media, from implements for expressing spiritual universals to visual textbooks in which both common and uncommon objects of this world could be documented with photographic precision.

This is not to say that these artists left behind all traces of medievalism. On the contrary, their training and the books upon which their scholarly sense of the world were based came directly out of medieval sources. Some more than others retained crucial aspects of past aesthetic tradition, and all kept something of the earlier centuries intact, whether in the gestures and arrangements of their holy subjects, in the use of gold to depict light, or in the lack of secular topics. But here their debt ends. A difference far greater than mere application lies between oak leaves and animals crawling across a sacred page and vast landscapes populated by trees, rivers, valleys, mountains, famous castles, ships, and every sort of human dress and face. The new materialism in art carried with it a necessary precision, an adoration for the physicality of things. It was a monument to observation. It is no accident that the first naturalistic drawings of the heavens occurred outside the limits of astronomy itself. It is a vast step in the history of illustrating the world that the Moon and the stars finally entered the list of worthy subjects at this time.



# 6

# The First Drawings of the Lunar Surface

## ART ASCENDS THE HEAVENS

There is a small yet striking truth about medieval European art: for more than eight hundred years, from the end of antiquity to the opening of the Renaissance, not a single figure was painted to cast a distinct shadow. After so long an absence, shadows reappear in the frescoes of Masaccio and in the oil paintings of early Netherlandish artists, most notably Jan van Eyck.[1]

For Masaccio, whose *Acts of the Apostles* appears in the Brancacci Chapel of St. Maria del Carmine in Florence, shadows are a central character to a particular drama—the tale of St. Peter healing the sick with the touch of his shade. The artist has attempted to reenact events for the viewer, who is then a virtual eyewitness. There is a crucial continuity with the medieval universe here. From St. Gregory onward, one of the stated functions of art was to teach the illiterate the stories of the Bible.

For Van Eyck, on the other hand, the "conquest of appearances" has a very different quality to it. Shadows, for example, are never magical or miraculous. They are instead ordinary, simple, darkening extensions of objects in