For five hundred years Roman artists maintained a fixed gaze through their open window to the sky. Astonishingly, there are almost no signs of innovation in Roman sky painting after the time of Pompeii. The theme of aerial perspective was repeated almost ad nauseum while other features of the sky such as clouds and optical phenomena were virtually ignored. Yet even as Rome lay dying, she managed to bequeath a viable tradition of sky painting to the Early Christians and Byzantines.

Rome's beneficiaries took a brilliant but all too brief glance at the heavens and produced a few mosaics that stand as landmark works in the history of sky art. To them we owe the glory of the sunset and the resurrection of clouds in art. But once in power, it no longer served their interests to examine the sky. They then barred all further access to the heavens with a curtain of gold, and sky painting throughout Europe slept for almost a thousand years.

Early Christian Art and the Byzantine Demise

The beginning of Rome's long decline might symbolically be traced to a seemingly minor incident that occurred early in the reign of Vespasian. Vespasian reached Rome in October AD 70, resolved to restore order and discipline to a Roman government that had languished under Nero and several dissolute successors. He embarked on a vigorous construction program which included the Colosseum. Suetonius relates that an inventor approached the emperor with plans for a hoisting machine that would greatly reduce the need for manpower but was rebuffed with the reply, "I must feed my poor." Vespasian feared the machine would exacerbate unemployment in a society already overrun by idlers and slaves. Labor saving devices such as the water wheel were not wanted and consequently were neglected until there was a significant decline in both the general population and the number of slaves late in the 4th century. But a society that does not use its inventors will eventually lose its inventors.

Writing about 70 AD, Pliny the Elder addressed this troubling issue. He noted that his fellow citizens were driven solely by shortsighted commercialism and wrote further,

no addition whatever is being made to knowledge by means of original research and in fact even the discoveries of our predecessors are not being thoroughly studied.

Pliny, it should be noted, was a man of his times, for in his encyclopedic writings he indiscriminately lumped scientific findings together with the grossest superstitions. Pliny's characterization of Roman society as totally unoriginal, uninventive and shortsighted was unduly harsh but must have contained a core of truth. Perhaps a more profound aspect of Roman society was its surprisingly desultory and haphazard attitude toward innovation. The concept of progress was undeveloped and little value was attached to research. Romans did appear to be directed almost entirely by immediate results. Specific innovations were not adopted unless they produced an immediate improvement (which is rare for new inventions). Promising general techniques were disregarded. And, if new devices or techniques produced only a minor improvement, the old methods were seldom abandoned but were maintained side by side with the new. In an environment with such a casual and perhaps even cavalier attitude
toward experiment, civilization will eventually decline and innovations in sky painting will also cease.

The indifference with which Romans greeted new and more accurate observations can be seen in Roman sky and landscape art. Uniformly blue skies appeared side by side with color graded skies, as if old falsehoods were as good as new truths.

The unbroken series of carved scenes that spiral up Trajan's Column dedicated in 113 AD (Fig. 3-1), betrays the same curious ambivalent Roman attitude toward innovation. Recession into distance is handled reasonably well in some of the scenes but in others the depth seems severely limited and characters are packed together in a manner that would come to characterise Medieval art. Little, if any, room is left for the sky in these scenes. Roman sculptors apparently saw no compelling reason to incorporate the aerial discoveries of their fellow painters.

Fig. 3-1. Scene from Trajan's Column. 113. British Museum, London.

For almost 50 years after Trajan's death, Rome enjoyed peace and prosperity. But early in the reign of Marcus Aurelius, revolts broke out in Britain and Germany and Parthia declared war. Roman armies squashed the uprisings but brought plague back from the East as the price of victory. The pestilence spread through the Empire, decimating the population and reducing the normal conduct of business to chaos. Sensing Roman weakness, rebellions against Rome erupted everywhere. For the remainder of Aurelii's tenure in office, the stoic and peace loving philosopher felt compelled to remain almost constantly on the battlefield.

The high mortality rate caused by the pestilence and the seemingly interminable military difficulties of these years did much to
sap Roman confidence. Pessimism and a feeling of helplessness infiltrated all levels of society, leaving their mark in Roman art and philosophy. The long inviolable classical rules of proportion and organic form were relaxed. In art, relative size was once again employed to denote the social or spiritual importance of a figure, as it had in much Egyptian art.

This technique was employed in one of the scenes from Marcus Aurelius's Column, the Miracle of the Rain (Fig. 3-2). The scene recounts how a meteorological event altered the outcome of an important military encounter between the Romans and one of the Germanic Tribes. A drought dehydrated the Roman forces while the enemy maintained control of the water supply in the river valley. When death from thirst seemed certain, a flash flood saved the Roman forces and simultaneously drowned many of the unfortunate enemy in the flooded river valley.

Fig. 3-2. Marcus Aurelius's Column. The Miracle of the Rain.

The rain in the Miracle seems to emanate from a winged figure that is larger than life (although some rain is also falling beyond the range of his outstretched arms). The enemy is shown swept beneath the swirling flood waters while the conquering Romans are about to trample on them.

This scene also marks the reappearance of the supernatural and the beginning of the slow but inexorable degeneration of naturalism in Roman art. Apparently, during Aurelius'
regime, the Romans began to rely increasingly on miraculous and supernatural solutions for their problems. The old world order was impotent to combat plague and could no longer provide an adequate sense of security against human foes. Rome was still able to win her battles but the effort was exhausting. Each victory seemed merely to reveal yet another hungry and eager enemy massing on the frontiers.

Artists at this time also began to place more emphasis upon emotional suffering. The Greeks and Romans had never flinched at showing physical pain in their art but had long been reluctant to represent spiritual agony. From the time of Aurelius's Column, spiritual troubles were depicted with increasing frequency. At first the new expressiveness was largely restricted to conquered barbarians but by 230, some 50 years later, even Roman citizens and Emperors were shown in this way. Spiritual unhappiness had become a widely recognised and publicly acceptable Roman emotion.

The emotional vulnerability provided the opportunity for religion and philosophy to inject once again into the public forum their essentially irrational and mysterious prescriptions for the nature of the universe. A host of new cults and doctrines filled the marketplace and competed for control of people's minds and souls. Slowly, Christianity emerged victorious. Constantine's conversion in 323 may have been little more than a tacit acknowledgment that Christianity had already become a major political force in the Empire. Thereafter Christianity quickly replaced paganism as the principal religion and began to build great churches. These had to be filled with appropriate works of art.

The Good Shepherd mosaic (Fig. 3-3) reflects the changes that had come over the Empire and its art. The Good Shepherd represents a radical departure from most earlier Roman art. It has a soothing quality. The setting is pastoral and the shepherd is comforting and protecting his placid flock. The sheep are healthy, the land is green and fertile, and no storm clouds or wild beasts threaten.

Fig. 3-3. The Good Shepherd. C. 450. Mausoleum of Galla Placidia, Ravenna.

The brightness and clarity of The Good Shepherd mosaic are among its most striking and new features. The prevalent Roman haze has finally been washed away, as by a good rainstorm, and even the most distant parts of the landscape (which admittedly do not seem very far away) can be seen distinctly. The youthful and confident religion was announcing to the world the clarity and purity of a new creed. It had nothing to hide. Its shepherd was providing paternal comfort and divine guidance. He was cleansing his flock's soul of spiritual suffering. All was candor, joy and love.

The shepherd, of course is Christ, while the sheep represent the greatly increased Christian flock. Christ's head is surrounded by a gold nimbus or halo and his staff is a gold crucifix, each to imply divinity.

But Christ's love and protection came with a high price tag. The good Christian was required to focus attention on otherworldly concerns. This is why the scene is placed on an elevated mesa, and set off from the rest of the world by a precipice of unknown height. The
landscape is also severely flattened to affirm that corporality as indicated by physical depth, the seat of all evil, is to be despised.

The sky of *The Good Shepherd* remained blue despite the mosaic's new message, for the Early Christian Church enlisted classical values and images as allies in its accession to worldly power. The sky consists of two bright blue stripes, with the lighter stripe near the horizon and the darker one above. The Romans had frequently used this simple convention to represent the graduated sky (recall Fig. 2-4), and apparently never lost sight of its physical significance.

The Early Christians adopted the convention of sky banding and, for a brief time, also used it with discrimination. Ultimately it would be stripped of its connection with the world of nature so that by the time of Carolingian art the banding had acquired its own meaning. The Early Christians inherited Roman culture and benefitted from it even as they set about dismantling its exposed and rotting foundations. This is one of the ironies of history. The Early Christians disparaged and ultimately helped destroy the Classical heritage that had been placed at their fingertips while many of their descendents would yearn for the Roman past - its order, magnificence and sophistication - but had fallen so far they could not even begin to comprehend it.

For some years after *The Good Shepherd*, the Early Christians and Byzantines continued to find inspiration in the sky. To them, as to St. John the Divine, the sky was important as a source of Revelation and a symbol of heaven. Even the clouds merited attention for it was written that Christ had disappeared into a cloud and prophesied he would once again appear in clouds - "Behold, he cometh with clouds; and every eye shall see him."

And so, in the Church of St. Cosmas and St. Damian in Rome, we find the magnificent mosaic of the apse, *Christ Appearing in the Clouds* (Fig. 3-4). This was executed about 530 and was accompanied by the inscription,

\begin{figure}
\centering
\includegraphics[width=0.8\textwidth]{mosaic.jpg}
\caption{Christ Appearing in the Clouds. C. 530. Church of St. Cosmas and St. Damian, Rome.}
\end{figure}

This hall of God shines in its adornment with enamels, a hall where the precious light of faith gleams even more brightly. To the people a sure hope of salvation comes from the martyrs who heal their ills, and the temple before named as sacred has increased in honour. Felix has made to the Lord this offering, worthy of the Lord's servant, that he may be granted life in the airy vault of heaven. *The Mosaics of Rome.* p 94. Walter Oakeshott

The mosaic is, indeed, a monument of religious splendor. Its brilliant and sparkling colors display the mosaic technique to
maximum advantage. A deep blue sky occupies a large percentage of the mosaic, for Christ has appeared in the clouds to announce the Last Judgment. It is the sky of twilight, perhaps the final twilight on earth. No wonder its blue is so deep and its clouds, which support Jesus, are streaked with such bright red.

This cloud-filled, twilight sky contrasts sharply with all known remains of earlier Roman art. The colors of Roman murals tend to be far more subdued than in this mosaic. This is due in part to the fact that mosaic colors retain their extraordinary brilliance while paints invariably fade or darken as they age. But earlier Roman mosaics never employed such spectacular colors and many were done in black and white. Bedazzling the spectator was one of the deliberate aims of the Early Christian Church.

The mere presence of clouds was also intended to strike Romans, who had generally preferred a clear sky with at most a few formless mists of clouds lacking substance. The attention that the Early Christian artists lavished upon clouds represents their singular contribution to sky painting. For the first time, substantial clouds were accorded their rightful place in the sky. Clouds helped buoy Europeans through the Dark Ages and finally liberated them in the 15th century. Never again would they entirely disappear from European art.

By the end of the fourth century, clouds were regularly appearing in Early Christian art. The first clouds tended to resemble tubes or loaves of bread, and can be variously identified as cumulus or their flattened and sometimes banded relatives, stratocumulus and altocumulus. The clouds of the Christ Appearing in the Clouds, for example, are most likely the flattened, banded stratocumulus or altocumulus clouds often seen at twilight.

Gradually, these smooth and pliable clouds froze into flattened triangles with horizontal bottoms and scalloped tops. In this odd and highly stylized form they were almost universally adopted by Byzantine artists and clung to life until the Renaissance. It is possible that these triangular clouds proved so enduring because they suggested the Trinity to the medieval mind. Yet as odd and stylized as such clouds may seem, their shape was ultimately derived from observation. They resemble either small cumulus or altocumulus castellanus, which characteristically do have flat bottoms and gently corrugated tops. They are also Mediterranean clouds, for summer skies around the Mediterranean are dry skies that stunt cloud growth.

Fig. 3-5. Apse of Sant' Apollinare, Detail. C. 550. Classe, Ravenna.

Then the sky disappeared. The mosaic from the apse of Sant' Apollinare in Classe, Ravenna (Fig. 3-5) was completed only a few years after the Christ Appearing in the Clouds yet its form is ossified. Here the viewer is besieged by legions of stylized triangular clouds with flat bases and scalloped tops, but some rotated by 90°. The cloud army appears in a sky that has become largely golden. The Church of this work is a confident, controlling power. It no longer has need of tolerance or innovation. As Eric Hoffer noted in The True Believer, "The conservatism of a religion – its orthodoxy - is the inert coagulum of a once highly reactive sap." The blue sky and clouds represented Christianity's highly reactive sap - the gold, its inert coagulum.
The gold sky served many purposes in medieval art and managed to outlive the Middle Ages. The gold imparted an aura of majesty to all works. It helped the figures stand out distinctly from the background. But its primary role was to remove the background. The gold skies simply emulsified any earthly reference point, dissociating the scene from the material realms of time and space and relocating it in the spiritual domain of the eternal and holy. And this, according to the Church fathers, symbolized ultimate reality. Heaven had blocked out the sky.

Sant' Apollinare represents the swan song of the Western Empire. Increasingly from the time of Constantine, men of talent had been drawn into the service of the Church, forgoing government careers, and hastening the civil decline. The stern Roman code of discipline had long since been drowned in a fragrant bath of luxury. Even the climate may have played a crucial role in Rome's downfall. Barbarians, probably forced from their central Asian grazing lands by an extended drought after about 300, migrated westward and repeatedly stormed an inward looking and fearful civilization.

In 542, when Sant' Apollinare was under construction, plague broke out in Egypt. It rapidly spread across Europe and then eastward into Asia. Repeated outbreaks over the next 25 years may have reduced the population by as much as 50% and wreaked havoc on the economy of the Empire. Justinian's costly wars to reunite the Empire only added to the chaos. Rome symbolized this decay - its population, once a million, had fallen to 40,000. It was at this point that darkness finally descended over much of Western Europe.

Byzantium, ensconced within the safety of her walls and at the economic crossroads of Eastern Europe, managed to lead a nervously comfortable existence through the Middle Ages. The Byzantines helped to preserve and transmit the accumulated heritage of the Classical world, but their efforts were marked by such conservatism that in many fields, such as sky art, they added little to this heritage.

The conservatism of Byzantine art was no accident. Church and State dictated the themes, flavor, and even the remains we have of Byzantine art and ensured their unwavering devotion to a timeless and changeless Christian creed. An almost Egyptian immobility returned to the human scene. Artistic creativity was simply not a Byzantine issue. A decree of the Church Council of Nicea in 787 ensured that artists were not to be regarded as individualists or creators. "It is for the painters to execute; it is for the clergy to ordain the subjects and govern the procedure." The role of religious art was defined quite narrowly in Byzantium. Its sole function was to illustrate theological truths in an orthodox manner. Just as we do not want our copiers to change the originals one iota, so too the Byzantine patrons demanded their artists to preserve the "true message" they were employed to transmit.

The Byzantine attitude toward painting fluctuated from a relatively benign inflexibility regarding innovations to a harsh and ruthless intolerance of the very existence of any painted images. Oddly enough, the Council of Nicea had the effect of liberalizing the attitude towards art in Byzantium. The Council helped weaken the influence of the Iconoclasts who had come to power in 726. The Iconoclasts abhorred all graven images and were responsible for a wave of destruction that eradicated almost all earlier works of art in Byzantium.

In Western Europe, no single wave of destruction matched the achievements of the Iconoclasts. Nevertheless, by the time of Charlemagne, some 200 years after Justinian, Roman heritage in Western Europe had faded to little more than a vague memory of past grandeur and glory. When Charlemagne returned from Rome in 800, he passed through Ravenna and was deeply impressed by the churches and their mosaics. He had his chapel
at Aachen modeled after the Church of San Vitale at Ravenna.

Ravenna's mosaics may also have served as models for Carolingian painters, since the striped sky is one of the trademarks of Carolingian illuminations. Most of the stripes are blue but a significant fraction are pink because of the popularity of twilight scenes. The color sequence of these stripes often bears a relation to the real world but at times,

The painters seem to have forgotten the actual significance of the convention and used it merely decoratively, as the sequence of colors has no relation to anything that exists in nature.


The *Frontpiece to Deuteronomy* from the *Bible of San Paolo fuori Le Mura* (Fig. 3-6) contains an aerial color sequence that has come unhinged from nature. In the upper left, Moses has died and is being transported across the sky to heaven by an apocryphal angel. Three colored stripes appear in the sky above the prophet's feet. From top to bottom they are light blue, almost white and dark blue. If the top two stripes corresponded to clear sky and the bottom to the ocean, as in some Carolingian manuscripts, then the sequence would be natural. But here, in contradistinction to anything from the natural world, all three colors also tint the clouds.

The fascinating, but stylized, clouds in the Frontpiece to Deuteronomy resemble the tops of burgeoning cumulus and give a distinct feeling of the eddying motion that molds them. Such a flowing representation of clouds is exceptional in European art but has long been familiar to Chinese artists. The clouds of the Frontpiece are probably based on some Roman or Early Christian prototype, now lost. Even though the cloud protuberances are ultimately abstracted from nature, the artist tilted a few of them so that they aim diagonally downward, a possible but most unlikely orientation.

Fig. 3-6. *Bible of San Paolo fuori Le Mura.* Frontpiece to Deuteronomy C. 870. Abbey of San Paolo fuori le Mura, Rome.
The indiscriminant jumbling of observations from nature in the *Frontispiece* reveals a basic aspect of the intellectual state of its creators. Imagination and, in its wake, symbolism had replaced substance. In a sense, the Carolingians were like children who have found an abandoned car. They played for a while with the steering wheel, perhaps hummed to imitate the engine's purr, but had no concept of the engine's design and little idea of its significance. The Carolingians were able to transmit to their descendents only the inert rusted frame of the vehicle of civilization. They knew only, like children know, that their car couldn't go but that once upon a time their forefathers, the Romans, had somehow smoothly run a vastly superior Empire. It was in this impotent state that barbarian marauders from the north and east returned again and again over the next two centuries to brutalize and ravish Western Europe. And as the Europeans huddled together, paralyzed with fear and saddled with ignorance, the forests slowly but inexorably grew over them and cast them back into darkness.

**The Divine Light of Natural Halos**

The halo, emblem of divine light and beacon of medieval painting, was the only reliable source of illumination for the souls that lived through the long Dark Ages. Figures 3-3 to 3-6 give some indication of how common halos were in medieval art. During the same time period, Buddhist painters in Asia were equally enthusiastic about halos. Indeed, there is good reason to name the period from about 450 to 1000, the Age of the Halo.

Halos in art have an ancient source. In Sumeria, where the halo was recognized as a sign of impending rain, the sun was sometimes represented as the wheel of a heavenly chariot, while the rim served as the prototype of the halo. By the ninth century BC, the Assyrian god, Ashur was painted in the aura or halo (see Fig. 1-15). The imagery of a heavenly chariot, taken from Babylonian sources, was absorbed into Jewish culture through The Vision of the prophet Ezekiel, which was represented in later Jewish and Christian art as a series of halos. Spiked aureoles also appeared around the head of the Persian sun god, Mithra and in that form they were appropriated by the Greek sun god, Helios. Rome, in its turn, embraced the cult of Mithra, perceiving the god as a beautiful youth with a radiant halo emanating from his head. The Roman halo formed one more channel in the braided halo river that discharged directly into the sea of Christian art.

![Fig. 3-7. Buddha With Halo and Nimbus. Cave 249, Dunhuang, Gansu Province. C. 530](image-url)

By the time halos appeared in Christian and Buddhist art, they had mostly lost their spikes or rays. In Christian art the halos, invariably encapsulating the heads of holy and divine figures, were represented as circular disks of solid gold, sometimes accompanied by thin radial rays. Buddha had both a halo around his head and a nimbus or mandorla enveloping his body. These were concentric rings of various colors, but on occasion, spiked flames...
still burned on the shoulders of various divine Buddhist figures, as in *Buddha With Halo and Nimbus* from the Temples of the Sangim Gorge (Fig. 3-7).

A number of different atmospheric optical phenomena could have inspired artists to represent halos. First is the circular aureole immediately around the sun. This is produced by the scattering of sunlight by aerosols. Rays apparently emanating from the sun in clear weather are merely the physiological result of afterimages momentarily burned into the retina, for no rays extend from the sun when the sky is clear. A second phenomenon is the corona, which consists of colored rings of light usually a few degrees from the sun. Coronas only appear when the sunlight is partially obstructed by certain thin, translucent clouds. Both of these phenomena would properly be represented as solid disks rather than thin rings.

Fig. 3-8. The Vision of the Prophet Ezekiel C. 450. Church of Hosios David, Salonika.

The most likely natural source for ringed halos is the panoply of atmospheric ice crystal halos. Ice crystal halos are seldom, if ever, noticed by today's city dwellers, but they actually appear in the skies quite frequently. They are most common in polar regions during the winter where they can form right in front of your eyes, but they can be seen at any time of the year and at any place on earth because at heights above about four miles the air is always cold enough to produce ice crystals. Outside of the tropics, halos are frequently seen in sheets of translucent ice crystal clouds called cirrostratus, and serve as harbingers of approaching winter storms. During the summer or in the tropics, halos can be seen in the cirrostratus sometimes expelled from the tops of thunderstorms.

Ezekiel's mystical and apocalyptic Vision of a heavenly chariot is difficult to interpret because it is couched in prophetic and miraculous terms, but it still matches many features associated with atmospheric ice crystal halo displays. The Vision has also justifiably been compared to the Aurora Borealis, but artists from at least the fifth century, as in the mosaic, The Vision of the Prophet Ezekiel from the apse of the Church of Hosios David in Salonika (Fig. 3-8), have almost invariably interpreted it as a halo phenomenon.

Ezekiel noted the date and place of his Vision, but neglected to say whether it was day or night. This exile from Israel was then living in Chaldea by the river of Chebar, between the Tigris and Euphrates Rivers, about 50 miles southeast of ancient Babylon. According to the dating system employed by the prophets, the Vision occurred during July of the year 593 BC. If the *Vision* did in fact occur at this time of the year it would have been truly remarkable because summer is the dry season in Chaldea and the summer skies of Iraq are generally clear.

Which aspects of Ezekiel's description match observed features of atmospheric ice crystal halos? Ezekiel wrote of wheels like rings, and wheels within wheels, eyes, wings, and a single rigid leg. The apparition and wheels did not rotate as they moved about the sky and when the apparation was high in the sky the wings were let down. The colors were variously compared to burnished bronze, fire,
electrum, amber, beryl, sapphire, and finally a rainbow.

The extraordinary and spectacular but entirely natural atmospheric halo display seen at the South Pole (Fig. 3-9), seems to be almost an embodiment of *Ezekiel's Vision*.

![Fig. 3-9. South Pole Halo Display. Walter Tape.](image)

The main features of Fig. 3-9 are simulated in Fig. 3-10. Perhaps the most common halo is the 22º halo, so named because it is a circular ring seen at an angle of 22º from the sun (or moon). This is the inner wheel or ring. Large segments of the 22º halo can be seen about fifty times a year in much of the middle latitudes. The outer wheel is the 46º halo, seldom seen in its entirety. Just outside either side of the 22º halo and at the same level as the sun are bright spots (the eyes), called parhelia or sun dogs because they follow the sun in its transit across the sky. These are also common visitors in the sky. Bright arcs that touch the tops of both halos give the impression of wings. The arc touching the outer halo is called the circumzenithal arc while that touching the inner halo is called the upper tangent arc. There is also a rare cap like arc (a second pair of wings?) above the inner halo known as the upper Parry arc. At the bottom of the inner halo are two arcs which are almost fused and resemble a leg. Finally, there is an arc passing through the sun that stretches horizontally across the sky, known as the parhelic circle. When the sun is high in the sky the parhelic circle can be a complete ring centered at the zenith and crossing the 22º halo like two intersecting wheels.

![Fig. 3-10. Celestial hemisphere computer simulation of Halo Display similar to Fig. 3-9](image)

The entire display follows the sun in its path across the sky. Since the parhelia or eyes remain at the sides of the halo as the sun rises, and the parhelic circle remains horizontal and does not rotate, they might give the impression of wheels that do not turn as they move. The upper tangent arcs or wings are among the few halo arcs that actually change shape. The higher the sun in the sky the less arched the tangent arcs or wings. Thus, when the apparition is high in the sky the wings seem to be let down. Finally, the parhelia, the tangent arcs and the circumzenithal arc sometimes exhibit colors as bright and pronounced as those of the brightest rainbow.

Few people can recall ever having seen an atmospheric halo. This is partly because most ice crystal halos appear relatively near the sun and are difficult to see amidst the general glare. When searching for halos in the sky it is often necessary and always wise to block the sun from view. Even then, most halos are not bright enough to emerge clearly from the background, so it is still necessary to become somewhat practiced in finding them. On occasion,
however, halos are so bright and exhibit such spectacular colors, they can take your breath away.

**22 Degree Halo**

Atmospheric halos are produced when sunlight or moonlight penetrates clouds that consist of ice crystals (Fig. 3-11). The crystals act like prisms, reflecting and/or refracting the light. Light refracts or bends whenever it passes obliquely through a prism. The prism refracts each color or light wave at a slightly different angle - red the least and violet the most. Thus, when a beam of white light enters the prism a complete spectrum emerges from the other side.

Like halos, rainbows are also produced when sunlight is refracted and reflected. But while halos are produced by ice crystals, rainbows involve raindrops. The differences between halos and rainbows arise from the differences between the shapes of ice crystals, which are basically all hexagonal (six sided) prisms, and raindrops, which are all nearly spherical.

The wondrous diversity of halo shapes results from three principal factors, 1: the precise shape of the ice crystals, 2: their orientation as they fall and, 3: the sun's height in the sky. Most ice crystals have six rectangular sides and two hexagonal faces but this barely restricts their diversity. Ice crystals can resemble snow crystals, flat plates, long pencils or even bullets or umbrellas (Fig. 3-12). They can tumble in all directions as they fall or, like many wind-blown seeds, may fall with a preferred orientation. The longest axis tends to be horizontal for falling plates and pencils, but vertical for falling bullets or umbrellas. Finally, the altitude of the sun will determine which faces of a crystal the sunlight strikes and which it exits from.

**46 Degree Halo**

Fig. 3-11. The paths of light beams passing through ice crystals to produce the 23º and 46º halos.

Fig. 3-12. Ice crystal shapes. Vincent J. Schaefer.

The 22º circular halo (inner wheel) is often seen by itself. It is produced when light is refracted as it enters one of the six rectangular sides of the ice crystal and it exits another. Light following such a path is deviated by an angle of 22º or more from its initial direction (that of a sunbeam). The halo appears at 22º
because light deviated by the minimum value of 22º is produced by the greatest range of crystal orientations and is therefore the most intense and brightest.

To have a complete circular halo it is necessary that many of the ice crystals tumble in random fashion as they fall so that the light is equally likely to be refracted in any direction - up, down left, right, or diagonally.

The 22º halo possesses two additional pronounced features. First, the inside of the halo (the part nearest the sun) is always somewhat red because red is refracted the least of all the colors of the spectrum. Second, the sky immediately inside the halo is darker than just outside because light can not be deviated by an smaller angle than 22º but can be by larger angles. Thus, if divine halos maintained their link with atmospheric halos they would be red-rimmed translucent rings of light rather than solid gold disks.

The 46º halo (big wheel) results when sunlight passes through one rectangular side and one hexagonal face of a layer of randomly oriented crystals.

The various spots and arcs appear when the crystals fall with a preferred orientation. If only some of the crystals are oriented, the 22º halo will still appear but will be brighter either near the top and bottom or on the sides, where it joins some of the arcs and spots.

The sun dogs (the eyes) and the circumzenithal and circumhorizontal arcs are produced by plates or umbrellas that fall with their rectangular sides vertical. The tangent arcs on the top (the wings) and bottom of the 22º halo are produced by pencil-shaped crystals that fall horizontally so that light going through two rectangular sides will be bent primarily up or down.

Ezekiel noted that the eyes and the wings followed the sun without turning as they moved. The sun dogs result when light is refracted through two of the vertical sides to produce two spectral spots at the same height as the sun, their master. Light entering the top face and leaving a vertical side leads to the circumhorizontal arc, which is parallel to the horizon and a little more than 46º below the sun while light entering a vertical side and leaving the bottom face produces the circumzenithal arc, which circles the zenith and appears a little more than 46º above the sun.

When the crystals fall with a preferred orientation, the path of the refracted or reflected light is highly restricted and consequently is more highly focused. As a result, the arcs and spots can be far brighter and more brilliantly colored than the circular halos. The sun dogs usually have the greatest intensity and purest colors and are sometimes actually mistaken for the sun itself. On occasion the arcs can be as bright as the brightest rainbows. When bright halo displays arch across the sky, some of the arcs surely will appear like rainbows, perhaps as Ezekiel observed.

The elevation of the sun is very important in determining the brightness, shape and even the possibility of the arcs or spots. The sun dogs tend to be brightest when the sun is about 22º above the horizon. As the sun gets higher, the sun dogs begin to fade and move out from the 22º halo because of the oblique angle at which the sunlight enters the crystals. The sun dogs disappear when the sun climbs higher than about 61º in the sky because the sunlight can then no longer enter a vertical side. The circumzenithal arc tends to be brightest when the sun is about 22º above the horizon and disappears once the sun rises higher than 32º. The circumhorizontal arc, which even today is frequently mistaken for a rainbow, can only form when the sun is above 58º and is brightest when the sun is 68º above the horizon.

When the sun is near the horizon the upper tangent arc or wings are stretched high but as the sun rises they droop, and merge with the 22º halo once the sun climbs to 61º above the horizon (see Fig. 3-13). Since Ezekiel reported that the wings relaxed as the entire phenomenon rose in the sky it seems that the
Vision took place during the morning hours of a spring or summer day.

Fig. 3-13. The changing shape of the upper tangent arcs. *Rainbows, Halos and Glories*, Robert Greenler.

With the close of the Middle Ages the halo fell from favor. During the Renaissance, it appeared much less frequently, although the solid gold disk was refined to a more delicate, translucent ring that hovered weightlessly above the heads of occasional divine and holy figures. Somehow, as the world grew secular, the halo was never divested of its religious associations and so, virtually vanished from art. Only recently have a few artists begun to notice real halos. Otherwise, the 20th century has reserved the halo for almost exclusive use in cartoons, where it either identifies poor departed souls or represents our consciences. Even in such anecdotal uses, there seems to be an unwritten conspiracy to treat the halo as the exclusive property of the world beyond, an eternal symbol of divinity.

There is one notable exception in which the halo appears in all its naturalistic glory. On 21 April, 1535, from 7:00 to 9:00 AM an extraordinary halo display was observed over Stockholm and painted in the *Storkyrkan* (the Cathedral). The *Vadersolstavlan*, or weather-sun picture (Fig. 3-14) contains a topographic view of Stockholm. The halo complex appears in the sky above the city. The halos were considered nonsensical until Alf Nyberg pointed out that the artist used a fisheye view of the sky to represent them. A fisheye view is usually aimed vertically, showing the zenith near the center of the sky while the perimeter of the sky represents a circuit of the horizon. The sun appears as a blazing spot in the upper right part of a sky laced with cirriform clouds. The circle running through the sun is the parhelic circle. The two nearest spots or eyes are the sun dogs while there is a spot opposite the sun (the anthelion) and two spots 120º from the sun (the 120º parhelia). The small bright semicircle, concentric to the parhelic circle and facing the sun is the circumzenithal arc. The arc that presents its convex side to the sun is the infralateral tangent arc to the 46º halo.

The circle around the sun is probably the 22º halo but it has several problems. First, the sun should be located at the center of the halo, and second, when the sun is low in the sky, the sun dogs are only a short distance outside the 22º halo.

The two arcs that emanate from the sundogs are probably the upper tangent arcs. These cross at an angle that places the sun about 22º above the horizon, the height at which the sun dogs and the circumzenithal arc tend to be brightest. On 21 April at the latitude of Stockholm (59º 20’) the sun is found at this height at 7:35 AM, near the middle of the recorded observation period.

The halo complex of the *Vadersolstavlan* was a remarkable recording of an extraordinary event, but was interpreted by the church rector, Olaus Petrias as a warning from God to the Swedish King. Thus, even when the observed properties of halos were carefully recorded, their primary purpose was for divination.
Fig. 3-14. Vadersolstavlan. 1535, Storkyrkan, Stockholm, Sweden.

Half a world away and more than a century earlier, in 1425, the Emperor of China, Chu Kao-Chi, recorded a number of halo phenomena. It seems that the Emperor was preoccupied with halos and used them to foretell his fate. Unfortunately, he must have spotted the wrong arc, for within a year he was
ousted from power, and China quietly passed on to other hands.