INTERPRETING THE SKY

Von Del Chamberlain
Abrams Planetarium
Michigan State University
East Lansing, Michigan 48823


WHAT IS THAT BEAUTIFUL BRIGHT STAR?!
I'M SORRY, I DON'T KNOW.
I THOUGHT NATURALISTS WERE SUPPOSED TO KNOW ABOUT EVERYTHING IN THE PARK.
THAT ISN'T IN THE PARK.

Figure 1

WHY INTERPRET THE SKY?

Interpreters seldom, if ever, question the relevance of biology, geology and ecology in their work. It seems apparent that these subjects belong in the repertoire of competence of any naturalist. Who could consider walking the trail as a guide in nature without ability to relate participants to animal and plant species and discuss the factors producing the terrain exposed to view?

Great effort is expended to help people understand the ecology of our natural regions. School classes take field trips designed to help them understand the natural realms existing on the surface of Earth. Students examine fossils, plants, mineral specimens, rocks and soil. They thrill at the sight of various animal species in the natural habitat and wonder as they view the remains of both animal and plant decaying back into the environment.

But why sky interpretation? Most objects of the sky seem so removed from everyday life; so unimportant compared to other things. Who can touch a star and why should we care about the moon and planets? What difference do they make in our lives? Should interpretation of the sky really belong in the list of abilities and duties of those who teach in the out-of-doors? In the following we will list a number of reasons why sky interpretation is of great importance in environmental interpretation.

Let us consider and list some of the reasons why sky interpretation <u>is</u> both appropriate and important for campfire programs, nature walks and the like.

The cartoon in figure 1 is one of the oldest bits of humor used at campfire gatherings. It illustrates an important point. What is the vertical boundary of the landscape? Does it end at the tree tops or mountain tops? Would anyone wish to eliminate sunlight and starlight from its panoramic splendors? Contemplate the beauty of landscape features against clear, blue sky as one enjoys the penetrating warmth of sunlight. Consider the stirring of the intellect as skylight fades, the air slightly chills and the stars come out. Pause to contrast our current concepts with those we might have if we lived on the surface of a perpetually clouded planet.

Consider the impressive panorama of events which takes place in the sky. This is not a static, eternal, unchanging part of the environment. Rather it resembles a hemispherical stage on which we, the audience, glimpse images of great significance. The stage is decorated with a background of points of light we call stars and on this background the sun, moon and planets play out their respective parts. Occasionally the scene is torn asunder by the blast of a brilliant fireball as a meteorite body plunges into the atmosphere, dropping its fragments into the audience. Or, more frequently, it is split by bursts of lightning, followed by the breath of thunder. Stage lighting can be as soft and gentle as the aurora, shimmering its rays and curtains of soft colors across the northern or southern polar sky. Sky events continue to occur as audiences come and go to ponder the significance of what they see; to interpret the meaning of the drama.

Figure 2

No, the sky is not outside the park! It is not outside the forest. When examined carefully it becomes apparent that it is one of the special features that can best be studied and enjoyed in our natural areas. Point number one in our list of reasons to interpret the sky is that:

(1) The sky is part of the scene.

Look at figure 2 and consider the average visitor to a supervised natural area. His long planned expedition into nature probably starts in the tremoring city with its grey sky and ear splitting, bustling activities. It might end in the deafening silence of the quiet valley where sky vision extends millions of light years and one can, in essence, touch both the past and the future while standing in one place. Where else can one go to see this sky? To be introduced to its wonders by the skilled assistance of an interpreter is an unforgettable experience. Point number two in our list can be stated:

(2) The best conditions for enjoyment of the sky exist in natural areas away from cities.

The conditions existing in protected natural areas are becoming more and more special as population grows and the associated problems increase in magnitude and complexity. One of the most apparent of these features is the quality of the sky. Older people now residing in the city can be overheard to say, "I had forgotten what the Milky Way looked like. It has been ten years since I have last seen it." Younger ones, who have grown up in metropolitan areas are astounded as they gaze, almost in disbelief, at the star-flecked sky. One young man commented following a sky interpretation activity at a national monument, "I've found a whole new world to explore. I had no idea it existed as I see it here."

The clarity of the sky away from city light pollution combined with the freshness of the clean air and majesty of rocks and trees produce the feelings which so many people crave and go to such great expense in time and resources to experience. The sky should not be neglected in helping people more fully reap the rewards of their efforts. Indeed, people must be clearly aware of environmental factors illustrated by the deteriorating transparency of the atmosphere. Point number three can be stated:

(3) The contrast between city and country sky should be realized by as many people as possible.

Next, consider our growing awareness that the origin of the natural surface of our planet is to be understood as we look out in space. Perhaps one of the most important of the environmental messages from astronomy is the realization of the time scale and the physical processes going on in space to produce worlds like our own. We will consider this in some detail in later chapters, but let us mention here that science can now begin to trace the development of our world and ourselves through billions of years of time and natural processes. By looking out in space with telescopes and making use of the discoveries of physicists we can begin to comprehend the fantastic transition which slowly occurred over billions of years of time, starting with dust floating between the stars and continuing to our present sun and earth with mountain slopes bedecked with pigment of flowers and trails walked by emotionally motivated men. What a marvelous transition to

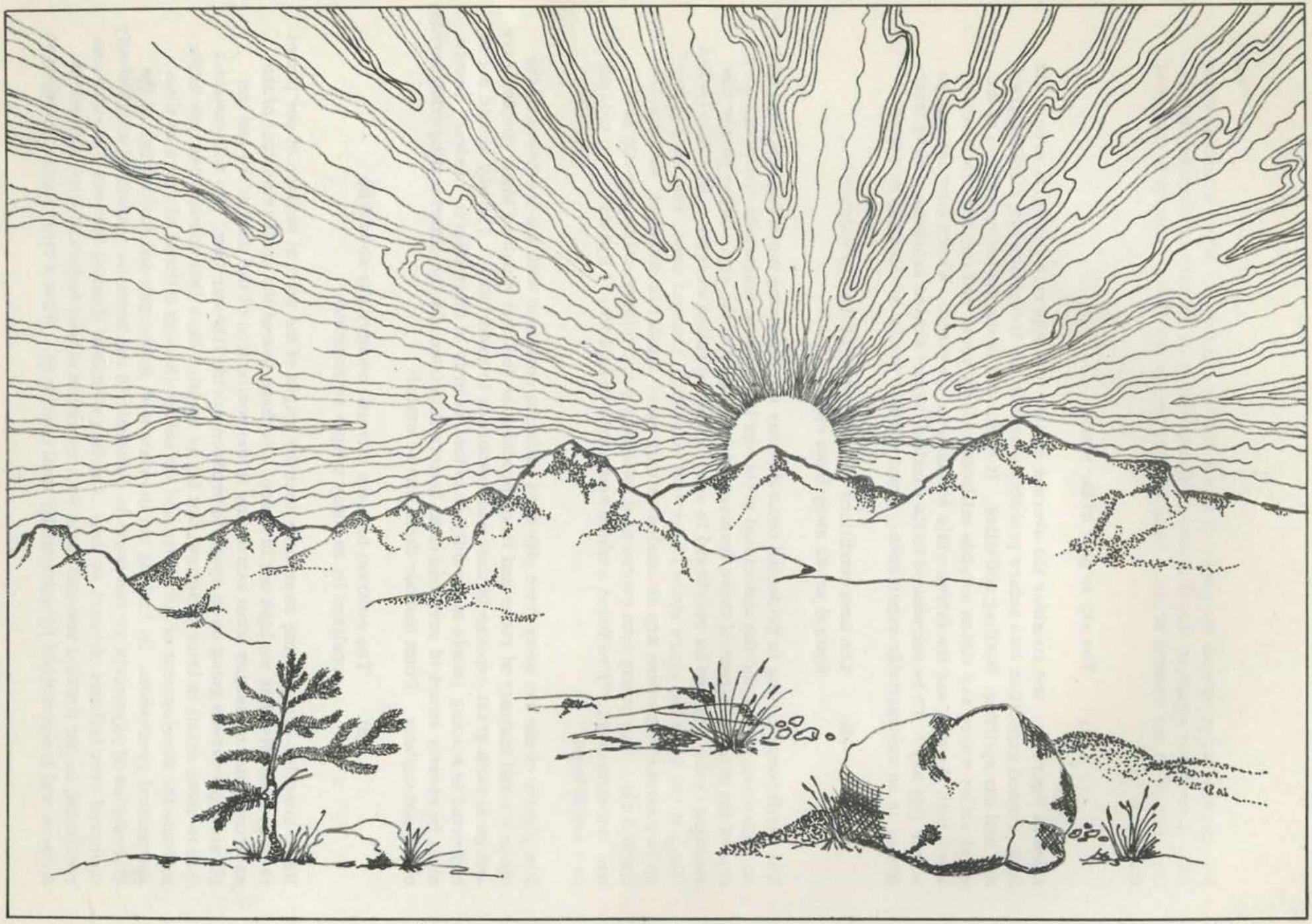


Figure 3

attempt to understand! Today we can look into the sky and see the evidences that the processes of "creation" are still going on around us. By studying these we can try to understand our moment on planet Earth culminating from the very types of processes we now see transpiring around us in deep space.

So point number four is:

(4) The planet Earth was derived from material which long ago existed in a disorganized state in space. What we see in the sky helps us understand and appreciate how it developed to its present state.

One more argument for inclusion of the sky in interpretative programs is the simple fact that most of the environment of man is out in space. Actually the entire solar system, which seems so vast to us, is like an impurity in the known universe. The earth, orbiting the sun, has been appropriately referred to as a "space ship," complete with its controlled conditions, sustaining its occupants as it drives through space. Indeed it is a "spaceship," and a tiny one to be sure. If we think about the entire volume of the known universe, the fraction of it represented on all the planets which might exist about all the known stars where conditions similar to those of the surface of the earth might exist is extremely small. This fraction is so minute that one could say to emphasize the concept that it is essentially non-existent.

We are so immersed within our immediate surroundings on the surface of our tiny planet, orbiting one star, that we are prone to forget that nearly all of the universe lies out there. Thomas Henry Huxley wrote, "To a person uninstructed in natural history, his country or seaside stroll is a walk through a gallery filled with wonderful works of art, nine-tenths of which have their faces turned to the wall." Unless one is acquainted with the starry sky, he really has no concept of the world at all; he is walking this planet blindly, completely ignorant of most of the universe which he is capable of perceiving. So our next point is:

(5) The earth is a "sub-microscopic" entity in the universe. Most of the environment of man is perceived as we look into the sky.

Perhaps we can better understand the magnitude and importance of the problems of preserving the conditions on the limited thin surface of Earth by knowing the factors which produced and sustain these conditions and contrasting them with the empty harshness beyond the protective atmosphere.

As we look out into the night sky we see the stars. What is the significance of a star? Figure 3 tells part of the story. Consider the importance of just one star in the sky. The energy generated deep in its multi-million degree core makes its way to the surface of the star and then leaps through space. A tiny percentage of this energy falls upon the little planet Earth, warming the atmosphere. Among our choicest blessings we must include the existence of sunlight and no pleasure is more worthy of our respect than that of warmth of sun upon the skin. One star of the many

known to exist in the universe - the sun. This one gives us warmth, food and sustains the Earth and other planets in their orbits, guiding us through regions flooded with enough but not too much radiant energy. The sun is the most apparent feature of the sky. Does it not deserve to be included in interpretative programs?

And yet the sun is only one star. By realizing its complete domination of our lives and then looking into the night, seeing thousands of other stars, we become aware that numerous other planetary systems might exist in space. Scientists estimate that there may be millions of other planets similar to Earth within our own galaxy. The other stars are energy sources like the sun. Realizing that they might supply energy for other intelligences thriving in the universe, we can understand part of the answer to the question of the significance of the stars.

Modern astrophysics gives us even greater perspective of our own existence. To just mention another item, which will be developed further, evidence suggests that the very elements composing our physical bodies were actually manufactured in the centers of the stars through nuclear fusion processes. If one contemplates such possibilities as he looks into the starry sky, he will see more than mere specks of light and he should appreciate the miracle of his own existence more than he could possibly do without interpretation of the sky. So point number six is:

(6) Knowledge of the sky helps us begin to realize the sources of life giving and life sustaining conditions and makes us aware of the beauty of the moment for us and possibly for a vast array of other intelligence existing in the immense universe.

Following a sky interpretation program people often comment that they feel so insignificant, looking into the starry night. Such comments are, perhaps, the most powerful reasons of all for interpreting the sky. The most important human quality, after all, is the ability to reason: to perceive stimuli, transpose them into mental impressions which are stored, sorted, retrieved; to formulate questions and answers. Only by the understanding which results from reasoning can one look into space and feel insignificant. This may be the most important type of human experience. An effective sky interpreter can assist people in benefiting from such experiences leading to establishment of important human values.

(7) Sky interpretation contributes to awareness of our most important human characteristics and development of well founded values.

There is much more to argue for including the sky in interpretative programs. Too much more to include in this introduction. Perhaps this is enough to whet your appetite for becoming an interpreter of the sky and reading further.

Before going on, let us briefly review the highlights of what we have considered.

We live on a planet, a natural spaceship, orbiting one star which makes life possible. The earth, other planets and their satellites, other bodies of the solar system, and the sun were derived from organization of material which was previously floating in space. Many billions of years were required. Our comprehension of our planet is significantly stimulated by careful study of both the day and night sky.

And here we are, standing under the stars, looking outward, wanting to comprehend ourselves existing in the universe. Are not the very best human qualities illustrated in this experience?

Where can this inquiry into the earth and the universe be better done than in natural areas, removed from city lights and smog, amid the surroundings which are so conducive to wanting to know?

And who can do it better than those involved in natural interpretation? Probably no other group of people have a better combination of skills, interests and opportunities to inform the general public about the sky and space than interpretative naturalists and others who teach in the out-of-doors. Hopefully, you begin to understand your opportunity and responsibility to obtain the knowledge necessary to become an effective sky interpreter.

Interpreters seldom, if ever, question the relevance of biology, geology and ecology in their work. You should agree now that environmental interpretation is incomplete without the upward dimension to sensitize people to the total perceptible environment and relationships between its members.

The sky is part of the scene.

The best conditions for enjoyment of the sky exist in natural areas.

The contrast between city and country sky should be clearly realized by people.

The earth developed over a long period of time through physical processes operating on material in space.

The earth is an extremely small part of the vast universe.

Life support conditions result from astronomical relationships.

Sky interpretation helps people comprehend themselves on the earth in the universe.

Interpreting the Sky: Section I, Chapter 2

MAN, EARTH AND SKY

Man: The beholder and expounder of heaven.
Posidonius (135-51 B.C.)

Man

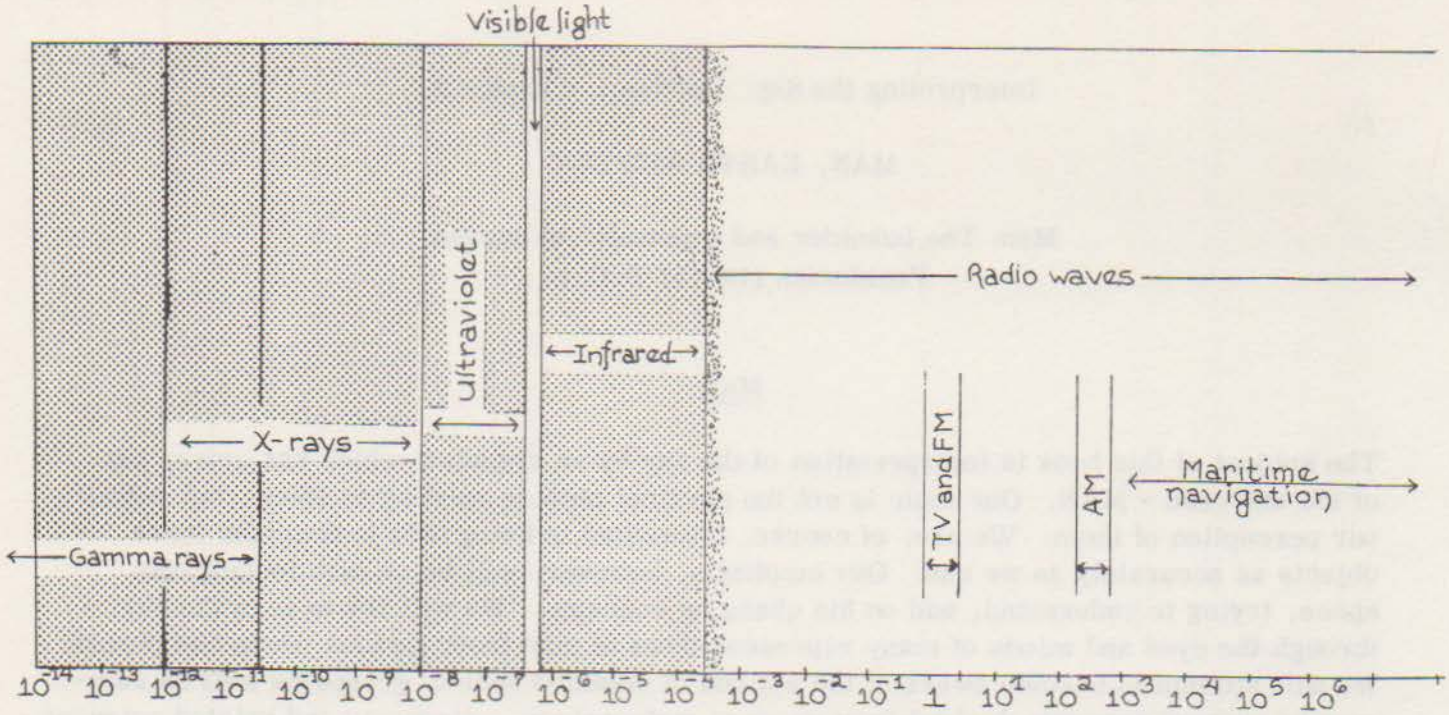
The subject of this book is interpretation of the sky by an organism which has arisen out of the universe - MAN. Our topic is not the physical objects existing in space, but rather our perception of them. We are, of course, interested in being able to describe these objects as accurately as we can. Our emphasis, however, will be on man looking into space, trying to understand, and on his changing concepts. We will try to scan the sky through the eyes and minds of many representatives of man from various times and places. We will attempt to become aware of the notions of selected ancient groups as well as summarize current concepts derived from modern meteorology, astronomy and related sciences. Our emphasis will also be on presenting information about the sky to others, i.e. interpreting the sky and its features for other people.

And so, to begin, we realize that we cannot really know the physical objects and materials of nature in their pure forms. We interpret them by carefully planned observations and experimentation. We can never isolate our understanding of them from ourselves. It is, therefore, appropriate at the outset to briefly review what man is as a perceiver.

Man is an organism. Like other organisms he eats, grows, moves and senses his environment. The very special quality he has is not his keenness of perception - many other organisms are more sensitive to the environment - but rather his ability to associate the various perceptions he makes with each other. He is able to sense stimuli, store impressions, sort them, rearrange them, retrieve and analyze them. We have given this ability a name - REASON.

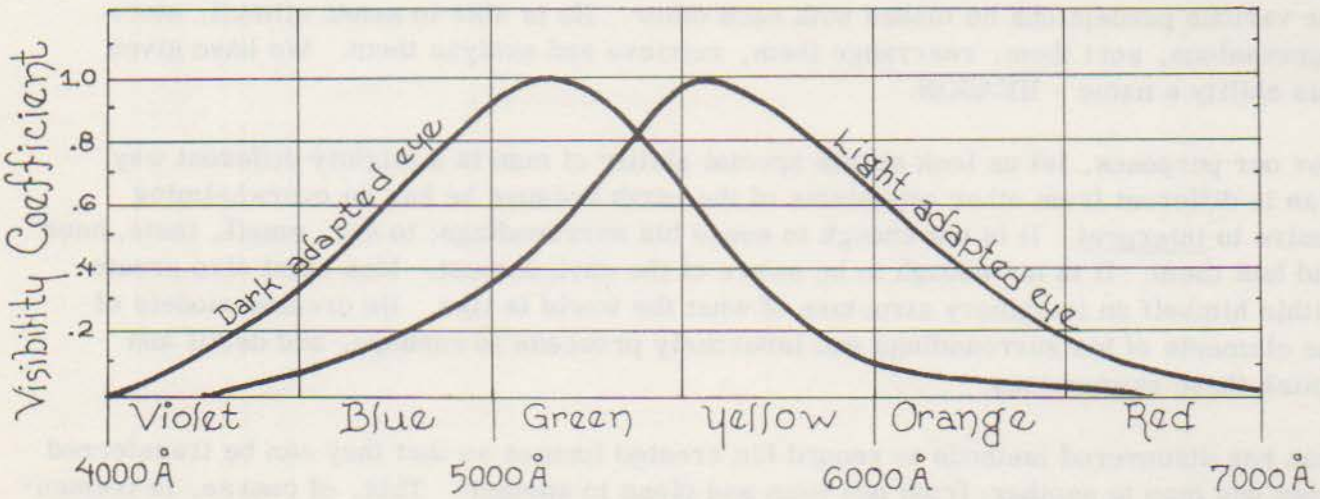
For our purposes, let us look at this special ability of man in a slightly different way. Man is different from other organisms of the earth because he has an overwhelming desire to interpret. It is not enough to sense his surroundings; to see, smell, taste, hear and feel them. It is not enough to be aware of the environment. Man must also create within himself an imaginary structure of what the world is like. He creates models of the elements of his surroundings and laborously proceeds to reshape, add detail and polish these expressions.

Man has discovered methods to record his created images so that they can be transferred from one man to another; from one time and place to another. This, of course, is tremendously important in his attempt to carefully scrutinize the world and build a model of it. Each facet can be examined by multitudes, again and again. The model and its components can be taken apart and reassembled time after time, shaping each part until it fits so snugly against its neighbors that the boundaries begin to disappear. At times parts of the structure are completely discarded and new ones sculptured in their places.



Wavelength in Meters

Fig. 4



Wavelength in Angstroms

Fig. 5

Through these processes of perceiving and analyzing the environment, man has learned that his own ability to sense the world is very incomplete. We sense by various transformations of energy. We see because light energy is absorbed in the rods and cones of our eyes creating chemical changes which cause electrical impulses to pass along the optic nerve to the visual cortex of the brain. We hear because our ears contain delicate membranes, fluids and nerves which transform energy of vibrating air molecules into nerve impulses fed to the temporal lobe in the brain. Taste and smell result from chemicals, transferred through the air or deposited into the system, dissolving in liquids around sense organs attached to nerves which send impulses to the olfactory center of the brain. We are able to feel (touch) because nerve endings in body tissues respond to pressure and temperature changes (energy of motion).

Because of his curiosity (desire to interpret), man has learned that every one of our senses is very crude. The real world contains energies we cannot directly perceive: colors we cannot see; frequencies of vibrations we cannot hear; gases and materials (chemicals) we cannot smell or taste; and scales of refinement we cannot feel. In each case the range beyond our perception is far greater than the minute portions we can sense.

Sight is often referred to as the most important sense. Figure 4 is a diagram of the "electromagnetic spectrum." Note how narrow the visible light region is. The visible realm is expanded in figure 5. The human eye is sensitive to wavelengths from about 3900 angstroms to about 7500 angstroms (one angstrom is equal to 10^{-8} centimeters). It is most sensitive to green light as shown by the sensitivity curve in figure 5.

Notice that the eye responds to one of the regions where the unclouded atmosphere of earth is transparent. These regions are referred to as "windows." Because of the existence of the visible window the world is lighted and we see and are aware of the stellar universe. The science of astronomy owes its existence to this window. Radio astronomy developed and is possible because of the radio window. By putting telescopes and other devices into orbit beyond the atmosphere we are able to study much more of the spectrum than we can from the surface of earth. Thus the new space astronomy combines with continuing refinements in surface astronomy to improve our knowledge of the universe.

A similar analysis could be made to indicate the lack of sensitivity of the senses of hearing, taste, smell and touch. This is left to the reader. We do sense the external world, but not very "sensitively."

Thus we must admit that the universe exists in forms so intricate that, as sensing organisms, we know very little of it. We sense it as we look out the windows of our houses and our minds, and yet we don't sense it directly very effectively. We see only small parts of it and then incompletely. The point is made by saying that we glimpse it as we might the contents of a great art gallery as we pass over it at 30,000 feet in a jet liner.

Fortunately man is never content with his interpretations. He has learned that his sensory perception is incomplete and he continues to increase his range of perception

in the laboratory. He isolates sensing materials from his surroundings and manufactures detectors of the colors, sounds, aromas, flavors, and structure of matter which he is incapable of sensing directly. The existences of manifestations of the universe in these realms are recorded and amplified in the realms which man does perceive and used to continually modify our models of the real world. Thus we perceive the macroscopic and microscopic worlds in extensions of our senses.

We do not expect to ever have a model which exactly reproduces the real world, but the closer we feel we come to it, the more our desire to interpret is satisfied. We do not perceive the complete physical world, but we interpret what we do perceive.

Earth and Sky

The ancients considered the human eye to be the gateway, opening the soul to the infinite. It is the sense of sight which has made us aware of the external universe; but not the eye alone. It is the whole man who perceives the world and it is the combination of the senses and the mind which has led us through the multitude of conceptions of our surroundings.

Any one of us can look out into the sky; and what do we see? We see essentially what the ancients saw. The same stars and other stimuli are perceived by us that introduced the Chaldeans to astrology and the American Indians to sun worship.

The difference between our awareness as we look out and that of the ancients is one of interpretation of what we see, not a difference of the stimuli, but a difference of our responses to those stimuli conditioned by the continual process of looking and asking questions, usually the same questions in each generation. The answers to the questions have changed as people have desired better, more consistent and satisfying answers and learned to more carefully analyze stimuli, inventing instruments to supplement the senses. What we see in our minds as we look into the sky we owe largely to the labors of a vast multitude who has stood and looked into the sky before us.

But let us try to look at the sky in its naturalness as the senses allow us to scrutinize it. Think about the visible sky and try to ignore, for the moment, your current conception of it. Think of yourself as a primitive human, living thousands of years ago. Close your mind to the explanatory models and open it to the actual observations you might make. What might you see during one full day-night cycle?

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A chorus of bird sounds swells forth to announce the birth of light. You are standing alone on a great open plain as the light of dawn begins the day. Off in the distance in one direction is the silhouette of mountains standing against the nearly dark sky. You have been into those heights and realize their majestic qualities. In the opposite direction the landscaping is nearly flat with gentle variations along the horizon. To the left and right, nearer than the mountains, are jagged badland formations, dark against the slowly brightening sky.

First light of day touches the sky with blue which brightens to become nearly colorless, then orange and yellow colors spread upward in the east. Above the mountains opposite the glow of dawn a purple-gray region develops in the crystal clear sky. You can now discern the rapid brightening of the dawn as you watch in reverence the repeated miracle of the coming of day. How does it make you feel as the east is powdered with the rosey glow? You try to determine the moment when the color is most intense, then realize that, already, it is fading as the entire sky becomes lighter.

You have often stood like this and watched the miracle happen. It occurs each day, yet never exactly repeats itself in color and composition. Turning, you notice the distant mountains behind you are softly lit, then they begin to glow as if reflecting fire from their snowy slopes. Turning again you witness the first gleam of the intense rays as the rim of the sun emerges from the edge of the world. Quickly the disk rises and the day bursts forth; the land is flooded with light. The sun loses its color and takes on painful brilliance as it climbs its pathway to shower the earth with its life giving qualities.

Turning to scan the entire visible world, it is apparent that, even though you refer to "earth and sky," the two are really parts of one entity. Everywhere they blend into each other forming a continuous panorama at the visible horizon. Their intimate relationship is unquestioned and you recall stories told of brave souls who were able to run so far that they reached the place where sky joins earth, perhaps to witness the emergence of the sun from its subterranean resting place to renew its divine travels.

As the day continues bringing increased warmth to the air and ground, you fail to notice the ever changing lighting. Brightness and color hue change continuously, often rapidly. The day sky can be white with heavy haze, or slightly grey, or frighteningly dark with tumultous clouds. Then it may explode with fiery lashes and darts streaking between heaven and earth as winds and sheets of rain or ice pellets sweep the ground. At times brilliant white clouds contrast in every conceivable shape against azure background. Sometimes the blue dome is uncluttered and occasionally untouched by clouds. Scanning of the entire clear sky reveals to the astute observer that the depth of blue is different in various directions relative to the direction of the sun and other factors.

The freshening smell of skywashed earth reaffirms your awareness that earth and sky are one. Each directly influences the other in so many ways. Somehow, although you cannot explain the feeling, you are aware that profound relationships exist between these realms which are beyond your knowledge and experience.

Both morning and evening bring warm colors to sky as earth and air reflect increasing and decreasing solar influence. Evening is essentially the reverse of morning and it is touched with sadness and a trace of fear in place of joy and renewed faith. As life responded with quickening activity at dawn of day, it counters at dusk by tending to retire to the seclusion and protection of caves and other shelters, closing eyes and mind to the challenges of the night.

The day fades away. Again the hills and mountains are dark against the lingering twilight. Their grotesque forms combined with chill of air bring the desire to hide away with the others. And yet you boldly remain to watch, alive to every sound and glitter. Certain birds sing soft benediction of day and soon the coyotes send forth long, rising tones aimed toward heaven as if lamenting the dying day.

A point of light appears against the fading sky. Soon another and another. Eventually the entire vault of sky is flecked with stars. Some patterns are familiar to you, having previously walked into the night. That bright star is one of the drifting ones which tracks around the entire sky, amid a path of stars, in a period of many years. But never before have you maintained this vigil into the depths of night; you notice patterns of lighted points which never before impressed your mind. A faint streak crosses the sky. Perhaps a star dislodged to come to earth; perhaps a missile hurled by battling gods.

A gentle glow fills the northern sky. Rays of soft colors streak upward. Now waves of pale light shimmer and flow throughout much of the sky while great wings of light spread over the zenith. How can you describe this awesome spectacle? How can you calm your tremoring soul? Sky flames testify that heaven is ablaze and you fear lest the flames drop to consume the earth below. What does it mean and what will become of earth and sky and you? It passes.

Again only the stars break the darkness. They vary somewhat in color, a fact which you have not noticed so clearly before. Suddenly the sky is shattered by a blast of light, a shaft which quickly brightens from spark to furnace as it approaches the zenith. Hands over face you cower. After several seconds which seem like minutes, after flaring several times, the fiery ball bursts into fragments, each reddening and disappearing. Your mind is saturated as you contemplate what you have seen. In a few minutes you have almost convinced yourself that it was not real, but placed in your mind a warning to leave the solitude of night. Then the sharp explosive sounds shake ground, body and soul, driving you to panic. Again and again the voice barks out and then deteriorates to fainter cracking, trailing off to rumble in the distance. Surely this is a warning from on high.

Only the eventual rising of the half-moon, its pale light revealing the rocks and brush around you, once more begins to bring courage back into your mind. As it first appeared in the distant plain, it too was frightening since it looked so large. Its reddened light faded as you recognized it once it cleared the horizon. It bathes the land and removes the blackness to comfort you as you remain in the cold quiet night.

You watch on until the moon stands high and the glow begins to return to the east. With this your heart is gladdened. You have endured the great trial and received night visions to initiate you into the apprenticeship of the shaman.

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Not quite a typical twenty-four hour period as the earth pivots once upon its axis. But not many days and nights would be required at certain times of the year and certain locations to produce most of the variations just described and more.

The earth and sky do appear as one. Both are dramatic in their ways. All creatures are aware of some of their variations. Those who carefully study their surroundings become aware of a tremendous variety and number of changes and relationships in the environment, including the sky.

If one wishes to really begin to comprehend the earth and sky, he might begin by spending several complete twenty-four hour periods of time (not consecutively) in a variety of remote locations, concentrating his full attention on his surroundings. In doing so, watching the continual variations of earth and sky, he should wonder how other people might have felt about these things. He should recall, from his studies, how various people lived and worshipped. Such experiences, combined with lectures, films, books etc. produce a perspective which cannot be obtained from formal learning alone. One must sense the same environment under similar conditions to surmise interpretations of people at various times and places and to become unusually skilled at interpreting the universe for others.

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