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IMAGES OF THE AURORA (GUEST EDITOR'S INTRODUCTION)

The spectacular displays of light in the polar skies, known as the aurora, predate recorded history. It has been suggested that the earliest images of the aurora may be found in the serpentine meanders, or macaronis, of Stone Age man.¹ These appear on rocks and cave walls from Cro-Magnon times. Other scholars claim references to the aurora in the passages in the Old Testament from Genesis, Jeremiah, Ezekiel, and Zachariah.² The first chapter of Ezekiel provides a clear written description of the aurora:

...a stormy wind blew from the north, a great cloud with light around it, a fire from which flashes of lightning darted ... [living creatures appeared]... between these animals something could be seen like flaming brands or torches, darting between the animals; the fire flashed light, and lightning streaked from the fire. ... Over the heads of the animals a sort of vault gleaming like crystal, arched above their heads... [a human form appeared] ... And close to and all around him from which seemed his loins upward was what looked like fire; and from what seemed his loins downward I saw what looked like fire, and a light all around like a bow in the clouds on rainy days...

Descriptions of the aurora are included in the writings of Hippocrates and his student Aeschylus in the fifth century BC, in Aristotle's *Meteorologica*, and in Seneca's *Naturales Quaestiones I*. Several possible references to the aurora in ancient Chinese writings before 2000 BC have been recently compiled and published.³

In modern times, images of the aurora appear lavishly in poetry and literature, including Longfellow's *Driftwood-Frithiof's Saga*; Chaucer's *The Knight's Tale*; Shakespeare's *Julius Caesar*; and Coleridge's *The Rime of the Ancient Mariner*. Other authors who have included the aurora in their works are Goethe, Byron, Keats, Tennyson, Scott, Dickinson, and Service.²

Fascination with the aurora transcended the arts to become a subject of very active scientific study. A partial list of famous scientists who involved themselves

in auroral research includes Kepler, Galileo, Gassendi, Halley, Euler, Descartes, Celsius, Cavendish, Dalton, Gauss, Franklin, and Angström. Before photography was developed to the degree that auroral forms could be permanently recorded from the ground for further study, scientists sketched auroral forms. Figure 1 is a woodcut of an aurora, made by Fridtjof Nansen, the famous Norwegian explorer, from a crayon sketch that he drew in 1893. Nansen was a marine biologist, oceanographer, intrepid explorer, artist, poet,



Figure 1 — *Northern Lights* by Fridtjof Nansen (1910-11). Cover illustration from his book *Nord i Tøkeheimen (In Northern Mists)*.



Figure 2 — *Aurora Borealis* by Frederick Edwin Church (1865). Oil on canvas, from the National Museum of American Art, Smithsonian Institution, Washington, D. C.

and Nobel laureate (for Peace), and he studied the relationship between auroral forms and magnetic disturbances.

An outstanding example of an auroral image is Frederick Church's painting *Aurora Borealis* (1865) (Fig. 2). It shows discrete red and green auroral forms due to the 6300 and 5577 angstrom emissions, respectively, of atomic oxygen.

Techniques of imaging the aurora have progressed substantially this century, especially since the beginning of the space age. Satellites have provided images of the aurora that have confirmed previous theories that it is indeed a global phenomenon and can occur in a continuous band encircling the geomagnetic pole.⁴ However, the images discussed above could only be acquired in the night sky. Although it is impossible to view auroras with the unaided eye in the sunlit sky, satellite, rocket, and surface measurements of energetic particles, ionospheric disturbances, and geomagnetic disturbances have confirmed that they must be there. The HILAT (High Latitude) satellite described in this issue has provided, by means of the Auroral Ionospheric Mapper instrument, the first images of the aurora under full daylight conditions. The sunlit image of the aurora acquired by HILAT and shown on the cover of this issue has a complicated and beautiful form that cannot be seen by any observer

on the ground. This is due to the fact that the ultraviolet wavelength (1493 angstroms) of the image is absorbed by the atmosphere below the altitude of the emission. One expects, however, that if this aurora occurred at night, it would have features such as those portrayed by Nansen or Church.

As spectacular as these images are, they represent only a portion of the objectives of the HILAT program. The auroral regions are the focal points of an important type of solar-terrestrial interaction. A considerable amount of energy from interplanetary space (approaching 10^{12} watts) is funneled into the auroral regions, producing light, ionization, heat, X rays, and low-frequency sound waves. The primary mission of HILAT over the next few years is to explore the complicated plasma processes that occur in these regions. The unique complement of radio propagation, in situ, and remote sensing instruments onboard HILAT is described in this issue.

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