Celestial Events and the Early Acquisition of Knowledge

BY CURT ROSLUND & MARIE RÅDBO

Abstract

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The science of astonomy is commonly regarded as a difficult subject to study and to pursue, requiring extensive knowledge of mathematics and physics. This probably stems from people's immense admiration for the astronomers' skill in calculating to the nearest second the progress of an eclipse of the sun or the moon, and for their ability to probe into the physical conditions prevailing during the birth of the universe and its subsequent evolution into galaxies, stars and planets, including the earth. The purpose of the present paper is to call attention to the fact that there are simple astronomical phenomena, that are no longer readily observable in the highly artificial world we live in, but that once could have easily evoked early man's curiosity and speculations. This would have provided an intellectual milieu necessary to set the mental process in motion in the direction of creative imagining and abstract thinking, which we regard as hallmarks of the human mind.

Curt Roslund and Marie Rådbo, Gothenburg University, Sweden.

> For it is owing to their wonder that men both now begin and at first began to philosophize; they wondered originally at the obvious difficulties, then advanced little by little and stated difficulties about the greater matters, e.g. about the phenomena of the Moon and those of the Sun and of the stars, and about the genesis of the universe.
> Aristotle, Metaphysics II, 2

Introduction

The splendour of the starry heavens pleased the eye and excited the imagination of people long before astronomy developed into a science. The poetic imagery in star myths and legends from all parts of the world bears witness to the great impact the stars had on the mind of early man. The enjoyment and fascination of the heavens is unique to humans and is probably as old as his invention of tools and taming of fire. It has humorously been said that man was given his upright posture so that he could better appreciate the wonder of the stars. This wonder might have been the key agent that set the evolution of man's mental processes in the direction of creative imagining and abstract thinking, so essential for the generation of new knowledge.

Incitement to learning

As long as primitive man had only rudimentary understanding of the workings of nature, the world around him must have appeared chaotic and hostile, with one important exception. The unchangeable pattern of the fixed stars and their immutable movement across the firmament assured him that harmony reigned in the sky. The inherent human desire to seek order out of chaos could have set in motion man's inquisitive mind, searching for the laws that govern the universe. The fear people often felt at the appearance of comets and eclipses of the sun and moon undoubtedly stems from their inability to place these events in an orderly world.

The struggle for survival under harsh con-

ditions need not necessarily have absorbed all the thoughts and feelings of early man as was until recently presumed. Australian Aboriginal people, living as they do as hunter-gatherers, have been shown (Flood 1995, p. 282) to have ample leisure time for non-utilitarian pursuits. After dusk, only the light from the camp fire could rival the stars. The relaxed atmosphere around the warm fire in the pleasant company of friends and relatives under the canopy of innumerable twinkling stars must have inspired them to speculation and contemplation about the wonders of the heavens.

The celestial vault is a vast stage on which the heavenly bodies perform their acts for all of us to see. Only a casual exposure to the starlit sky is needed to reveal that the stars move in an orderly and predictable fashion. In the daytime, the sun is a dependable and constant source of light. The moon, on the other hand, is somewhat changeable. It varies in appearance, it wanders and wobbles but no more than can be resolved by observations over some length of time. The case is entirely different for the planets. Their movements are seemingly erratic, although some common traits are readily discernible. The urge to explain their movements satisfactorily has been a great challenge in the history of astronomy.

Events in the sky could easily have provoked early man's curiosity to a degree where he felt himself compelled to diligently search for knowledge. The movement of the heavens could have been one of the main factors in initiating the mental process of rational thinking and logical reasoning that we treasure as distinctly human.

Immutable stars

The grouping of stars into constellations of easily recognizable patterns has held a great fascination to mankind. They have formed the imagery for a rich body of star myths all over the world; in Classical Greece (Ridpath 1988), in North America (Monroe & Williamson 1987), and in Australia (Haynes 1992, pp. 127 ff.). People have turned to the stars to seek order and structure on earth and to relate themselves to the universe. The constellations continue to this very day to form a very useful background as reference for events taking place in the sky.

It does not take much effort for a keen star watcher to discover that there is a kind of symmetry in the motion of the stars. In the east the stars drift upwards, while those in the west pass downwards. They all share in a continuous and uniform motion that one would find if the stars were pinned to the inner face of an immense sphere, rotating from east to west around an imaginary axis through the place where the observer stands. The fact that we perceive the stars and other celestial objects as lying at the same distance, in spite of their vastly differing spatial arrangement, has greatly helped our mind in exploring the sky. The introduction of a simple geometric model such as that of a rotating sphere shows how celestial events can spur the imagination.

The stars faithfully repeat their paths in the sky from night to night, but they will reach their positions in the sky a little earlier for each new night. In the morning at daybreak, new stars that were not seen there the previous night will come into sight on the eastern horizon. A careful and persistent observer will soon learn to tell from the slow progress of the stars with the seasons where a particular star will be seen at a specific time of the year.

The first appearance of certain stars with the sun at dawn has been extensively used in calendar making. The ancient Egyptians used the bright star Sirius to warn them of the annual flooding of the river Nile that usually began in the last week of June (Dicks 1970, p. 28). The Greeks timed their harvest after the morning appearance of the Pleiades, a well-known cluster of stars (Pannekoek 1961, p. 95). Australian aborigines see the morning rising of the same asterism as a sign that the

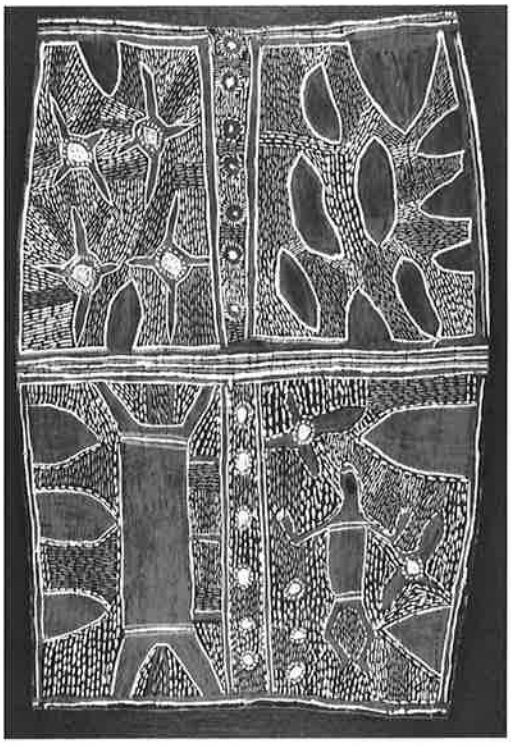

Fig. 1. This bark painting was made in the 1950s on Groote Eylandt on the north coast of Australia by an unknown aboriginal artist. The upper left panel shows the four bright stars that make up the Southern Cross. When they can be seen all night long, they are a sign that the torrential rains of the wet season will soon cease. Fishermen visiting from Macassar in Indonesia would then in the old days set sail for home. Such a sail is pictured as a rectangle in the lower left corner of the painting. The upper right panel shows water receding from the flooded land. Food now becomes abundant. The aborigines then come together for feasting and merry-making and to dance all night under the stars that make up the tail of the constellation Scorpius, the three small stars to the left of the dancer in the lower right corner of the painting. The two big stars in the same panel show Venus and Jupiter. Photo by the authors.

cold season is coming (Mudrooroo 1994, p. 134). The Pleiades were also regarded as a precursor of the June solstice by Andean Indians (Urton 1981, p. 71), and as a sign that the June rains would soon commence by Swahili people in East Africa (Snedegar 1995, p. 533). Even the horrible deed of human sacrifice was said to have been timed by the Skidi Pawnee Indians of North America by the appearance of an unidentified morning star (Chamberlain 1982, pp. 60 ff.).

A 32 cm wide circular bronze disc, originally adorned with 32 small round, thin gold plates which might be interpreted as symbols for stars – and among them the Pleiades – was recently found by two treasure hunters near the small village of Nebra in central Germany. If this interpretation is correct, and nothing contradicts it, the disc, which has been dated to 1600 BC or the Middle Bronze Age, shows the oldest known surviving depiction of astronomical objects in Europe (Schlosser 2004, pp. 44 ff.).

A readily recognized feature of the motion of the stars is that they always rise and set at fixed points on the horizon. The Egyptian pyramids outside Cairo may have been accurately orientated towards the four cardinal points by observing a star rising due east (Haack 1984, pp. 119 ff.). Similarly, the street grid of the ancient Teotihuacán on the Mexican high plateau may have been set out with the help of the setting of the Pleiades (Chiu & Morrison 1980, pp. 54 ff.).

Ceaseless sun

The sun displays a reassuring constancy. It rises every morning in the east and sets in the evening in the west. The solar disc always appears in fullness and shines with unvarying brilliance. In spite of these remarkable signs of constancy, the sun is nevertheless the cause of the earth's seasons.

The changing length of the day in the course of a year outside the tropics is an indication that the daily path of the sun across the celestial vault varies according to the time of the year. Settled people living at a place with distinct horizon features would also easily have

Fig. 2. The sun is seen rising behind Mount Fuji 200 kilometres away from the holy twin islets, Meoto-Iwa, on Midsummer Day's morning. The sun goddess Amaterasu has been venerated on the rocky islets since about AD 700 and she still is. Photo by courtesy of the Futami Okitama-jinja shrine, Futamigaura.

discovered that the sun's rising and setting points shift with the advance of the year. The sun's behaviour is regular and predictable. The sun rises and sets in the same directions at the same location on the same date every year.

At the vernal equinox in March in the northern hemisphere, the sun rises exactly due east and sets due west and the length of the day equals that of the night all over the world. As the year continues, the sun's daily path moves north, finally coming to a standstill on the longest day of the year at the summer solstice, when the sun rises and sets at its most northerly points on the horizon. The sun's path then reverses its movement. It again passes east and west on its way south at the autumn equinox, reaching its southern standstill at the winter solstice on the shortest day of the year, when the sun rises and sets at its most southerly points on the horizon. After that the sun resumes its northerly trek.

Due to the importance of the sun to the growth cycle, it is reasonable to assume that the first agriculturalists would have watched the sun's annual movement with great anxiety to make sure that it did not stray from its accustomed course or overshoot its standstill limits. There is evidence that solar alignments were incorporated into various prehistoric monuments like Stonehenge in England (Burl 1987), the Newgrange passage tomb in Ireland (O'Kelly 1982, pp. 123 ff.), the Goseck walled earthen structure in Germany (Bertemes & Schlosser 2004, pp. 48 ff.), the temple Angkor Wat in Cambodia (Stencel et al. 1976, pp. 281 ff.), the Torréon at Machu Picchu in Peru (Dearborn & White 1983, pp. 37 ff.), and the kiva of Casa Rinconada in Chaco Canyon in

New Mexico (Williamson 1984, pp. 132 ff.), to mention some notable cases.

To people deeply dependent on the yearly revival and regeneration of nature, the life-giving sun would have been an obvious object of veneration. Sun wheels on Scandinavian rock carvings and the famous miniature sun-chariot from the Bronze Age found at Trundholm in Denmark (Green 1991, p. 66) might be the surviving manifestations of a sun cult.

Although the sun cannot be observed together with the stars, it is still possible to deduce that the sun does not move with the heavens as a fixed object. The slow progression of new stars appearing at dawn is the result of an equally slow eastward motion of the sun with respect to the stars. The sun makes a full revolution around the sky in a year. Its annual path among the stars, the ecliptic, can quite accurately be traced with the naked eye alone.

Fig. 3. The four-spoked wheel in Scandinavian rock carvings is generally believed to be a solar symbol. From Aspeberget at Tanum in western Sweden. Photo by the authors.

Much interest has been attached to the zodiacal constellations along the ecliptic as a result of a superstitious belief in astrology (Lindsay 1971).

Changing moon

The moon is an intriguing object to watch. Like the sun, it is a prominent celestial body. At full moon, it floods the night sky with light that obliterates all but the brightest stars. Its disc is exactly of the same size as that of the sun, but unlike the sun which is always seen as a full circle, the moon changes its appearance cyclically, repeating the same shape after a period of 29.5 days. Regular monitoring of the moon will show that the moon changes its face in relation to its angular distance from the sun.

The moon emerges from the glare of the sun in the beginning of its cycle as a faint thin crescent in the evening twilight above the western horizon. The moon waxes and brightens, appearing higher in the sky as it moves away from the sun on the following evenings. When the lunar disc is half lit, it is seen near the meridian at sunset, moving towards the western horizon as the night progresses and finally setting at midnight.

The bright part of the moon's disc continues to grow as the moon moves further away from the sun. The waxing gibbous moon sets after midnight and shines most of the night. When the moon appears as full, it is directly opposite the sun. It then rises in the east when the sun sets in the west and sets in the west when the sun rises in the east. The full moon is visible all night.

The moon's brightness declines as it enters its waning phase, moving towards the sun again. Darkness envelops the lunar surface in the same order as it first came to light during the waxing phase. When the moon again is half lit, it rises in the east at midnight and stands near the meridian at sunrise. At the end of its cycle, the moon is once more reduced to

a thin dim crescent, this time sighted low in the east before sunrise. It then vanishes altogether for two or three nights before reappearing in the west as the new moon.

It is an easy task to track the moon's movement among the stars. Its orbit is similar to that of the sun, but while the sun takes a year to complete its circuit, the moon travels the same distance in just a month. Another difference is that while the sun always stays right on the ecliptic, the moon wanders off to both sides in a regular manner. Due to its deviation from the ecliptic, the moon can from time to time be seen in the sky slightly outside the standstills of the sun.

The moon with its monthly cycle of phase changes can readily be given strong symbolic meanings. It must therefore have aroused considerable interest among early societies. There is mounting evidence that lunar symbolism played a decisive role in the erection of early monuments, both in the Old World; at Stonehenge in England (Burl 1987) and in the New World; on Fajada Butte in Chaco Canyon in New Mexico (Sofaer *et al.* 1982, pp. 169 ff.). It is highly probable that one of the earliest recorded Mesopotamian festivals, the á-ki-ti festival, was connected with the appearance of a particular lunar phase (Cohen 1993, pp. 140 ff.). It has also been claimed that series of markings found in Palaeolithic art may represent day counts for months and phases of the moon (Marshack 1972).

Wandering planets

As far back as we have written records, man has recognized five luminaries other than the sun and the moon that move relative to the fixed stars. Shining with a steady light in contrast to the twinkling of the stars, they are in all other respects indistinguishable to the unaided eye from ordinary stars. We call them planets, imitating a Greek word for "wanderers". They have been given names after Roman gods and goddesses; Mercury, Venus, Mars, Jupiter and Saturn. Being bright objects, they are easily picked out among the stars.

Instead of moving steadily eastwards through the zodiacal constellations like the sun and the moon, the planets slow down to a stop at regular intervals, remain stationary relative to the stars for a while, then move westwards to stop again before finally resuming their usual eastward motion.

Mercury and Venus present a peculiar feature in their movements. They never get very far from the sun. When to the east of the sun, they appear in the west as evening "stars" only visible shortly after sunset. After moving westwards past the sun, they become morning "stars" rising shortly before dawn.

People must have been puzzled over the strange wanderings of the planets. It was a great scientific accomplishment when Mesopotamians as early as about 1700 BC were able to show that the complex and variable motion of Venus could be reconciled with order and harmony. They discovered that the appearance and disappearance of this planet followed a specific scheme (Weir 1982, pp. 23 ff.) which made it possible to predict the position of Venus at any time with considerable accuracy. The Maya Indians of Central America independently made the same discovery, although much later (Aveni 1980, pp. 83 ff.).

The planet Venus, owing to its great brilliance and predictable appearance, was much revered. It is possible that sightlines to Venus's extreme points on the horizon were incorporated in the Caracol tower at Chichén Itzá and the Palace of the Governor at Uxmal on the Yucatán peninsula in Mexico (Aveni 1975, pp. 178 ff.).

Legacy of the sky

The sky was an integral part of early man's natural environment. Events taking place

there could be seen by everybody who cared to lift his eyes towards the heavens. The sky was not an alien world. Apart from the rare occurrence of a comet or an eclipse of the sun or the moon, the sky was not felt to constitute a threat. Instead, people saw it as a constant source of comfort and inspiration.

To reach out for the stars, man could not use his hands. The exploration of the heavens was the first field of study where man had to rely solely on the capacity of his brain. The search for order in the sky provided an outlet for man's probing mind and a training ground for his intellect. The inaccessibility of the heavens set no bounds to his speculations and dreamings, giving the beholder a feeling of elation and desire to increase his knowledge and understanding of the universe. There is no doubt that observations of celestial phenomena have vastly contributed to the advancement of ordinary man's creative abilities and his intellectual capacity, long before astronomy was taken over by an educated elite of philosophers and scientists.

The sky is the last vestige of unspoilt nature that we can all aspire to enjoy. Yet most people today are largely unaware of the stars. The glow from urban lighting has virtually obliterated them from our sight. When the city lights went out in Los Angeles during a recent earthquake people wondered whether the eerie lights they saw in the night sky had something to do with the quake (Krupp 1994, p. 6). Even bright objects like the sun and the moon seem lost in the maze of buildings that obstruct the skyline in our big metropolises. Only occasionally, with the appearance of a comet, is the public's interest awakened for what is going on in the sky. Yet without doubt, the sky away from street lighting and city smog has the same capacity to stimulate and ignite the human imagination as it had of old.

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