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1

The Study of Cultural Astronomy

CLIVE L. N. RUGGLES AND NICHOLAS J. SAUNDERS

1.1 The Sky as a Cultural Resource

What do people see when they look at the night sky? The answer is as much a cultural as an astronomical one. Thus, the study of cultural astronomies is concerned with the diversity of ways in which cultures, both ancient and modern, perceive celestial objects and integrate them into their view of the world. This fact, by definition, illustrates that a society's view of and beliefs about the celestial sphere are inextricably linked to the realm of politics, economics, religion, and ideology. In this sense, cultural astronomy is but part of the wider endeavor of investigating and interpreting human culture.

Anthropologists and archaeologists are concerned with retrieving data on cultural systems, identifying patterns in these data, and attempting to elicit meanings from these patterns. A crucial aspect of this process, and one that has hitherto been largely overlooked, is the consideration of perceived relationships between a society and its environment. How cultures conceive of themselves in relation to what may be called the "natural world" determines their view of and attitude toward all beings and entities that they recognize as coexisting in their phenomenological universes.

In one sense, every culture makes an appraisal of its own environment by selecting certain aspects of its physical surroundings—such as other people, animals, mountains, meteorological and celestial phenomena—and assigning meaning to them and to the relationships that they regard as existing between them. Interaction with different aspects of the "natural world" can be seen as taking place through "channels of interaction" that are culturally defined (Wobst 1990: 327). Thus, cultures can be seen as creating or constructing their own meaningful universes

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(Kus 1983: 278), without which human behavior would be virtually ungovernable (Hodder 1985: 2).

In order to explore these ideas more fully, to illustrate their relevance to cultural astronomy, and to situate cultural astronomy within the debate about the epistemic limits of inquiry, we will begin by analyzing what we consider to be three distinct but inevitably linked processes that hitherto have often been lumped together with a consequent loss of analytical precision.

1.1.1 Observation

In general terms, the observation of celestial objects can be either casual or deliberate (that is, more or less organized). In many cases, for example, where recurrent phenomena are involved, a certain level of observational competence is required. All those who attain this level of competence can, in one sense, be called astronomers, although they will in general bear little resemblance to astronomers in the modern sense of the word.

1.1.2 Perception

Quite distinct from observation is the process of perception: the process, in other words, of making sense of and attaching meaning to particular observations. Different cultures and individuals may "see" the same objects in the sky, but the significance that they attach to them will be influenced by their classification of the natural world and the various ways in which they interact with it. Thus, when the Bororo of central Brazil lay down at dusk and look at the night sky, they ignore meteors when they are distant and silent. However, when they hear or see one land they react with great alarm and consult the local shaman (Crocker 1985), an act that links astronomy directly to other spheres of cultural activity, such as religious belief and mythology.

Perceptions are guided by both cultural and psychological factors (Neisser 1976). They may also be channeled (though not necessarily constrained) either explicitly or implicitly by a culture's level of socio-economic and political organization, its ideological imperatives, and the nature of its relations with the environment. In particular, and despite statements to the contrary (for example, Vogt 1990: 52), star lore cannot necessarily be expected to survive cultural attrition any better than any other kind of knowledge. This is because the practice of observing and making sense of celestial phenomena is as much a cultural activity as any other, and consequently it is equally sensitive to the varied processes of culture change.

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Different societies discern in the sky culturally appropriate patterns of both appearance and movement. The former may be correlated with latitude. For example, in the western Classical tradition, rooted in the northern hemisphere, patterns of appearance tend to be composed of groups of stars that are regarded as entities in their own right (for example, constellations such as Orion). By contrast, the definition of constellations among traditional cultures of equatorial and southern latitudes may include either groups of stars, the prominent light and dark areas of the Milky Way that are only visible in southern skies such as the Andean llama (Urton 1981a), or a combination of both. However, even where there exists a concordance of shape or form between constellations recognized by different cultures this does not necessarily imply a convergence of meaning.

Perceived patterns of movement are strongly latitude-dependent. Thus, in the tropics, where the characteristic motion of the heavenly bodies is predominantly vertical, cultures tend to be concerned with up-down movement. The Borana of southern Ethiopia, for instance, reckon days by identifying the stars that rise and set on a level with the moon—in other words, the stars at the same right ascension as the moon (Bassi 1988; Ruggles 1987; 1993). A circular motion is easily perceived at these latitudes, in which the heavenly bodies continue round below the horizon when not visible above it.[1] Special importance may be attached to their passage (and particularly that of the sun) through the zenith and nadir, as is widely evidenced in the American tropics, both in Pre-Columbian times and among modern indigenous groups (Aveni 1981a: 40–45; Urton 1981a: 76; Zuidema 1981).

On the other hand, at higher latitudes in the northern hemisphere, where the heavenly motions are predominantly horizontal, there is a widespread image of the sky as a huge bowl rotating overhead with an axis at Polaris and held up by a "world pole" (Eliade 1964: 262). Such world poles have ancient and widespread roots (for example, Martynov 1988: 12–29).

By contrast, in subpolar regions the long winter nights give rise to very different realms of perception, such as fortnightly lunar "days". The Inuit, for instance, have little in the way of star lore because the stars and planets are seldom very visible due to sunlight, moonlight, and bad weather (Pearce 1993).

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1 We also, however, encounter the perception—for example, in Vedic hymns (Lyle 1991: 93–95, 163)—of a sun which, after completing its daily journey from east to west, rises again into the sky with a dark side turned toward the earth and retraces its journey back to the east during the night. This dark sun, moving invisibly in the opposite direction to the other celestial bodies, tends to be associated with misfortune and death.

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1.1.3 Use

The final process to consider is the political and ideological "use" of the astronomical knowledge gained through observation and perception. This knowledge, like any other, may be seen as a resource that can be brought to bear in support of the dominant ideology to reaffirm and reinforce the structures of a particular society. A particularly good example is the way in which the so-called priest-astronomers of Pre-Columbian Mesoamerica used the movements of Venus to regulate their elaborate and often dynastic system of warfare (Carlson, this volume; Kelley 1975; Lounsbury 1982).

The "use" that can be made of celestial phenomena, as with any aspect of the natural world, depends upon the meaning and significance that culture ascribes to its constructed universe. While use-values are established by consensus within a society, in practice it is those who guide or construct the social consensus who have the power to persuade and influence, with the likely outcome of reinforcing their own position and status. For example, in terms of religious activity, considerable social prestige and political power may accrue to those individuals who are regarded as affecting a degree of control or influence over otherwise "manifestly" uncontrollable natural phenomena. For example, an astronomer-priest may hold the solstice ceremony around the time that the sun sets in a particular horizon notch so that he can demonstrate the power of "turning it around". As, in one sense, celestial (and meteorological) phenomena are the most uncontrollable of all, the psychological effect of appearing to control them is, presumably, one of the most impressive displays of "supernatural power" (and its socio-cultural correlates) available to elites.

1.2 Perception and the Natural World

An essential distinction among the stages of observation, perception, and use is that the first is universal whereas the second and third are culture-specific. What one society might perceive as significant might arouse little or no interest in another. For example, the supernova of AD 1054 that resulted in the formation of the Crab nebula was marked as a dire event in China (Ho et al. 1972),[2] but left no known comment in the histories of northern Europe. Similarly, there may be a diversity of views about the sky within the same society, as the following account of the Mursi of Ethiopia illustrates:

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2 Claims have also been made that this event is represented in rock art of the US Southwest (Brandt and Williamson 1979); but see Young (1986).

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> On one occasion a man, who had been wearing a knotted cord round his ankle for several weeks, announced to a group of bystanders that 72 days had elapsed [between] the planting and first harvesting of his sorghum crop. He had been keeping track of this interval by successively knotting a piece of cord for every day that passed. The other members of the group treated this information as a curiosity without relevance to their daily lives, not as a "discovery" to be added to their total stock of knowledge about the world. Their main reaction, in fact, was one of mild surprise that anyone should have taken the trouble to record such a trivial fact, and it was, without doubt, quickly forgotten (Turton and Ruggles 1978: 592).

What we consider an empirical reality does not necessarily have any relevance for other cultures; even if it does, its meaning is likely to be very different from ours. Thus, significance and meaning in the night sky, as elsewhere, are neither given nor self-evident, but are culturally established by social agreement and use (Saunders 1991: 13). In other words, individuals and cultures negotiate the meaning of their constructed "natural world" and arrange the material and non-material aspects of it accordingly (Hodder 1985: 4–5). In acknowledging that things only mean what people and cultures agree that they mean, concepts of "nature" and the "natural world", together with the resources contained within them, are revealed as cultural appraisals (Sauer 1954: 2–3). What we recognize as "empirical reality" is merely our own cultural appraisal couched in the framework of a "rational", Cartesian, and thus quintessentially Western view of the world.

In attempting to understand how and why cultures assign meanings to objects, the objects themselves may be seen as possessing a set of "invariant properties" (Ingold 1988: 13). Formalized in Gibson's (1979) theory of "affordances", natural or artifactual objects are regarded as affording different uses to different people and cultures at different times. For example, the possible affordances of a standing stone might be as a trackway marker, a boundary stone, a focus of witchcraft or folk superstitions, or an integral part of a megalithic structure. In more recent times, such standing stones may also have afforded local inhabitants a good source of building material. Each of these affordances may, of course, lead to particular cultural attitudes toward the object, which may in turn lead to its modification or destruction, and consequently to bias in preservation. The difficulties that this can produce in attempting to reconstruct the object's original form and meaning is well illustrated by Ucko et al. (1991) in relation to Avebury. Similarly, Stonehenge always possessed the possibility of being used as a computer, but this has

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only become one of its affordances since about AD 1950, a fact that illustrates the important point that only certain types and levels of society can recognize and make use of a particular affordance.

In different cultural contexts, or merely in different situations, the same affordance may have similar or very different meanings. A jaguar pelt, for example, afforded a use as a prestigious item of clothing both to fashion-conscious women in the 1960s and 1970s and to (male) Amazonian shamans and warriors from time immemorial. However, while no Westerner would regard the wearing of such garments as bestowing supernatural powers on the wearer, those native Amazonians who wore such clothing were often regarded as particularly brave and powerful, and consequently attracted more lovers (Roe n.d.: 3). Thus, despite wholly different cultural aesthetics, the connotations of sexual attractiveness afforded by a jaguar's skin were in one sense shared, whereas other connotations remained distinct. Meaning and significance are therefore situation-dependent—even within the same society—and apparent similarities between societies may have quite different explanations.

1.3 Structuring the Natural World

In order to understand a culture's perception of its environment we need to consider how it has constructed its "natural world". All cultures seek to structure the world according to classification schemes that codify the meanings attached to objects. This is because, as Lévi-Strauss (1976: 15) noted, any classification is preferable to chaos, and through assigning meaning and order both within and without society a culture creates and sustains its own meaningful universe (Kus 1983: 278).

Indigenous cultural attitudes toward and perceptions of what constitutes the natural world may be very different from ours. As significance, like similarity, is not an inherent quality but is culture-dependent (Douglas 1990: 26), this will be reflected in a culture's classification scheme. Thus, something that seems significant to us might be acknowledged by another culture yet not be visible in their classification schema. On the other hand, their animated natural world may include what, within the framework of Western science, would be classified as inanimate objects, such as stones, mountains, and stars (for example, Bastien 1985; Lévi-Strauss 1976: 184–185), or not recognized as an object or entity at all, such as earth spirits and sky gods.

In this sense, a culture's constructed world is free to include creatures and objects we would term "fantastical"—entities that appear to us as disarticulations and amalgamations of "real" objects, animals, and people, and yet may embody vital cultural qualities. For example,

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"Old Star", chief protector of the inhabitants of the sacred *He* world of the Barasana of the Colombian Amazon, is at once a short trumpet, Orion, the fierce thunder jaguar, and a human warrior (Hugh-Jones 1979: 138–146). To our understanding, myth and reality are here inextricably mixed. Yet in the historically contingent classifications of other world-views, fantastical beings such as the "fish-man" or "bird-woman" are regarded as every bit as much a meaningful part of the perceptional universe as physically real ones. According to their type of significance such fantastical creations may populate art, mythology, or the night sky; and they may quite possibly be perceived to do so alongside what are to us "natural" objects (for example, Sagittarius and Leo). For non-Western traditional societies, objects or entities we regard as inanimate or fantastical may be seen as "fellow beings" with which the individual or society may enjoy a more or less advantageous relationship (Wax 1968: 235).

Ordering within classification schemes is based in part upon correspondences that are perceived to exist within the boundaries of a society's phenomenological experience. The Barasana, for example, link the "Caterpillar Jaguar" constellation to the appearance of living caterpillars, which form an essential part of their diet. Regarded as the "father of caterpillars", the Caterpillar Jaguar is believed to be responsible for the increase in their numbers as he rises higher and higher in the sky at dusk. To us, the correlation can be seen to be due to the fact that the constellation is in the eastern sky at dusk at the time of year when caterpillars pupate and come down from the trees on which they feed (Hugh-Jones 1982: 191). In Barasana thought there exists a correspondence between two entities that to us are quite distinct: a constellation and its position in the sky and an important part of the seasonal food supply.

Correspondences between objects or entities in the natural world may be perceived by means of characteristics that are regarded as being shared in common. In other words, a correspondence is predicated on the social acceptance of a stated affinity existing between two or more types of "being", "object", or activity (Saunders 1991: 85). Thus, to the Mursi there was a direct association among four stars in Centaurus and the Southern Cross, the river Omo, certain flora, and the successive disappearance of the stars in the morning sky—all of which were in turn correlated with terrestrial events such as the flooding of the river and the flowering of plants (Turton and Ruggles 1978: 590). Similarly, to the people of the Andean village of Misminay, the Vilcanota river is regarded as a reflection of the Milky Way in the sky, and both are conceived as part of an integrated system that serves to circulate water through the terrestrial and celestial spheres (Urton 1981a: 64).

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It is clear that the acknowledgment of such correspondences depends upon a definition of meaning that is not inherent but relative, variable, and culture-dependent (Douglas 1990: 26). It follows that the resulting classification is, in part, psychological and may bear very little resemblance to the principles of Linnaean classification that underpin Western (that is, "rational" or "objective") scientific thought. Linnaean procedures have the advantage for our society that categorization is, by definition and design, predictable. Indigenous folk-categories are not necessarily predictable in the Linnaean sense, either in their meaning or their ordering, but they may nonetheless be methodically established in their own terms and exhibit a greater or lesser degree of correspondence with Western scientific categories (Saunders 1991: 16).

Whereas in Western classification membership of a category (taxon) depends, as Darwin (1985: 408–409) noted, on genealogical connections regardless of appearance or emotional reactions by humans, any entity may be a member of a folk taxon if enough society members agree that it should be (Clark 1988: 18–19). This does not mean that the folk taxonomy is unsystematic—merely that it adheres to its own principles rather than Linnaean ones (Saunders 1991: 16). In the twentieth-century Western world the Linnaean system has become the dominant one; but in terms of human societies in general it is nevertheless one system of classification among many.[3]

Classifications need to be expressed; qualities that the process of classification attaches to objects in the natural world must be brought to the fore and displayed for all to see. This is effected, in part at least, by the use of symbols, expressed as verbal or visual metaphors mediating among individuals, culture, and the environment. Thus, for the Aztecs, the jaguar (*ocelotl* in Nahuatl) symbolized qualities such as strength, courage, haughtiness, and pride (Sahagún 1950–1982, book 11: 1), human characteristics assigned to the animal in Aztec classification. In the same way that qualities of human behavior and animal behavior may be linked, so may human concerns and the movements of the heavenly bodies. Thus, to the Aztecs, people born under the calendrical day-sign *Ocelotl* were "destined to be like the jaguar" and demonstrated the qualities associated with it (Durán 1971: 402). In Aztec perception, therefore, there were symbolic associations—that is, correspondences of meaning—among a particular animal, certain individuals, and a constellation.

3 Even in the twentieth century we find the Western so-called "rational" tradition coexisting both with various religious classifications and with powerful "folk" classifications, such as the one that lies at the basis of modern astrology.

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1.4 The Special Role of Cultural Astronomy

Even though we may fully appreciate that many systems of classification exist in different cultures, we inevitably attempt to understand and to assess other cultural systems from a perspective created by and framed within the "rational" structures of Western scientific thought.

From this point of view, relationships between people and their surroundings fall broadly into three categories: those with other people, those with the terrestrial environment (fauna, flora, landscape, and sea), and those with the celestial environment (that is, astronomical and meteorological phenomena). Of these, only the third deals with that part of the environment that is not susceptible to physical alteration by humans. In other words, the celestial sphere can be regarded as an untouched, untouchable, and hence immutable part of the environment.

The study of astronomical phenomena in this context has a significant advantage over studies of other aspects of people's interaction with their surroundings, because the "raw resource" is directly accessible to us. Modern astronomy and physics can reconstruct important components of the night sky at any place on earth and any time during the last several millennia, to within certain largely determinable margins of error.[4] The results can then be recorded on computer or reconstructed in the planetarium. Thus, subject to uncertainties about the time and place being studied, we can construct directly a part of the celestial environment of a group of people in any remote culture. This ability to access an exact configuration of one aspect of the past is manifestly not available to other kinds of anthropological investigation.

Within this immutable database of the night sky we can pick out, at various levels, features that are common to different cultural contexts: at one level, for instance, the appearance of the same objects such as Polaris or the Pleiades, and at another level, the same general pattern of

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4 The most reliable components are the positions of "fixed" objects, such as stars, nebulae, and the Milky Way. Also generally reliable are the positional aspects of recurrent phenomena, such as the limits of the solar and lunar motions. Their theoretical positions in the sky can be calculated with very great precision, and their actual appearance, which is subject to uncertainties caused by atmospheric effects such as refraction and extinction, can be modeled and subjected to empirical verification. Temporal aspects of periodic phenomena—such as the position of a planet relative to the stars at a particular time, or the timing of coincidental events such as conjunctions and eclipses, and hence whether they are visible above the horizon at particular places—are subject to cumulative errors as we extrapolate back in time from the present, and estimates become less accurate further into the past. Generally, we cannot accurately reconstruct non-recurrent or very long-period events such as the appearance of novae or comets. For a detailed survey, see Schaefer (1993).

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the motions of the heavenly bodies at similar latitudes—tropical, temperate, or subpolar. The immutability of the sky, the commonality of the features within it, and the fact that we can reconstruct it directly, give a number of special advantages to the study of cultural astronomy within the study of cultural systems as a whole.

1.4.1 Cross-Cultural Comparisons

The first advantage concerns cross-cultural comparisons which are particularly valuable at the level of seeing how the same celestial resource is perceived, integrated into different systems of classification and belief, and manipulated to different or similar ideological ends. Especially interesting are comparisons of cultures for whom the skies are the same or very similar, but who might have very different perceptions of the celestial sphere. As a well-known example, the ancient Egyptians saw the sky as populated by gods in the form of constellations: the Greeks did not.

In many cases, however, common features are evident in the classification systems of adjacent societies: cross-cultural comparisons are then most useful. Examples abound at various levels. In northeastern South America, the architectural design of Yekuana roundhouses reflects the cosmology of the adjacent Warao, inasmuch as the cylindrical floor of the world ocean and earth disk of the latter correspond to the ground plan and concentric rooms of the former (Wilbert 1981: 48).

A view prevalent in Pre-Columbian Mesoamerica partitioned the horizontal world into five parts: the center plus four quadrants associated with the cardinal directions (Carrasco 1987: 140–141), the latter being demarcated by the solstice sunrise and sunset directions (Köhler 1982; Broda, this volume). Four-directionality and six-directionality (including the vertical axis, zenith, and nadir) were of great significance. A similar view is evident among the Zuni to the north (Young 1988; 1989: 170).

Similarly, the recognition of radiality as an influential general concept is found in a variety of cultural contexts in Pre-Columbian, historic, and modern South America. In particular, this has led to new insights into the possible ritual, kinship, and socioeconomic significance of the prehistoric Nazca lines (Aveni 1990).

A particularly interesting example is provided by two distinct cultural traditions, one from Andean Peru and the other from the tropical forests of the montaña to the east. In both cases the same configuration of dark cloud features in the Milky Way is recognized as a predator-prey scene—an interesting fact in itself—but whereas in the Andes it is conceived of as a black highland fox chasing a llama, in the montaña it is seen as a lowland black jaguar chasing a deer (Roe 1990).

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Comparative studies of cultural astronomy are thus shown to have particular potential to bring into focus the social and political dynamics of cross-cultural interactions. An example of such a study is given by Roe (this volume).

1.4.2 Cultural Correlates for Astronomy

Another advantage in studying cultural astronomy is that aspects of a culture's astronomy might bear some correlation to the nature and concerns of that society. The process of classification in general informs us of a society's perception of itself. The celestial part of the classification assumes special significance precisely because it is "locked away" in the immutable part of the natural environment. Yet this is a point that has been much undervalued in anthropological work to date.

Cultural correlates for astronomy have long been recognized, though usually at a superficial level. Literacy is a prime example, the supposed dichotomy between "preliterate" and "literate" astronomical activities being adopted as a primary classification within many conferences and publications, such as the 1974 joint Royal Society–British Academy conference on the place of astronomy in the ancient world (Kendall et al. 1974). Similarly, Aveni (1989b: Ch. 2) has more recently divided examples of early time-reckoning into the oral and written. However, literacy, taken in the narrow sense, is a crude and arbitrary indicator of cultural transition (albeit no more so than the technological boundaries used to denote prehistoric "ages"), and hence limited in value as a correlate for astronomical activity.

Of more interest are examples of symbolic notation in the wider sense, such as writing, numbers, and "notation" encapsulated in art and architecture. Various levels of symbolic notation evidently act as prerequisities for, or at least significant enablers of, certain levels of mathematical and astronomical activity. For example, high-precision lunar observations of the type envisaged by Thom (1971) require extrapolation calculations (ibid.: Ch. 8) performed, if not using written notation, by using an alternative medium such as grids of standing stones encoding the relevant information geometrically (ibid.: Ch. 9).

Crump (1990: 6–10) has identified three types of symbolic number, representing three levels of conceptual evolution, and surveys their uses in different cultural contexts (ibid.). This begins to suggest how studies of orders of relationship between levels of numerical notation in particular, and symbolic notation in general, and levels of astronomical activity could be put on a more solid footing.

Other correlates are also of interest. Thus, for example, Iwaniszewski (1993) explores the relationship between the conceptualization of east

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and west and the rising and setting of the sun. Such explorations need to be developed much further and within a rigorous anthropological framework. In the longer term, an "anthropology of astronomy" (Platt 1991), adopting an approach analogous to that of Crump, is much needed.

1.4.3 Cultural Responses to Astronomy

A third advantage in studying cultural astronomy is that despite the untouchability of the celestial sphere, astronomical expertise can, as has been noted, yield a degree of apparent control by virtue of the ability to predict certain kinds of phenomena, such as solar and lunar eclipses and heliacal risings and settings. The predictive capacity of astronomy, available to those with even a limited observational expertise, is not only a unique characteristic but also one of the few universal realities in the study of human societies, and illustrates the potential of cultural astronomy to shed light on the diversity of cultural responses to the "natural world".

It is, therefore, through the manipulation of perceptions that form the basis of a structured world-view that objects within the natural world serve as a cultural resource. In practice, this resource serves, politically and ideologically, to reaffirm and reinforce the structures of a particular society by serving as an impressive display and justification of elite power and prestige. For example, the very location and layout of the medieval Hindu city of Vijayanagara symbolized the place of kingship within the sacred and cosmic order (Malville and Fritz, this volume).

If an elite has persuaded others that they have powers and influence over the celestial sphere (on the basis of "understanding" patterned movements) then unpredicted or unpredictable events in the sky may undermine their authority and cause social and political instability. Examples abound where celestial events are correlated with the fate of the elite: an unexpected lunar eclipse appears to have caused two Teutonic armies to flee the scene of battle and postponed the Roman occupation of the Carpathian basin (Pásztor 1993); the appearance of Halley's Comet portended disaster for King Harold at the battle of Hastings in 1066; a spectacular meteor observed in Tenochtitlan around 1515 was taken as a bad omen and preceded the Spanish conquest (Sahagún 1950–1982, book 8: Fo. 12r; Köhler 1989). The degree to which people were panicked by unforeseen celestial events reflects the extent to which prestige and status were invested in the "control" and interpretation of celestial events by the elites of various cultures. Thus, our knowledge of the use of the sky as a cultural resource is informed equally from when it breaks down as from its everyday manipulation. This is because astronomy, like myth and religion, is not an end in itself but can serve the ends of political ideology.

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1.5 The Nature of the Evidence

How can we, as outsiders, penetrate the natural world of another culture? As we have seen, each culture makes its own sense of the environment, and so classifications of the world may be very different, even for contiguous cultures. Correspondences may be predicated upon empirical reality (for example, rivers flooding when certain stars disappear), or upon something that appears to us as physically impossible and/or esoteric, such as the idea that an individual's personality or future life can be affected and predicted through the astrological interpretation of astronomical phenomena surrounding the person's birth.

How, then, can we attempt to understand and describe another culture's classification? Other cultures' notions of reality and unreality, if they exist at all, will be different from ours, and will certainly be expressed in ways that are difficult (if not impossible) for us to comprehend. This is due, at least in part, to differences of ontological perspective, and between the classificatory structures and terms employed (Hallowell 1969: 50–58). One approach to overcoming this problem is to acknowledge that correspondences in a classificatory scheme are essentially psychological and expressed by metaphorical representation, which takes the form of symbols and their manipulation in ritual activity. One way to penetrate another classification scheme, therefore, is partly through the recognition of metaphor—by, for example, recognizing the display of distinctive combinations of symbols in ritual activity.

Here, once again, the sky assumes special significance because it can only be used symbolically to express correspondences in the culturally constructed "natural world". It is an exclusively metaphorical resource —a never-changing database of potential symbols.

The symbolic use of the sky is not restricted to celestial objects in isolation. There is a correlation between a society's classification of things on the ground and those in the sky. Thus, at Misminay there is a correspondence between the gradual rise of the celestial llama in the sky each morning and the breeding period of terrestrial llamas (Urton 1981a: 187; 1981b). While it may be assumed that the earthbound phenomenon came first, it is arguable that Misminay's inhabitants would have perceived a llama in the sky regardless of the actual distribution of celestial objects. Similarly, symbolic relationships may find expression as, say, a recumbent stone circle oriented upon the southern moon (Ruggles and Burl 1985); a cluster of aligned temple-pyramids at Uxmal (Aveni and Hartung 1982, 1986); the supernatural ordering of the universe reflected in the layout of a kiva (Williamson et al. 1975; Williamson 1982); an Amazonian roundhouse (Wilbert 1981); or a

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whole scheme of "state-sponsored" sacred geography, as in the Valley of Mexico (Broda, this volume; Tichy 1981), the Inca ceque system (Aveni 1981b; Zuidema 1964), and the Islamic world (King, this volume; n.d.).

1.6 Methodological Conflict

In order to recognize an object or a relationship between objects that may have had symbolic significance to another culture, we have to consider not only the different types of available evidence, but also the paradigm-dependent interpretational biases through which we perceive pattern and meaning.

Hitherto, the study of cultural astronomy has brought together three major disciplines: cultural anthropology, archaeology, and ethnohistory. Each of these has its problems and limitations, which, in turn, create problems of integration (Charlton 1981). Thus, for example, the Yanomamo of South America conceive of themselves as the "fierce people", and actively conduct an elaborate and graded system of club-fights, raiding, and warfare. According to Yanomamo myth, it is in their nature to fight because the blood of the moon spilled upon their layer of the cosmos, causing them to become fierce (Chagnon 1977). Their "use" of the moon in this instance is mythological, and could only have been retrieved by cultural anthropology or ethnohistory. It would be invisible to the archaeologist.

Each of the three disciplines also has very different methodologies of explanation. The cultural anthropologist observes a living society and attempts to understand its totality by studying the articulation of its component parts. This "top-down" approach must acknowledge problems such as prior biases, the linguistic competence of the anthropologist, the reliability of informants, and the appropriateness of questions asked and the meaning of answers given. Ethnohistory inherits many of the problems of cultural anthropology but has in addition to cope with the often even more pronounced ideological persuasions and prejudices of those who collected, preserved, and interpreted the historical documents in the first instance.

The problems facing the archaeologist are the most severe of all. Extreme financial, political, and temporal constraints often force the archaeologist to sample a site with particular research questions in mind, and hence to rely heavily on inference. The archaeological approach also suffers from problems related to the limitations of the material record and its interpretation, such as distortion processes, possible bias in sampling strategy, and objectivity in the selection of data. There is, in addition, an ethical problem, as "viewing" by excavation necessarily involves partial or total site destruction.

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The problems of recovery and interpretation of archaeological data pertain to the dominant set of beliefs that left a physical pattern retrievable from the material record. We should not forget, however, that these may have coexisted with other systems of belief that are much less likely to have produced recoverable or identifiable physical remains. In addition, a culture may have had more than one system of classification or belief operating side by side. For example, an official ideology may have coexisted with a local folk tradition, as happens in the Western world today with scientific astronomy and astrology.

The clash of methodologies of the three "parent disciplines" creates severe problems for the study of cultural astronomy. This is evident from debates within archaeo- and ethnoastronomy, the twin banners under which most work in cultural astronomy has taken place during the last two or three decades. These differences have created a methodological divide characterized hitherto by Aveni's "green" and "brown" classification (Aveni 1986, 1989a). Emanating respectively from different approaches in Europe (Heggie 1982) and the Americas (Aveni 1982), "green" methodology came to epitomize a prepossession with using statistical rigor to interpret the archaeological record in the absence of other kinds of evidence; "brown" methodology, faced with a rich ethnographic and ethnohistoric record, often felt it could relegate statistical arguments to a secondary supporting role.

While this bipartite division has often hindered the development of a cohesive identity for cultural astronomy, it is nevertheless true that statistical rigor is a prerequisite for estimating the likelihood that observed patterns have real (and quantifiable) cultural significance. Thus, the cautious use of appropriate statistical methods is relevant to any study in cultural astronomy that includes patterns in the material record among its dataset. However, before the use of such methods can even be considered, a more fundamental and underlying problem must be addressed: the need for objective selection of data. While objectivity is itself a problematic concept (see what follows), it is at least clear that negative data—that is, those that do not fit a given theory—should be considered on an equal basis alongside positive data in weighing up the idea, and presented with equal prominence so that others can judge it fairly. While the many critiques within "green archaeoastronomy" in the late 1970s and early 1980s addressed such issues (for example, Moir 1981; Heggie 1981a, 1981b; Ruggles 1981, 1982), similar "brown" critiques (for example, Ruggles and Saunders 1984; Köhler 1991) have been comparatively rare.

It is evident from this discussion that a serious problem in studying cultural astronomy is the lack of a rigorous methodology for *combining* evidence from the three main disciplines, as well as associated subjects

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such as folklore, mythology, art history, and the history of religion. How should we, for example, assess different types of ethnographic and archaeological data? This is, of course, merely one aspect of a general problem of data integration, a crucial issue that has been thrown into sharp relief by the recent excavations at El Templo Mayor in Mexico City (Boone 1987; Broda et al. 1987; Matos Moctezuma 1988).

Despite these problems, it is precisely cultural astronomy's integration of different but complementary types of evidence that has led to the establishment of a new and unique cross-disciplinary approach followed by those working in the mainstream of the parent disciplines.

1.7 Toward a Methodology of Data Integration

The breadth of view of cultural astronomy is its great strength and its main justification for recognition as a discipline in its own right. In order fully to exploit its cross-disciplinary potential, the integration of diverse data must be given a sound methodological underpinning. This would ensure that, among other things, cultural astronomy has something more to hand back to its parent disciplines than interesting—but mostly peripheral—data (Kintigh 1992).

As an illustration of the sort of methodological issues needing to be addressed, we shall consider one aspect of the problem of assimilating different types of cultural data, namely, how to weigh patterns observed in the archaeological record against other kinds of cultural data. First, we consider some of the special difficulties that arise in dealing with the material record.

1.7.1 Dealing with the Material Record

A number of studies, particularly of astronomy in the prehistoric British Isles, have adopted an approach led by a statistical methodology, paying close and often meticulous attention to rigorous criteria for the selection of data in an objective manner (Cooke et al. 1977; Hawkins 1968; Patrick 1993; Ruggles 1984a). Recently, however, there has been an increasing awareness of the limitations of classical statistics in the context of archaeoastronomy (Aveni 1988: 471; Ruggles 1988: 248–249), as indeed more widely within archaeology as a whole (Bell 1986; Orton 1980: 220; Ruggles 1986). There are a number of reasons for this.

First, statistical arguments can only enable us to pick out the most general trends of repeated patterns in the material record, and ignore the rich variety and diversity of symbolism that was almost certainly perceived in the celestial and terrestrial environment by a particular culture. Thus, in the context of "green archaeoastronomy", superficially

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similar sites may have had complex, differing, and changing functions of which astronomy, if it played a part at all, may have entered in various ways, differing from site to site (Ruggles 1988: 249).

A second and more fundamental problem is that the methodological foundations underlying classical statistics itself are based on the hypothetico-deductive paradigm (Popper 1959). Arguable enough in the context of the physical sciences (for example, Feyerabend 1978), this paradigm is totally inappropriate for studying the material record left by human activity, despite the efforts of the "new archaeology" to place archaeology on "objectively scientific" foundations (Binford 1967: 10; 1968: 18). Whereas in the numerate sciences explanation is prediction, archaeological evidence, because it was produced by humans as part of social processes, is not amenable either to prediction or the formulation of universal laws (*pace* Binford). On a practical level, in the hypothetico-deductive model theories are tested by repeated experiment, and any set of data may be used only once to test a hypothesis and then must be thrown away. In the material record we have only small amounts of data, which we may wish to examine over and again for patterning in the light of new ideas and theories.

Finally, the notion of objective data is itself problematic, and leads to a fundamental paradox. Objectivity is necessary because we work within the framework of rational, "scientific" thought. Thus, for example, the idea that certain horizon notches were used as high-precision lunar indicators is undermined when the full extent of the "beaver-gnawed" horizon at some alleged megalithic lunar observatories is revealed (Burl 1976: 143; Gingerich 1981). Similarly, the idea that three pecked cross-circles in the vicinity of Teotihuacan acted as surveyors' benchmarks (Aveni et al. 1978) is undermined by the presence of at least eleven that are in no position to do so (Ruggles and Saunders 1984). It is clear that unless we can demonstrate that we have not simply selected the data that fit an idea and ignored the rest, any conclusions will tend to reflect our own cultural input rather than providing any insights about the culture being studied.

However, in order to be "objective"—in other words, to formulate selection criteria—we need to make prior decisions about which types of pattern in the material record to consider and which to reject. These decisions will inevitably be made on a prior assessment of which patterns have the greatest potential significance—for example, which types of architectural alignment have the greatest astronomical potential—in order to make the ensuing investigation worthwhile. This is evident, for example, in Ruggles's selection criteria for examining megalithic alignments in western Scotland (Ruggles 1984a: Ch. 3). The eventual results will depend upon how closely the prior ideas reflect the classification of

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the target culture. For example, a "bad" prior guess at which megalithic alignments to choose might result in other alignments that really did have symbolic significance to the builders being missed in the statistical analysis. In short, any criteria for the "objective" selection of data will themselves reflect a cultural input; where there are little or no independent data considered relevant to the target culture, which could be used to guide the formation of prior decisions, this cultural input is entirely our own.

The recognition of these problems carries the danger, evident in some reactions to the "new archaeology" (Hodder 1985; 1989: 68–71; Shanks and Tilley 1987), of concluding that there is unlikely to be any single, unifying theoretical approach to archaeological knowledge. This implies the abandonment of any attempt to supply a general methodological framework for interpreting material data. Such an extreme view is unproductive, since it implies that all interpretations ultimately reflect little other than our own cultural input, in which case the only sensible course of action is to abandon interpretation altogether.[5]

However, while human behavior cannot be predicted and while some cultural input of our own can never be escaped, objectivity and quantitative support for particular conclusions on the basis of given data are still of paramount importance. To take an example from the archaeoastronomical literature, while the recognition that the Mesoamerican cross-symbol had a variety of possible meanings and uses (Aveni 1988; Iwaniszewski 1993) serves to emphasize the limitations of the statistical approach in examining a single possible use in isolation, it should not lead us to abandon methodological rigor in attempting to assess these possible meanings in their broad cultural context. The key point is that this assessment needs to be achieved within a methodological framework suitable to investigations of cultural data, rather than with one imported from an entirely different area with a totally inappropriate methodological framework.

1.7.2 The Role of Analogical Inference

How, then, should we proceed? It is clear that, working with the material record alone, we can never reconstruct the original meanings of objects retrieved by excavation. However, the limitations of the archaeological record can be partly offset and our interpretive horizons widened by the use of analogy. Despite Gould's (1980) view that analogy is an unwarranted assimilation of the past to the present, it can be properly used as an inductive, probabilistic argument, keeping in

5 For a more recent debate concerning this topic, see Hodder 1991; Mithen 1991; Tilley 1991; for another view, see Binford 1989.

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mind that only a partial similarity is suggested, never a complete or exact identity (Wylie 1982: 392–393). In addition, and significantly, the formulation of our contemporary views of the past has been irrevocably shaped by the ever-increasing availability of ethnographic sources since the sixteenth century (Orme 1981: 3–14).

Analogical inference is of considerable importance because the multidisciplinary nature of cultural astronomy, like post-positivist archaeology, is increasingly concerned with the epistemic limits of inquiry, in other words, with the status of what can be understood of the past. It is important to note that what can be known of the past is seen to depend on the theoretical and ideological presuppositions that are brought to the inquiry (Wylie 1989: 94). Thus, "facts" about what constitutes the past are themselves neither stable nor self-evident, but are paradigm-dependent and consequently open to continuing revision in the light of empirical and theoretical developments.

Through the use of analogy it may be possible to ascertain certain correlations in the original culture's classification scheme by recognizing the symbolic associations between celestial and terrestrial features that were used to express them. Thus, for example, changes from lunar to solar symbolism in the alignments in burial and ceremonial monuments in prehistoric Britain (Burl 1987) tell us something about changing views of the natural world and their prevalence in different areas at different times. Similar insights may be gained by studying the evolution of architectural alignments through time at ceremonial complexes such as Group E, Uaxactún (Aveni and Hartung 1989).

The central problem is to assess our degree of confidence or belief that an association we observe in the material record represents one of symbolic significance to the culture being studied—one, in other words, which did express a correlation in their classification scheme. This assessment is not made in isolation, but in the context of a *class* of associations about which we have a degree of confidence prior to examining the data in question. For example, consider the class of associations between the principal axis of a Scottish recumbent stone circle and the path of the moon near major standstill (Ruggles and Burl 1985). A particular *instance* of an association found in the material record, such as the alignment of the Cothiemuir Wood recumbent stone circle in Scotland upon the moon setting at declination –30°, needs to be assessed in the light of our prior degree of belief in the association (strictly, class of associations) between recumbent stone circle orientations and the moon. Thus, the original question might be rephrased as follows. Given a prior degree of belief in a class of associations, how should this degree of belief be modified in the light of new data from the material record? If we could express our prior model of the world

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(that is, of the class of associations currently under consideration) in terms of probability distributions of suitable parameters, and develop a formalism for how this model should be modified in the light of new data, then we could justifiably have more confidence in our assessment of the situation. This is the Bayesian paradigm (Barnett 1982: Ch. 6), and suggests that Bayesian statistics might provide a suitable formalism for the integration of material data and other cultural data, both in the study of cultural astronomy (Ruggles 1986; 1990: 247–248) and in a wider context (Buck et al. 1991; Buck and Litton 1991).

1.7.3 Data Interpretation and Integration Methodology as the Determination of Priors and Likelihoods

In order to use a Bayesian approach to a given problem of data integration and interpretation, it is necessary for the anthropologist to quantify the prior probability density ("prior"), which expresses his or her beliefs about the unknown parameters before the data are examined, and for the statistician to quantify the likelihood function ("likelihood"), which expresses his or her model of how likely the observed data are to arise, given specific values of the unknown parameters. By combining the two using Bayes's theorem, we arrive at a posterior probability density ("posterior"), which expresses how the anthropologist's beliefs should be updated in the light of the data. What interpretation is placed upon these modified beliefs is entirely the concern of the anthropologist and cannot be prescribed by the statistician.

The Bayesian approach has a number of attractive features in the context of the development of methodologies for the integration of diverse cultural data. Two are paramount. First, data of many different kinds may be considered in the formulation of a prior, and indeed must be if they have contributed to the anthropologist's belief about a particular issue. (Classical statistics, in contrast, lacks any means of taking into account "background" or "corroborating" evidence relating to the hypothesis being tested.) Second, data may legitimately be reused to examine how the same data affect different prior ideas. In addition, knowledge may be accumulated, for the posterior obtained after the consideration of one set of data may subsequently be used as a new prior.

The formulation of suitable quantifications for the prior and likelihood is far from easy, and has been attempted in very few archaeological contexts, exceptions being the megalithic yard (Freeman 1976), paleoethnobotany (Kadane and Hastorf 1988), cluster analysis and chronological seriation (Buck and Litton 1991), and radiocarbon dating (Buck et al. 1991). Such attempts are under way in the context of cultural astronomy (for example, Ruggles and Hills n.d.). However, a few general observations are of value here.

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The anthropologist may have acquired his or her background knowledge of the culture being studied, and hence his or her prior beliefs about the parameter distribution of a model, through data of various kinds, including all those of concern to cultural astronomy. How removed each of these sources is from the primary activities of the culture concerned, and hence which should be given greater prominence or afforded greater weight, must ultimately be the decision of the anthropologist. The Bayesian paradigm represents a framework within which the methodological basis for such decisions could be couched. As far as the material record is concerned, classes of association are best evidenced by repeated trends. This harks back to the old "green" approach, but now diverse background data can be taken into account to permit an assessment of whether alignment trends reinforce or counteract current cultural ideas (Ruggles 1986).

The problem of quantifying background data into parameter distributions in a prior model also bears strongly upon the question of data selection and "objectivity". Data selection criteria formulated in the absence of cultural input, such as those of Ruggles (1984a), amount to the prior selection of data—alignments, horizon features, and so on—considered plausible as astronomical indicators per se. The decision on what is plausible per se is inevitably made in the context of our own cultural perspective. It would, however, be wrong to dismiss such analyses out of hand—that is, to take the view that there is no point in studying astronomical alignments without some independent cultural evidence. Such a view would eliminate not only "green archaeo-astronomy" but also most of prehistoric archaeology in general.

We must, however, develop criteria for these situations that are more rigorous in the anthropological sense. For example, selection criteria in the absence of direct cultural input could likely be improved through techniques such as cultural deconstruction or simulation. A recent exercise was undertaken using Earthwatch volunteers, largely ignorant of background work on astronomy in prehistoric Britain, who were asked to give their personal assessments of the relative prominence of horizon features from positions at or near to certain sites on the Scottish island of Mull (Ruggles and Martlew n.d.). Only a small proportion manifested a view at all similar to those propounded by Thom (for example, Thom 1971) and generally followed in studies of prehistoric British astronomy.

1.7.4 Discussion

The Bayesian paradigm is not necessarily the panacea for the integration and interpretation of diverse data, and there are a number of significant problems to be overcome in defining suitable priors and likelihoods.

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The general approach does, however, seem to be a promising one in a number of respects, as already outlined.

The facility of repeatedly using the same data in the light of new ideas is, we believe, closely linked to recent developments in the theory of analogy. A powerful argument for using an analogical approach is that the assessment of the limits of what is knowable about the past is open to continuing revision, and so different kinds of interpretive inference can be assessed against continually changing background knowledge (Wylie 1989: 108). The distinctive character of Bayesian statistics together with recent thoughts on analogical reasoning combine not only to highlight the inappropriateness of classical statistics but also to undermine the "objectively scientific" foundations of the "new archaeology's" hypothetico-deductive philosophy. Unlike in the physical sciences, cultural "facts" vary in time and space and thus are neither immutable, stable, nor "given". Thus, Bayesian statistics would seem to be particularly well suited not only to addressing the problems confronting cultural astronomy per se but also to a more considered use of analogical reasoning.

Thus, cultural astronomy, with its cross-disciplinary origins and approach and its avowed aim of integrating a diversity of data, follows—at least in part—Hodder's (1985: 9) suggestions for the development of post-processual archaeology, where the challenge is to develop theories that specify integration and allow for both general principles of human activity and the particularity of cultural constructions. As Hodder (ibid.: 7) noted, the problem with processual archaeology was that it subverted the role of the individual to that of the system; it was part of a trend toward determinism and the quest for causal relationships and laws. Cultural astronomers, as anthropologists, cannot make general deterministic laws about human behavior; however, they can perhaps aid the search for general principles by which individuals construct their "natural worlds" within cultural-historical contexts.

1.8 Conclusion

Any culture must inhabit a meaningful universe, the content and boundaries of which it creates and sustains by classification. Within this phenomenological world of collective and individual experience, cultures attach meanings to objects and use symbols to express those meanings. They also perceive correspondences to exist among people, animals, and the terrestrial and celestial spheres, and use symbols to express those correspondences. Thus, cultural classifications lie at the heart of all meaningful social activity. Albeit mostly unconsciously, they guide patterns of attitude, thought, speech, and activity. In both secular and sacred situations, symbols are used to display the qualities that are considered to exist and to reinforce their meanings.

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From ancient Babylonia to China, Mexico, and Peru, from empire and city state to tribe, astronomical information was gathered, recorded, and used by those whose interests lay as much in the spheres of status enforcement and political ideology as in predicting rainy seasons or planning agricultural schedules. By making natural phenomena appear liable to social manipulation in the form of cosmological myth, cleverly aligned architecture, and appropriately timed religious ritual, the elite used the predictive value of astronomical knowledge as an impressive display and justification of their power and prestige (Saunders 1989: 58).

Cultural astronomy affords direct access to a vital part of the cultural resources of any remote culture and is in a unique position to use this information to seek meaning within particular cultural contexts and through cross-cultural comparisons. Astronomy can provide unequivocal knowledge of what was there to be seen; ethnohistory and the ethnographic record can provide an indication of types of perceptual explanation (and so widen our interpretive horizons); and the archaeological record can provide material evidence of symbolic associations through time.

Cultural astronomy provides a unique opportunity to explore the relationships between human societies and their wider environment. Cross-disciplinary perspectives, access to immutable data, the use of appropriate statistical methods, and the cautious use of analogical reasoning can together provide a unique insight into the diverse ways in which human societies have conceived of the heavens and how they have situated themselves in relation to them.

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