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SCHOOL OF ARCHAEOLOGY, HISTORY AND ANTHROPOLOGY

SOPHIA CENTRE FOR THE STUDY OF COSMOLOGY IN CULTURE

**MA in CULTURAL ASTRONOMY and ASTROLOGY
ARCHAEOASTRONOMY
AHAN7010**

Module Tutors: Nick Campion, Kim Malville

MODULE DESCRIPTOR

This Handbook should be read together with the MA CAA Handbook and the MA CAA Student Assessment Handbook. The Official Module Descriptor is downloadable from the MA CAA General Information Page. Students should also consult the writing guidelines on the MA CAA General Information Page.

ASSESSMENT

1. One 1000 word assignment (20% of total marks)

'Write a critical review of one of the following:

1. Aveni, Anthony (ed.), *Foundations of New World Cultural Astronomy*, Boulder: University Press of Colorado, 2008, chap. 10.
2. Aveni Aveni, Anthony (ed.), *Foundations of New World Cultural Astronomy*, Boulder: University Press of Colorado, 2008, chap. 32.
3. Hawkins, Gerald, *Stonehenge Decoded* Doubleday, 1965; Chapters 6, 7, 8, appendix A.
4. Ruggles, Clive, *Astronomy in Prehistoric Britain and Ireland*, New Haven and London: Yale University Press, 1999, 'Introduction'.

You should read the guidelines on writing critical reviews on the MA CAA General Information page. You should critically evaluate the writer's arguments and views and should refer to other literature in the field (five or more works, as a guide)

2. One 4000 word assignment (80% of total marks)

Example assignment: A research project within the subject area.

You may take one of the following approaches

1. You may take a literary or ethnographic approach analysing debates in the theory or history of the discipline, in respect of general issues or particular examples, or modern attitudes to or uses of, sites with archaeoastronomical significance.
2. Select two regions of the world where archaeoastronomy has been investigated, e.g. India, Egypt, Great Britain, Mesoamerica, Peru, and American Southwest. Compare and contrast cultural differences that led to different or similar expressions of archaeoastronomy; contrast also the different styles of research by archaeoastronomers.

3. You may conduct a simple fieldwork exercise, investigating the likelihood of celestial alignments at a prehistoric or sacred site. We can suggest places and projects, depending upon where in the world you live or would like to travel. Separate guidance will be posted. If you choose this approach, you will have to provide a literary justification and context.

Your research project and title MUST be approved by your course tutor, and we will provide suggestions for additional reading in your chosen area.

Your initial step will be to complete the Research Proposal Form

Archaeoastronomy is the study of beliefs and practices relating to the sky in the past, especially in prehistory, and the uses to which people's knowledge of the skies was put.

Clive Ruggles, <http://www.cliveruggles.net/>, accessed 8 December 2009.

The study of the astronomical practices, celestial lore, mythologies, religions and world-views of all ancient cultures we call archaeoastronomy. We like to describe archaeoastronomy, in essence, as the "anthropology of astronomy", to distinguish it from the "history of astronomy".

The Centre for Archaeoastronomy,
http://terpconnect.umd.edu/~tlaloc/archastro/cfaar_as.html, accessed 8 December 2009.

Archaeoastronomy is the study of the incorporation of celestial orientation, alignments or symbolism in human monuments and architecture.

'Archaeoastronomy', Sophia Centre,
<http://www.lamp.ac.uk/sophia/ma.html#archaeoastronomy>, accessed 28 December 2009.

Cultural astronomy: the use of astronomical knowledge, beliefs or theories to inspire, inform or influence social forms and ideologies, or any aspect of human behaviour. Cultural astronomy also includes the modern disciplines of ethnoastronomy and archaeoastronomy.

Campion, Nicholas, 'Editorial', in *Culture and Cosmos*, Spring/Summer 1997, Vol. 1, no 1, p. 2.

Astronomical dating can be a powerful tool for establishing absolute chronologies, but it is also a tool that must be used conservatively, for it can easily produce precise and impressive looking results based on invalid assumptions – results so precise and impressive they may not be questioned by scholars in other fields.

John Steele, 'The Use and Abuse of Astronomy in Establishing Ancient Chronologies', *Physics in Canada/La Physique au Canada*, 59 (2003): 243-8.

Required Reading

You will need to buy or borrow these books. They are all reasonably priced 2nd hand on Amazon or Abebooks.

Aveni, Anthony (ed), *Foundations of New World Cultural Astronomy*, Boulder: University Press of Colorado, 2008.

Malville, J.McKim, *Guide to Prehistoric Astronomy in the Southwest*, Boulder: Johnson Books, 2008.

Ruggles, Clive, *Astronomy in Prehistoric Britain and Ireland*, New Haven and London: Yale University Press, 1999.

Optional Reading

We have not specified optional reading for each week. However, at the end of this handbook you will find an extensive list, including JSTOR articles. You should select from the available literature works which reflect your particular interests.

In addition, these on-line resources will be important.

Archaeoastronomy & Ethnoastronomy News Archive

<http://terpconnect.umd.edu/~tlaloc/archastro/ae.html>

NB This is an excellent resource. Strongly recommended.

Archaeoastronomy: the Journal of Astronomy in Culture

<http://www.utexas.edu/utpress/journals/jarch.html>

The Centre for Archaeoastronomy

<http://terpconnect.umd.edu/~tlaloc/archastro/index.html>

WEEKLY READINGS

Week 1

Weekly Description and Reading

The Earliest Astronomy: what drives people to connect with the heavens?

The word 'cosmos' comes from the Greek *kosmos* meaning a "well-ordered whole." Our modern cosmos has strict boundaries at very small and very large scales. We cannot probe inward without limit, for we eventually reach an

impenetrable boundary associated with the Uncertainty Principle of quantum mechanics. The smallest piece of the microcosm is known as the Planck length, 10^{-32} centimetres. Smaller scales are *absolutely* unknowable due to quantum mechanical chaos in which an ordered sequence of elements of space (such as occurs along a ruler) cannot exist. The large-scale boundary of the universe lies at a far distance of 10^{27} cm, corresponding to 15 million light years. Beyond that edge of the expanding universe, all of space and time is unknown and forever unknowable because space and time beyond the edge would be receding from us at speeds greater than light.

Like the walls of the ancient city, these numbers set the boundaries to our cosmos of today. Within those walls, all space is woven into a single continuous fabric. No isolated islands of energy or matter can exist in our universe, and much of modern physics today is involved in demonstrating the interconnectedness of all of its parts. Newton's concept of Universal Gravity, which tied the falling apple to the orbiting moon, pointed the way to the unification of the cosmos and thereby established much of the holistic approach of today's physics.

Ancient people unified their world. Perhaps more so than modern people, the world was seen as interconnected. Stones, springs, sun, moon, stars, trees, animals were all part of a unified whole, of which humans were part. Myths were created that gave voice to this feeling of oneness. Some of the earliest attempts to connect with that universe were animism and shamanism. Our exploration of the astronomy of the ancient world should start with the human encounter with the world and heavens. Often these encounters were in the form of hierophanies, a sense that the other had entered this world through its sacred geography. The basic ingredients of archaeoastronomy are stones, springs, mountains, lighting flashes, shells, as well as the sun, moon, meteors, and stars. A terrestrial network of mountain, stones, and springs established a sacred landscape, where simply moving through it, brought one in touch with extraordinary powers.

Hierophanies

The historian of religion, Mircea Eliade has developed the concept of hierophany, which he suggests lies at the beginning of the human encounter with the skies and the sacred. A hierophany is the perceived entry of the divine into the normal world, a breaking through of the sacred into the mundane world. Hierophanies consist of natural phenomena that are unusual, spectacular, and memorable. They may be astronomical events, unusual geographic features, sunrises, stars, thunder in the mountains, avalanches, rainbows; in other words hierophanies are those experiences of the natural world and sky that can bring one up short and take one's breath away.

The best source is Eliade: *Patterns in Comparative Religion*: University of Nebraska Press, \$19.95 (\$17.13 Amazon)
Chapters

- 2: The Sky and Sky Gods 38-123
- 3. The Sun and Sun Worship 124-153
- 4. The Moon and Its Mystique 154-187
- 6. Sacred Stones: Epiphanies, Signs and Forms 216-238
- 11. Sacred Time and the Myth of Eternal Renewal. 388-409.

The sky is an inexhaustible source of hierophanies: the rhythm of the stars in their revolution about the north celestial pole; quickly moving clouds; immense thunderheads, thunderbolts, meteors, and rainbows, vivid sunrises and sunsets are hierophanies.

"Gazing into the clear blue sky by day or the multitude of stars by night, nowhere could one discern more completely the divine origin and sacred value of knowledge. For traditional man who invented these sky gods, knowledge and understanding were epiphanies of power and sacred force. He who sees and knows all, is all and can do all." Eliade

While sun worship was once thought to be common to all of human history, it has been prominent in Egypt, Asia, "primitive Europe" Peru, and Mexico; rarely in Africa, Australia, Melanesia, Polynesia and Micronesia. It is present, Eliade argues, among "historic destinies", i.e. where history was on the march thanks to the exercise of power by kings, heroes, and empires. The Inca was the son of the sun and appeared in ceremonies emerging from the sun, wearing a brilliant golden medallion. The Aztecs fed the sun daily with human blood to keep it alive, but also recognized that in spite of their attention to its welfare, the sun and the universe could come to a violent end some time in the future. Water is offered to the sun daily by devotees standing on the banks of the Ganga River at Varanasi, not so much to feed it, but to cool its rays to prevent inadvertent incineration of the earth.

In many ways the moon was a more interesting object than the sun. Although it dominates the sky, it presents an unchanging face. The moon is always changing over its 29.5 day cycle, presenting an eye-catching metaphor for the birth, death, and rebirth of plant and animal life. The moon was immensely important for hunter-gatherer cultures for which the full moon was a vital time for hunting. Lives and sex were perhaps organized around the phases of the moon as suggested by Knight (1987). The moon was equally important for maritime cultures that would fish and collect shell fish in tide pools during low tide. Recognition of the relation between tides and the moon would have been an absolute necessity in order to avoid being caught far from shore as the tide rose. The moon was in many ways a more threatening master than the sun. It would seem that the power of the moon would have been more deeply felt by women who collected shell fish than by men who used the light of the moon to hunt. One was a matter of life and death, the other was a matter of convenience and success of the hunt.

Besides the sun, moon, and stars the sky contains spaciousness and immense height. Mountains are the nearest things to the sky and share the

symbolism of spatial transcendence. They are the domains of hierophanies of the atmosphere such as rain, snow, flowing water, lightning, and thunder. Every mythology has sacred mountains and sky gods have high on mountains for their worship: mountains are where sky and earth meet, an axis mundi pass through them. The mountain is at the center of the world; many temples, palaces, holy towns are symbolic mountains. To circumambulate these holy places is to circumambulate the axis of the universe, and therefore the universe itself. The ziggurat is a cosmic mountain with seven levels representing the visible planets; Borobudur is a cosmic mountain; Mt. Kailash is the most cosmic mountain of them all. Three dimensional sacred space was created by walking amongst sacred mountains.

Required Reading

Campion, Nicholas, *The Dawn of Astrology: A Cultural History of Western Astrology*, Vol. 1, The Ancient and Classical Worlds, London: Continuum, 2008, Republished as *A History of Western Astrology*, Vol. 1, The Ancient World, London: Continuum, 2009, chap 2.

Ruggles, Clive, *Astronomy in Prehistoric Britain and Ireland*, New Haven and London: Yale University Press, 1999, Introduction.

Ruggles, Clive and Michael Hoskin, 'Astronomy before History' in *The Cambridge Concise History of Astronomy*, edited by Michael Hoskin, Cambridge: Cambridge University Press, 1999, pp. 1-17.

<http://assets.cambridge.org/052157/2916/sample/0521572916web.pdf>

Eliade, Mircea. *The Sacred and the Profane* (New York: Harcourt Brace 1959), pp. 20-65.

PDF

Optional Reading

Eliade: *Patterns in Comparative Religion*: Chapters 2,3,4,6,11

Week 2

Weekly Description and Reading

Astronomy of Ancient Britain

The modern era of archaeoastronomy began under the cloud of controversy about Stonehenge, a fierce feud between the archaeologists' interpretation of Stonehenge and that of Gerald Hawkins' contained in the book *Stonehenge Decoded*. His proposal that Stonehenge functioned as an astronomical observatory containing some 24 alignments to the solstices and major and minor lunar standstills seemed wildly inconsistent with the archaeological record. The leading authority on Stonehenge, Richard Atkinson wrote an article "Moonshine

on Stonehenge”, initiating a feud between archaeologists and astronomers in Great Britain, which poisoned the relationship for decades. Except for the alignment to June solstice sunrise and December solstice sunset, none of Hawkins’ proposed solar and lunar alignments has firmly stood the test of time.

In his 1963 book *Stonehenge Decoded*, Gerald Hawkins claimed to have discovered a large number of alignments, both lunar and solar, and argued that Stonehenge could have been used to predict eclipses. Hawkins’ book received wide publicity. Readers were especially intrigued that he used an IBM 7090 computer to make the calculations, which was a novelty at that time. Archaeologists were especially annoyed by the title of his book: “decoded” implied that the meaning and purpose of Stonehenge was settled one and for all time.

Many people were fascinated by the idea of lost knowledge and a waxing and waning of cosmic power, which could be seen metaphorically in cycles of the sun and moon. Stonehenge became identified as an observatory displaying a level of prehistoric science, which was so advanced that we are now only beginning to understand it. The builders seemed to have a preoccupation with astronomy and mathematics. In Great Britain there was a particular fascination among the public with an alternate archaeology not practiced by professional archaeologists. Every culture and every time seems to have its archaeological and astronomical mysteries that lie beyond normal science. There was a desire for direct interaction with a mysterious past.

Hawkins’ first paper on Stonehenge was published in *Nature* (Hawkins, Gerald, *Stonehenge Decoded*, New York: Dorset Press, 1965). It is an extraordinarily useful example of how *not* to carry out research in archaeoastronomy. It seems that he was guilty of nearly everyone of the Seven Deadly Sins of Archaeoastronomy, which I suggest below. Hawkins had not mapped the site himself, but used maps provided to him by Richard Atkinson and by the Ministry of Public Works. He made no measurements himself and initially assumed that the horizon was flat. The high latitude of Stonehenge and elevation of the horizon is critical as objects can move significantly in azimuth as they rise. Two years later when Hawkins published his book, he had obtained a chart from someone whom he does not identify, giving the actual horizon. A serious researcher would have visited Stonehenge in the meantime with a theodolite to measure the horizon himself. Another absolutely vital piece of information for such a study is the orientation of the structure with respect to true north. Neither had Hawkins taken the effort to make that determination himself. For the direction to true north, he used measurements of Norman Lockyer made more some 50 years earlier.

Hawkins describes the process with great relish in his book, how programmers took the map containing 165 points and measured the positions with an automatic plotting machine. They gave the punched cards to a computer

operator who processed the data and provided him with 240 possible solar and lunar alignments. The result was 24 alignments that were close to rising and setting positions of the sun and moon at solstices and lunar standstills. There were 10 solar hits, of which one was the heel stone and the Stonehenge avenue, which had been recognized for some time as aligned with June solstice sunrise and December solstice sunset. There were 10 hits to the major lunar standstill and 4 to the minor lunar standstill. Hawkins justified his approach on the basis that "If I can see any alignment...then these facts were also known to the builders."

The archaeologist Richard Atkinson replied with his article *Moonshine on Stonehenge* in the journal *Antiquity* in 1966. Atkinson was a leading authority on Stonehenge, which he had excavated in the 1950s. He described Hawkins' book as "tendentious, arrogant, slipshod and unconvincing," pointing out that some of the pits Hawkins had used for his sight lines were more likely to have been natural depressions. He pointed out that because Hawkins had allowed himself a generous margin of error of up to 2 degrees in his alignments, the probability of so many alignments being visible from 165 points to be close to 0.5 rather than the 'one in a million' possibility that Hawkins had claimed. An estimate of probability of coincidence is revealed by considering how much of the sky is covered by 240 possible alignments with an error of 2° . If there are 240 possible target around the horizon and each has a width of 2 degrees, these targets have a total width of 480 degrees, covers the entire circle of the horizon. Thus it seems that Hawkins was virtually guaranteed to find an astronomical a sunrise, sunset, moonrise or moonset that coincided with his targets. Atkinson also noted that the Station Stones stood on top of the earlier Aubrey Holes meant that many of Hawkins' alignments between the two features were illusory.

A constantly nagging concern has been whether the English climate would have permitted the kinds of repeated observation of astronomical events that is needed to establish the standstill cycle of the moon. The minor standstill of the moon is especially subtle and it is truly surprising, in fact one could say it is unreasonable to believe that the builders of Stonehenge could have located the 5 orientations to minor standstill that Hawkins identified. Gerald Hawkins looked for alignments with phenomena he already knew existed. The builders did not have this advantage. Solstices of the sun are very easy to observe. Major standstills of the moon are noticeable when moon rise or moon set occurs on an irregular horizon. But the moon passes through its minor standstill position twice a month and claims for minor standstill need to be backed up by an analysis going beyond simply looking for a particular azimuth. Few people, if any, have ever knowingly viewed a rising or setting moon at its minor standstill.

The main lesson to be learned from Gerald Hawkins and also from Alexander Thom, is that a major aim of the research design should be to scrutinize the idea as thoroughly and as piteously as possible in the archaeological record in the field. If we hope to provide meaningful tests of our ideas we must strive to collect

and examine all evidence facing what is contradictory as well as that which is confirmatory, coping with the negative as well as the positive (Ruggles 35)

Ruggles 162: Different interpretations are always possible, even given the same empirical data. Personal convictions should never go beyond statements such as 'it seems possible that the evidence seems to indicate'. One important approach is to attempt to estimate the probability that the observed astronomical alignments could have arisen fortuitously, through a combination of factors unrelated to astronomy.

Hawkins, Gerald	
1963	Stonehenge Decoded, Nature 200:127-130
1964	Stonehenge: A Neolithic Computer, Nature 202: 1258- 1261.
1965	Callanish, A Scottish Stonehenge, Science 124:127-130

Seven (Deadly) Sins of Archaeoastronomy

1. **Ethnocentrism:** (a) Considers that every building with astronomical features was an observatory; assumes ancient sky watchers had goals and attitudes similar to those of modern astronomers. Considers ancient sky watchers to be proto-astronomers and proto-engineers. The word "observatory" should be used with great caution. There were very few true "observatories" in the ancient world: one would be the observatory in Jaipur, India, the Jantar Mantar. North (1996:xxxvi): "*It will not of course be suggested that the monument on Salisbury Plain was an astronomical observatory, at least in the current meaning of that word. The stones were not erected as a means to investigate the heavens in a detached and abstract way. Their aim was not to discover the patterns of behavior of the sun, Moon, or stars, but to embody those patterns, already known in broad outline, in a religious architecture.*"
(b) Another hazard of ethnocentrism is to assume that because certain beliefs, goals, and patterns of behavior seem crazy and unreasonable to us now, they did not occur in other cultures or in the past. Lekson (2006:43) who inspired me with his list of the Seven Sins of Archaeology, elegantly identifies this as "*Sin #4: The Sins of Ockham: Misapplication of the Razor to the question of interest, rather than the*

logic of its answer. To err cautiously in archaeology is to err egregiously". An example is the rejection of lunar standstills before testing the possibility in specific contexts.

(c) Cartesian dualism: the modern world draws a firm ontological distinction between animate and inanimate, between life and death; these may not apply in other cultures.

2. **Thin description.** (Clifford Geertz, *The Interpretation of Cultures* (1973) A thick description of an anthropological phenomenon or feature of the archaeological record is one that both describes and explains the implicated behavior, but also explains its cultural context. A wink is an example. When someone winks at us without a cultural context, we have no what it really means. It might mean the person is attracted to us, that they are trying to communicate secretly, that they understand what you mean, or really don't mean what they are saying. Simply reporting a solstice sunrise, for example, is similar to reporting a wink. A thin description comes from treating an archaeoastronomical puzzle simply has an astronomical problem, not considering the cultural context. Failure to attempt to consider the full picture: ethnography, anthropology, and the archaeological record. Too much from the outside ("etic") with little attempt to understand the culture from the inside ("emic").
3. **Two-dimensional thinking:** Ignores the full three-dimensional nature of an archaeoastronomical investigation; does not consider elevation of the horizon; draws lines across landscape based on reported azimuths of solar or lunar extremes regardless of what people could actually have seen.
4. **Emphasize the rich and powerful:** Long a problem in archaeoastronomy as well as in archaeology itself. Fascination with Egyptian pyramids and temples, Mayan astronomer-priests, royalty, cities, and temples, Chacoan great houses. The story of the real people is usually more interesting.
5. **Excessive post-positivism:** Fail to frame testable hypotheses and to test them robustly.
6. **Sloth:** Disregard statistics: Fail to test whether astronomical orientations are fortuitous. Sloth also enters when insufficient attention is paid to determining true north: in many cases measurement with a magnetic compass does not provide sufficient precision unless it is backed up with a photograph of the actual solar or lunar event.
7. **Hubris:** Excessive self-confidence: fails to use terms like "perhaps", "may be", and "seems possible." Does not seek alternate interpretations. Voltaire: "*Le doute n'est pas une condition agréable, mais la certitude est absurde*". Doubt is not a pleasant condition, but certainty is absurd"

Required Reading

Ruggles, Clive, *Astronomy in Prehistoric Britain and Ireland*, New Haven and London: Yale University Press, 1999, Parts, 1,2,3

Sims: The Solarization of the Moon: Manipulated Knowledge at Stonehenge
http://www.radicalanthropologygroup.org/old/pub_sims_solar_moon.pdf

Week 3

Weekly Description and Reading

Cosmic and Sacred Landscapes; Cosmic and Sacred Cities.

Nabta Playa was on the shore of a seasonal lake, which was annually visited by nomadic cattle herders, who built a regional center sometime after 5300BC. Their interest and knowledge of the skies must have come from their need to navigate by the stars across the Sahara. They marked the rising positions of the brightest stars in their sky (Arcturus, Sirius, alpha Centauri) by dragging megaliths into the lake and setting them along alignments oriented with the stars. In the case of Arcturus they even observed the precession of it over periods of several hundred years. That they were nomadic rather than sedentary agriculturalists is a surprise in terms of their astronomy. The evolution of their culture was probably driven by the climatic changes occurring in North Africa between 8000 BC and 3500 BC; between 8000BC and 5300BC the Sahara was a well-watered savanna and life was relatively good: water was plentiful. A short but intense period of drought occurred around 5300BC, and a new style of occupation appeared on the shore of Nabta Playa. When the rains became patchy the Nomads had to rely on more sophisticated stellar navigation techniques find the few water holes remaining, one of which was this basin of Nabta Playa. Trying to find a small lake in the vastness of the desert was similar to the challenge of finding a small island in the Pacific. Perhaps associated with their sharpened survival skills, the regional center on Nabta Playa acquired a complexity that had not been seen before. The calendar circle would built, megaliths were aligned with the brightest stars, complex structures were built overlying table rocks several meters deep in the sand; burials of cows and people were oriented to the cardinal directions. Who know how this burst of creative energy may have led. The cultural developing around the nomads and their regional center was finally finished off when the summer monsoon rains ceased entering Egypt in 3500BC and the area became hyperarid. Perhaps driven by a changing climate, the part time residents established a culture containing the earliest examples of megalithic astronomy. When the area became hyper-arid around 3500BC Nabta Playa was abandoned; some may have moved to the Nile valley and played a role in developing the high cultures of Dynastic Egypt.

Other cosmic or spiritual centers started on the banks of a river, where travelers would have paused before crossing, such as Harappa on the Indus and Varanasi on the Ganga. These are examples of places on ancient trade routes where travelers stopped to spend the night before crossing the river. traders gathered, gradually becoming a place of meaning and power.

The first cosmic cities may have appeared in the Indus valley some 4,500 years ago, inspired perhaps by the human urge to live in a cosmos, governed by geometry rather than chaos. The orientation of the Harappan sites to the cardinal directions suggests not only the skill of the astronomer but also the apparent intent of an ancient urban planner to interweave, by means of geometry, the microcosm and the macrocosm. The Harappan cities appeared suddenly: the concept of planned urban space, in all of its complexity, may have evolved in 100 years or less (Parpola 1994; Possehl 1990). In an amazing burst of creative activity, a technique for determining true north was developed; a methodology for surveying geometrical grids was established; construction brick sizes were standardized; writing suddenly appeared; and a system of weights and measures was invented (Possehl 1990). Astonishing amounts of human energy and labor went into the planned construction of these cities. Mohenjo-Daro and Harappa covered approximately 1 km² each, and by means of their cosmic geometries, some 40,000 inhabitants in each city were brought into parallelism with the cosmos. The citadel of Mohenjo-Daro, which covered 400 x 200m and stood some 7m high, may have represented the cosmic mountain, in a manner similar to that of the ziggurat. In its Great Bath, rituals may have symbolized the emergence of life from the cosmic ocean (Parpola 1994).

The skies covering those ancient cities must have had astonishing powers of persuasion. The rising sun proclaimed the rebirth of days and years, and the moon measured the year. The absence of street lights and pollution produced a sky that was black between the bright stars. Perhaps all heaven and earth were seen as portions of a seamless whole, and at night the horizon may have vanished, eliminating any boundary between the celestial and terrestrial realm.

Fixed above the northern mountains was a star that did not move. Today we can that star Thuban, alpha Draconis, which reached 0.60 from the celestial pole in 2780 BCE. Following that time, precession of the earth's axis of rotation slowly moved Thuban away from the stillness of the centre and for three millennia no other bright star approached the celestial pole. The star we now know as Polaris has moved near the pole only within the last few centuries. Polaris will never reach as close to the celestial pole as did Thuban some 5,000 years ago.

Away from the pole, stars move across the dome of the sky in ever widening arcs. Some moved faster and more erratically than others; these were the seven "planets" as seen from the earth, Sun, Moon, Mercury, Venus, Mars, Jupiter, and Saturn. The "river" that the planets followed in the skies is the ecliptic, known as the Ganga of the skies, the *Akasha Ganga*. The Harappans (ca. 2500 BCE) would not have used that term, of course, but may have imagined their own river to be a reflection of that river of the skies. Mercury, perhaps represented as a little green fish in Harappan script, swam quickly along that river, and dim Saturn, dangerous and black, moved slowly along the ecliptic like a turtle (Parpola 1994). Today the ecliptic path, followed by the sun, planets, and the time-keeping moon,

is marked by the 28 *nakshatras* (lunar constellations). Parpola (1994) suggests that this manner of dividing the path of the moon started with the Harappans.

Not only did the Pleiades rise nearly due east at the time of the Harappan culture, but it also rose heliacally, just ahead of the sun, on the morning of spring equinox beginning in year 2240 BCE. This “double rising” of the sun, above the horizon and out of the south, may have marked the beginning of the Harappan year. In stories and myths that may possibly have been inspired by Harappan culture, there are many layers of symbolism that attest to this conjunction between the equinoctial dawn and the heliacal rising of the Pleiades (Parpola 1994). Most prominent is that the Pleiades is named after the Krittikas, the wet nurses of six-headed Skanda, who sympathizes the six-seasoned year. Before this date of 2240 BCE, the new year was brought in by the bright, rose-coloured star known both as Aldebaran and Rohini, which first rose heliacally on the spring equinox of 3050 BCE during the early Harappan period. Dholavira, is one of the largest fortified Harappan cities that had the history of strong astronomical perception, presumption and prediction (cf. Bist 2000). Building on Eliade’s (1959) ideas about sacred space and Wheatley’s (1971) studies of the origins of Asian cities, Jeffrey Meyer (1991) has provided an insightful and influential analysis of the characteristics of a “cosmocized sacred city,” of which Beijing was the last of a long line in China. The Shang period (approximately 1700-1100 BCE) may have generated the paradigm of the planned Chinese capital. Archaeological material from that period reveals cities at Zhengzhou and Anyang that were squares or rectangles containing individual structures all of which were cardinally aligned. In his summary of studies of Shang capital cities, Meyer (1991) notes the traditional belief that the prosperity and fate of a kingdom depended upon the quality of the geometry of the capital. Meyer (1991: 8) notes that a Shang dynasty ruler who wished to move his capital to a new location, argued that it had been moved five times and successfully took root each time: “As from the stump of a felled tree there are sprouts and shoots, Heaven will perpetuate its decree in our favour in this new city.” It did not matter exactly where the city was placed as long as it conformed to the proper geometrical rules.

This theme of the pre-planned cosmic capital was clearly evident and extensively articulated in the Zhou dynasty (1100-221 BCE). Texts from the period, in particular the *Zhouli* (Rituals of Zhou), indicated the use of a gnomon, observations of the pole star, and the design of the ideal capital according to rules of cosmic order. There should be nine north-south and nine east-west streets within the city walls which were pierced by three gates on each side. The king’s palace was in the centre, lying on a north-south axis which was a major axis of symmetry for the city. The archaeological record from this period confirms the cardinality and axuality of cities, which were mostly squares or rectangles. While this ideal geometry may have never been achieved with perfection during the Zhou period, it apparently had major influence on later Chinese capitals, both inside and beyond the mainland.

The parallelism, synchronism, and resonances between heaven and the capital were essential, and Wheatley (1971: 414) speaks eloquently of the “intimate parallelism between the regular and mathematically expressible regimes of the heavens and the biologically determined rhythms of life on earth as manifested in the succession of the seasons, the annual cycles of plant regeneration, and, within the compass of an individual life, birth, growth, procreation, and death.”

The Chinese capital was understood to be the centre of the cosmos, lying on the *axis mundi*. At its centre, marked by temple or throne, there was a meeting of heaven and earth (Eliade 1958, 1967). There can be little doubt about the social consequences of such a geometry and the hierarchical nature of such a society. Location of real estate was even more important than it is in the modern city. Access to cosmic power and political influence diminished monotonically with distance from the city’s centre.

The meaning of order, power, and the North Pole in the Chinese capital city may be so specific to the context of imperial China that extrapolation of the model of the Chinese “cosmic” city to other cultures may have limited usefulness. However, there appear several similarities in different context of cultural connotations, especially the orientation to the north and alignment to the Sun, all well exemplified in these seven essays.

Meyer also developed the characteristics of the opposite type of a city, the unplanned city of local sacrality. Such a place is a highly individualistic urban phenomenon, associated with singular events, unique people, and special places. Its specific location in the landscape is of primary importance, having been located at a special place because of spectacular landscape, a history of pilgrimage, local myths, and traditions. These are places where “non-transferable” and “non-repeatable” events of human history occurred. Their quality is one of “utter specificity” and uniqueness (Meyer 1991: 160), and often they are marked by unusual and dramatic geological features, powerful local traditions, and what Preston (1992) calls “spiritual magnetism.” In India, these are *tirthas*, the ancient and modern “crossing-over places” of body and spirit, often historically important fords of rivers, e.g. the sacred cities described in these essays. These places, often pilgrimage centres, have an egalitarian openness, as opposed to the more hierarchical and stratified structure of the cosmic cities. Meyer (1991: 157) argues that because these cities of local sacrality lacked planning by an imperial authority, “there is no recognizable geometry of form, no evidence of overall planning, no relationship to a sacred king, no orientation, or axial way.”

The cities of Varanasi and Vijayanagara contain geometries that indicate both cosmic and local influences, and both have been destination points for pilgrimage. In Varanasi, which has been in existence for perhaps three millennia, imperial power had no major influence on its design, although there are definite

examples of planning in certain of the pilgrimage circuits. Varanasi (Kashi) is rich with cosmic symbolism and is understood to be a copy of the universe, where Brahma, the lord of creation, was himself born. The eight directions of space and the lords of the seven planets were also reportedly born in the city of Varanasi, exemplified with 56 forms (8 x 7) of Vinayakas/ Ganesha. When pilgrims circumambulate the city on the Panchakroshi circuit, they are symbolically encircling the entire cosmos.

Vijayanagara was established in the early fourteenth century, as the capital city of the largest Hindu empire of medieval India, and the city lasted approximately 250 years until its destruction in CE 1565. Before it was chosen as a symbol of empire by the Vijayanagara kings, the area was a well-known pilgrimage site. The resulting city combined one of the most dramatic landscapes of the subcontinent, major mytho-historic traditions of the *Ramayana*, and an extraordinary display of imperial power.

Required Reading

Aveni, Anthony (ed), *Foundations of New World Cultural Astronomy*, Boulder: University Press of Colorado, 2008, Part 1

Malville, J. McKim and R. N. Swaminathan, 'People, Planets and the Sun: Surya Puja in Tamil Nadu, South India', *Culture and Cosmos*, Vol. 2, no 1, Spring/Summer 1998, pp. 3-15.
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Malville, J. McKim, 'Cosmologies of India', in H. Selin, ed., *Encyclopedia of History of Non-Western Sciences*, Springer, Berlin 2008.
WORD FILE.

Week 4

Weekly Description and Reading Archaeoastronomy of the Incas

The earliest Incas settled in the Cusco valley around AD 1200. Their existence appears to have been unremarkable and relatively stable until the early 15th Century, a time at which many significant events in Inca history began to occur. Inca mythology identifies Manco Capac to be their founding leader and that there was an unbroken dynastic succession that led to its 8th Emperor, Viracocha Inca, and his son who ultimately would be known as Pachacuti.

The Incas wanted people to believe they were the chosen people of the sun and that they were responsible for bringing order to the land. A major change in their fortune occurred in 1438 when their powerful neighbor, the Chancas, attacked. Legend has it that Viracocha Inca, sensing defeat, fled Cusco with his designated heir leaving its defense to a younger son, Inca Yupanqui. In an epic battle he routed the Chancas and following his victory seized authority from his father and

brother and banished them from Cusco. He adopted the name Pachacuti Yupanqui Inca and charged by his Chancan victory embarked on a campaign first to conquer the Chanca's allies, and then to expand Incan rule over all known tribes throughout the Andes.

The ensuing years were filled with both conquest and nation building. Pachacuti initiated a building program that created a many if not most of the palaces, temples and Inca roads that we find today. Tribes, such as the Chimú, when defeated were often dispersed throughout the Empire as workers called *mitmaes* and their culture effectively ceased to exist. The Incas assimilated much from many tribes as they conquered them, however, and further refined their civilization.

The empire of Tiwanaco built in the vicinity of Lake Titicaca was apparently a major inspiration for Inca architecture. There is a chronological gap between these two cultures, but distinct similarities exist between their architectural styles, symbolic motifs, and the role of flowing water in animating matter. The Incas built upon the many Andean cultural traditions that had preceded them and, in a sense represented the culmination of millennia of Andean culture, making their destruction by the Spanish invaders all the more tragic. Their empire would ultimately span 3000 miles of the Andes and coastal regions from Chile to Columbia. They avoided the rain forests of the Amazon (Zuidema, 1964). Pachacuti, his son, and grandson successively built the largest empire ever known in the Americas. They established armies in fortresses at distant stations with the infrastructure of roads and storehouses that was necessary to support them. Temples and shrines were constructed as part of their remarkably astute program of exerting state control over subjects. State-supported pilgrimage centers were established to reinforce the legitimacy of royal rule over the populace (Bauer & Stanish, 2001).

By the time Francisco Pizarro and the other Spanish adventurer and thugs arrived in Peru in 1532 the Incas had not only built an impressive empire, but also a remarkably complex society. Their civilization had advanced to its sophisticated level without European influence or even knowledge that nations such as Spain existed. As far as "the son of the sun" was concerned, he ruled the world as he knew it.

It is generally considered that because the Incas had no written language, we must rely upon the writings of Spanish chroniclers for much of what we know about fundamental cultural issues such as meaning and purpose and the structure of their society. However because the Spanish systematically burned their quipus and eliminated the quipu-readers, we shall probably never know how close the Inca came to achieving true literacy, using their novel technique of recording information

Modern studies of Inca astronomy really began with the work of the cultural historian Tom Zuidema. Relying upon the works of such as Cobo and Molina, Zuidema made a systematic study of the ceques and huacas of the valley of Cusco and developed an elaborate model for their calendars and social organization: *The Ceque System of Cusco: The Social Organization of the Capital of the Inca* (Zuidema 1964). His proposed calendar utilized the 328 huacas described by Cobo as days based on the sidereal period of the moon. The 37 day difference between 12 sidereal months and the solar year were identified by the approximate 37 days during which the asterism of the Pleiades was not visible. Based on his reading of the Spanish text, Zuidema argued that certain ceques functioned as astronomical sight-line, a conclusion hotly disputed by Bauer and Dearborn. They find that many ceques follow an irregular course with huacas at locations not in keeping with Zuidema's straight-line model. Bauer claims also to have identified over 400 huacas, compared to Zuidema's 328.

Our understanding of Inca astronomy and cosmology was enriched by the ethnoastronomy research of Gary Urton. His 1981 book *At the Crossroads of Earth and Sky: An Andean Cosmology* describes his 1976-1977 fieldwork while living in the Peruvian village of Misminay. Many of the Inca's astronomical traditions survive among *quechua* speaking villagers.

David Dearborn has been a major contributor to research of Andean astronomy and much of his work regards alignments at Machu Picchu. In 1983 he and Ray White described the Torreón as an observatory of the June solstice sunrise (Dearborn and White, 1983). With Katharina Schreiber, Dearborn proposed that the Intimachay was designed to admit sunrise sunlight at the December solstice (Dearborn, 1987). Working with Brian Bauer and Charles Dearborn verified that two pillars on Isla del Sol mark June solstice sunrise.

Hiram Bingham briefly located a section of Llactapata in 1912, but following his departure the site once again was lost to the cloud forest. In May 2003 Kim Malville, Hugh Thomson, and Gary Ziegler located Llactapata once again, this time in its entirety. The expedition found a prominent structure to be oriented to sunrise at the June solstice, with a design very reminiscent of the Coricancha sun temple in Cusco. Both buildings were constructed with double-jamb doorways opening to the horizon positions of the heliacal rising Pleiades and the summer solstice sun.

Required Reading

Aveni: Chapters 4 ,5, 6, 26

Campion, Nicholas, *Astrology and Cosmology in the World Religions*, New York: New York University Press, forthcoming 2011, ch. 6, PDF
ONLINE LIBRARY

Week 5
Weekly Description and Reading
Archaeoastronomy of North America

Malville: *Prehistoric Astronomy in the Southwest*: 1-150

The Ancestral Puebloans who lived in the monumental structures of Chaco Canyon, the dramatic cliff dwelling of Mesa Verde, and the enigmatic towers of Hovenweep appear to have developed a rich tradition of visual astronomy. What makes their astronomy so fascinating and so compelling is it that it appears to have been almost entirely homegrown, the independent discoveries of smart and alert people who paid attention to the heavens. Unlike the astronomy of Europe, Puebloan astronomy developed in an isolated culture in a relatively short period and was not associated with a writing system. Western astronomy, by contrast, borrowed heavily from other cultures and matured over millennia.

Not only did we adopt Greek, Roman, and Arabic star names and constellations, but also we relied heavily on earlier discoveries by astronomers in Greece, Rome, Egypt, and India. For example, the ancient Greeks used the difference between the shapes of the moon and of the earth's shadow during eclipse to estimate the relative sizes of the earth and moon. In the 80 year period of the Classic Bonito phase, AD 1020-1100, there were 26 total lunar eclipses that were visible in Chaco Canyon. What were Chacoans seeing in these eclipses? Could they have seen the shadow of the earth imposed on the moon and guessed what was happening?



A lunar eclipse reveals the shadow of the earth as well as the relative sizes of the earth and moon. The sun is behind the viewer and is casting its

shadow outward into space. The full moon is always opposite the sun in the sky.

On the other side of the earth, some 1350 years earlier, about 350 BC Aristotle, believing that a lunar eclipse occurred because the moon had entered the earth's shadow, concluded the earth could not be flat because of the curved shadow it cast on the moon. Then, nearly a hundred years later, Aristarchus of Samos noticed that shadow of the earth is less rounded than moon itself. He concluded that if the sun is very far away, the earth must be about 3 times larger than the moon (the actual value is 3.7). Thus had mankind advanced in understanding the cosmos: big earth, small moon, distant and very big sun. It was not bad for 23 millennia ago, but then Aristarchus had texts to read and collaborators throughout the Mediterranean to consult. A few years later Eratosthenes, a younger contemporary of Aristarchus, measured the diameter of the earth by comparing the shadows of sunlight in wells at Alexandria and Syene in Egypt.

The shape and sizes of the earth and moon were established by 200 BC, but not everyone in the west was convinced and it took another 14 centuries for the nature of the solar system to be grasped. The Copernican Revolution due to the combined efforts of an Italian physicist, Polish monk, Danish astronomer, German astrologer, and British physicist.

Aristotle, Eratosthenes, Aristarchus: we know the names of the ancient Greek astronomers, but what of the ancient Puebloan astronomers of Chaco, Chimney Rock, and Mesa Verde?. We shall never know their names but we know them by their works. What we can do is attempt to retrace the time line of their discoveries and the challenges they faced.

Perhaps, just perhaps, we can trace in broad strokes their thinking. The skies offered wonderful opportunities for the curious and persistent sky watchers to learn about the intricate cycles of the sun and moon. The Puebloans were the first people in the western hemisphere to discover the 18.6 year standstill cycle of the moon. Every 18.6 years it rises between the rock towers of Chimney Rock, where Chacoan built a great house to view the spectacle. The Puebloans also invented a horizon calendar, which would have been necessary to schedule annual festivals. Some of the huge and dramatic buildings in Chaco Canyon were aligned to true north with remarkable precision, which means they had invented a technique to determining true north within a tenth of a degree.

Migration, trade, periodic festivals, pilgrimage, even danger and violence contributed to the development and meaning of Puebloan astronomy. Ceremonials and festivals invariable contain elements of astronomy in traditional cultures. The sun is honored at dawn; festivals are established a ritual calendar based on the sun and moon. Astronomy is much more a constant and important feature of everyday life than it is for us today. For the ancient Puebloan people the sky was a region of mystery and power, sunlight and rain, danger and

sustenance. Its stars kept traders from wandering in circles and pilgrimage festivals running on time.

Before construction of great house and great kivas in Chaco Canyon, astronomy played a major role of people lives; they oriented their houses and ritual spaces approximately along a north-south line. Just at the dawn of village life in the southwest, hunter gathers began to establish semi-permanent settlements. These people are known to archaeologists as Basketmaker III. In Chaco Canyon they built two sites at either end of the Canyon. North of the San Juan beginning around 700 AD relatively isolated and short lived villages established their own supra-local patterns, orienting the axes of their above ground habitation and below ground ritual approximately along the local north-south meridian, tilted slightly toward the east of south.

Starting very early in the development of Puebloan society, there appears a remarkably consistent bimodality in the orientations of pit structures, kivas, unit-type pueblos and Chacoan structures has been present since the first semi-permanent dwellings of Basketmaker III. We suggest these two orientations reveal early nomadic traditions, origin myths, and two different cultural identities. Early pit structures possessed clearly displayed bi-lateral symmetries with axes that were oriented either north-south or tilted by approximately 25° east of south. A perpendicular drawn to an axis that has a tilt 25° away from north-south approximately is in the direction of June solstice and lothe major axis of these structures. Since these were underground structures, it is unreasonable to assume that perpendiculars to these axes were meaningful or intended. These two axial orientations are present in Prudden unit-type pueblos and Chacoan great houses and that they were basically front-facing structures. Line drawn along back walls of great houses, are not consistent with prior architectural traditions.

The surge in astronomy in the southwest occurred during the time of building of the great houses in Chaco Canyon, the so-called Bonito Phase. This was a time of peace, Pax Chaco, when pilgrims and traders could walk into the canyon across friendly lands. It is not clearly how peace was achieved. Was it due to a forceful and brutal creation of a political hegemony, enforced by a treat of violence and cannibalism? Were the Chacaon roads routes along which a rapid response police force would travel if any one of the outlying communities faltered in their expression of loyalty to elites occupying the center in Chaco Canyon. Or was Pax Chaco started with an increasing tradition of pilgrimage, trade, and period festivals in the canyon, and then sometime after 1080 when the leaders living in the canyon began to perceive themselves as being the center of the cosmos. Chaco developed a set of spatial metaphors similar to those of cosmic cities elsewhere in the world, namely integrating the north-south meridian into their lives and architecture. Peace may have come with a price, and Chaco acquired a bad reputation. The system may have been too complex, too greedy, too oppressive, and the Chaco regional system collapsed about 1140. Some power was transferred to the Totah region, Aztec, but the new society did not

have the cosmic dimension of the earlier Chacoan system. Violence grew apparently as the control diminished.

Toward the end of the thirteenth century, terrible things began to happen in the Four Corners. Life became difficult due to uncertain rainfall, and there was an agonizing and poignant downward slide into warfare and violence. Towers were built at for protection of families and sources of water. They gathered into walled villages such as Sand Canyon, Castle Rock, and Goodman Point. Even through massacre, torture, and cannibalism threatened, astronomy remained important. They oriented their buildings and great kivas to the solstice sun and to the North Pole. People seemed to turn to the ancient sky gods for protection during dangerous times. Eventually life got to be so difficult they abandoned the Four Corners area at the end of the Thirteenth Century in one of the great exoduses of human experience.

Required Reading

Malville, J.McKim, *Guide to Prehistoric Astronomy in the Southwest*, Boulder: Johnson Books, 2008.

Aveni, Anthony (ed), *Foundations of New World Cultural Astronomy*, Boulder: University Press of Colorado, 2008, Chapters 8, 27, 28, 30

Campion, Nicholas, *Astrology and Cosmology in the World Religions*, New York: New York University Press, forthcoming 2011, ch. 5 PDF.
ON-LINE LIBRARY

Week 6

Living Astronomies

Weekly Description and Reading

This week's reading looks at non-western cultural astronomies/astrologies in the modern world.

Required Reading

Aveni, Anthony (ed), *Foundations of New World Cultural Astronomy*, Boulder: University Press of Colorado, 2008, Chapters 15-21

Campion, Nicholas, *Astrology and Cosmology in the World Religions*, New York: New York University Press, forthcoming 2011, chs. 3, 4, 7.
ON-LINE LIBRARY

Week 7

Weekly Description and Reading

The Classic Maya

This week's reading examines the use of astronomy in Maya society and architecture.

Required Reading

Aveni, Anthony (ed), *Foundations of New World Cultural Astronomy*, Boulder: University Press of Colorado, 2008, Chapters 22-25, 33

Campion, Nicholas, *Astrology and Cosmology in the World Religions*, New York: New York University Press, forthcoming 2011, ch. 5 PDF.
ON LINE LIBRARY

Week 8

Weekly Reading

Beyond Orientation: Pilgrimage, Sacred Landscapes and Self-organized Complexity

One of the great themes of archaeoastronomy has been the measurement and interpretation of "orientation." Across the world, shrines, temples, great houses, and cities have been measured by compass and theodolite in a search for orientation to features of the heavens. Even when such orientations have been established in the archaeological record, the interpretation of their meaning remains a major challenge. Were they established by imperial or ecclesiastical authorities who were proclaiming their celestial heritage, by astronomer-priests who managed a calendar for public and private ceremonies or did they just happen, established unintentionally by people moving across a landscape that for them had mytho-historic and cosmic meaning?

There are two types of stable systems in our universe: the death state of perfect equilibrium and the infinitely fertile condition of self-organization. The latter provides useful models for many complex features of the natural world, which are characterized by fractal geometries, cooperative behaviour, self-similarity of structures and power law distributions. Pilgrimage systems may be viewed as natural and self-organizing structures wherein complexity develops through the spontaneous and coherent behaviour of free people pursuing their own search for the sacred. Examples of such systems in the natural world range from earthquakes, schools of fish, forest fires and rain forests. Openness to the outside environment and coherent behaviour are necessary conditions for self-organization and the growth of complexity. A closed system is in equilibrium and is boring. All equilibrium systems are alike. Forces that disrupt equilibrium may drive cultural systems and individuals into a state of metastability or self-organized criticality lying between frozen inactivity of equilibrium and disordered hyperactivity of chaos. As systems depart more from equilibrium the amplification

of small fluctuations may result in stress-releasing avalanches of people. The resulting cultural systems may be highly non-adaptive, absurd, and just plain silly as judged by prior paradigms. Self-organization lacks an overall goal or purpose (a teleology), because the future is an unfinished project, not yet realized, and beyond visualization. At each stage, along the trajectory of cosmic time, emergence of new purpose (a teleonomy) provides new meaning. A self-organizing system is characterized by self-similarity and scale invariance: similar patterns are repeated with different sizes or time scales without changing their essential meaning. The body, temple and universe are perceived as self-similar and fundamentally identical in many traditions. In the world of the Ancestral Pueblo, the sipapu (place of emergence) kiva, canyon, and continent are all self-similar and scale invariant. The pilgrim who follows a pathway to Rome, Mecca, or Varanasi pursued a route that can represent the spatial structure of universe from center to periphery or that mimics the evolution of the universe from birth to death.

The development of the accurate pilgrimage calendar was a major achievement of human culture. The expansion of a pilgrimage from local to regional scale awaited the invention of precise methods for measuring and structuring time. Not only were precise observations of the cycles of the sun and the moon necessary to develop an accurate calendar, but also calendrical knowledge had to be communicated across the pilgrimage “catchment” area. Few other events of humankind involve such precise voluntary behaviour of ordinary people.

What is the origin of the rich multilevel complexity of pilgrimage systems? Most pilgrimages are not ordained by kings or hierarchical power, but emerge as the collective behaviour of free individuals, each in search of a spiritual ideal. Similar examples of complex self-organization are found in forest and ocean ecosystems. An essential quality of pilgrimage systems specifically and of self-organizing systems in general is their openness. The difference between open and closed systems is especially illuminating when one compares the longevity of pilgrimage centres with the brief florescence of the closed imperial city. In closed political systems, processes are put in place that suppresses innovation and accident and the system become vulnerable to involuntary change.

In addition to providing the cosmological setting for pilgrimage, astronomy plays roles in organizing time through the calendar and in visual rituals such as viewing dramatic astronomical objects, e.g., the sun at dawn or the rising full moon. Organized by the pilgrimage calendar, vast numbers of people move across the landscape in resonance with the motions of astronomical bodies. Pilgrimage is one of the primary examples on our planet of a dynamic parallelism between the celestial macrocosm and the human microcosm.

Reading

Rather than recommend reading for this week, you should visit JSTOR and search for Pilgrimage. However, the following four articles could offer a suitable starting point.

Daniel E. Budd, 'Pilgrimage and Enlightenment', *Journal of Religion and Health* Vol. 28, No. 2 (Summer, 1989), pp. 119-127.
JSTOR

Carolyn V. Prorok, 'Transplanting Pilgrimage Traditions in the Americas', *Geographical Review*, Vol. 93, No. 3 (Jul., 2003), pp. 283-307.
JSTOR

J. Stopford, 'Some Approaches to the Archaeology of Christian Pilgrimage', *World Archaeology*, Vol. 26, No. 1, Archaeology of Pilgrimage (Jun., 1994), pp. 57-72
JSTOR

Fredrica R. Halligan, 'Vaasudevassarvam: A Journey into the Mystery of the Indian Subcontinent', *Journal of Religion and Health*, Vol. 43, No. 1 (Spring, 2004), pp. 11-18
JSTOR

ADDITIONAL READING

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Cunliffe, Barry and Colin Renfrew (eds.) *Science and Stonehenge*, Oxford: Oxford University Press, 1997;

Heggie, D.C. (ed.) *Archaeoastronomy in the Old World*, Cambridge: Cambridge University Press 1982;

MacKie, Euan, *Science and Society in Prehistoric Britain*, London, Paul and Elek, 1977;

Ruggles, Clive and Nicholas Saunders, *Astronomies and Cultures*, Niwot, Colorado: University Press of Colorado 1993;

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Surveying

Lockyer, Norman, *Surveying for Archaeologists*, London: MacMillan, 1909.
Available as a full colour PDF, b&w PDF or text only at
<http://www.archive.org/details/surveyingforarch00lockrich>

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Classics of Science: Stonehenge as an Observatory, *The Science News-Letter*, Vol. 13, No. 369 (May 5, 1928), pp. 285-286
JSTOR

Web Resources

Archaeoastronomy & Ethnoastronomy News Archive
<http://terpconnect.umd.edu/~tlaloc/archastro/ae.html>
NB This is an excellent resource. Strongly recommended.

Archaeoastronomy: the Journal of Astronomy in Culture
<http://www.utexas.edu/utpress/journals/jarch.html>

The Centre for Archaeoastronomy
<http://terpconnect.umd.edu/~tlaloc/archastro/index.html>

Clive Ruggles Personal Website
<http://www.cliveruggles.net/>

Steve McClusky
<http://www.as.wvu.edu/~scmcc/>

http://www.archaeoastronomy.com/wiki_history.html

NB. This page is a comment on the Wikipedia Archaeoastronomy page, of interest because it is an insight into the way in which the discipline is represented in public

Take Care: there are many websites which you may turn to for information. It is inevitable, though, that most websites which do not have an academic base should be treated with caution. At the very least, they are indications of the kind of opinions and debates which flourish in this area.

<http://www.knowth.com/>

<http://www.archaeoastronomy.com/>

<http://library.thinkquest.org/C0118421/largemain.html>

Papers on the Web

Lionel Sims 'Entering the Underworld: Silbury Hill'.

<http://www.soli-luna.co.uk/>

Lionel Sims 'Lighting up dark Moon: ethnographic templates for testing paired alignments on the Sun and the Moon'.

<http://www.soli-luna.co.uk/>

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Chippindale, Christopher, review of *Stonehenge: A New Interpretation of Prehistoric Man and the Cosmos*, by John North, *Isis*, Vol. 93, no. 4 (Dec., 2002): 680-681.

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Ellegård, Alvar, Anthony F. Aveni, Elizabeth Chesley Baity, Donald J. Blakeslee, John B. Carlson, Marvin Cohodas, M. S. Edmonson, Laurence N. W. Flanagan, Owen Gingerich, Ronald Hicks, Thomas F. Kehoe, Alice B. Kehoe, Stephen C. McCluskey, Euan MacKie, Colin Renfrew, Jonathan E. Reyman, Clive Ruggles, T. C. Tsen, David Turton, 'Stone Age Science in Britain?' [and Comments and Reply], *Current Anthropology*, Vol. 22, no. 2 (Apr., 1981): 99-125.

Voss, Jerome A., 'Antiquity Imagined: Cultural Values in Archaeological Folklore', *Folklore*, Vol. 98, no. 1 (1987): 80-90.

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Baity, Elizabeth Chesley, Anthony F. Aveni, Rainer Berger, David A. Bretternitz, Geoffrey A. Clark, James W. Dow, P. -R. Giot, David H. Kelley, Leo S. Klejn, H. H. E. Loops, Rolf Muller, Richard Pittioni, Emilie Pleslova-Stikova, Zenon S. Pohorecky, Jonathan E. Reyman, S. B. Roy, Charles H. Smiley, Dean R. Snow, James L. Swauger, P. M. Vermeersch, 'Archaeoastronomy and Ethnoastronomy So Far' [and Comments and Reply], *Current Anthropology*, Vol. 14, no. 4 (Oct., 1973): 389-449.

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