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Cultural Astronomy for Inspiration

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Abstract. Cultural astronomy is the study of the astronomy of ancient cultures and is sometimes called the anthropology of astronomy. The many ways that astronomy was used by ancient cultures are fascinating and this can be used to inspire interest in all astronomy, as well as astronomy in culture. Archaeoastronomy is interdisciplinary and among its practitioners are not only astronomers and astrophysicists, but also anthropologists, archaeologists, and Indigenous scholars. Much can be learned about ancient cultures though examination of how and why they used astronomy. This paper will highlight several examples that can capture public attention.

Keywords. archaeoastronomy, cultural astronomy, Inca astronomy, Machu Picchu

1. Introduction

Cultural astronomy examines the astronomy used in ancient cultures, including orientations found at sites and structures of ancient peoples. Many people find cultural astronomy to be fascinating, and this can be advantageous as an opener to inspire further interest in other areas of astronomy. Several examples follow from the astronomy of the Incas. .

2. Astronomy of the Inca Empire

Astronomy was at the center of the Incas' religion and agriculture. The Incas were the children of the Sun and believed their emperor to be the Sun's direct descendant (Bauer, B. 1995). Solar worship was the official religion of their empire. The first emperor of the conquest, Pachacuti, imposed it across the realm, maintaining that he was the son of the Sun and his wife the daughter of the Moon. The ruling Inca was the central figure in solar worship, supporting the assertion that he was the descendant of the Sun (Zuidema, R. T. 1964). The Incas learned the cycles of solstices and equinoxes and used this knowledge as a key component of their annual crop management activities, as well as for determining dates for religious celebrations.

The Huaca (Shrine) of Kenko Grande

Kenko Grande is a large carved limestone outcropping north of Cusco. On its upper surface are two gnomons carved and situated to create a specific light and shadow effect. At the June solstice sunrise, light passes through a carefully designed fissure aligned to illuminate first one of the gnomons and then the other, with both casting shadows that create an image. The result is known as "the awakening of the puma" (Gullberg, S. R. 2020) Fig. 1. Pumas were one of the three most sacred creatures in the Inca cosmos, the other two being the condor and the serpen.

The Huaca of Lacco

Lacco is an even larger limestone outcropping to the northeast of Kenko Grande. Its prominent astronomical features are three caves with astronomical orientations

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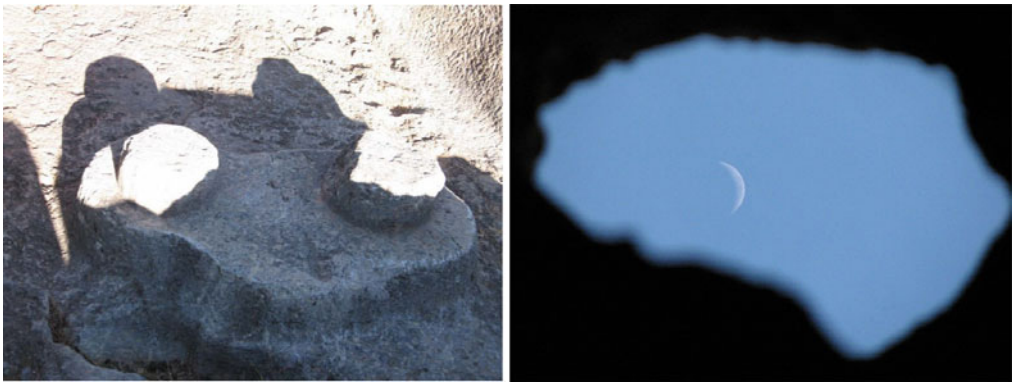

Figure 1. a) Awakening of the Puma b) Crescent Moon (Author's photos)

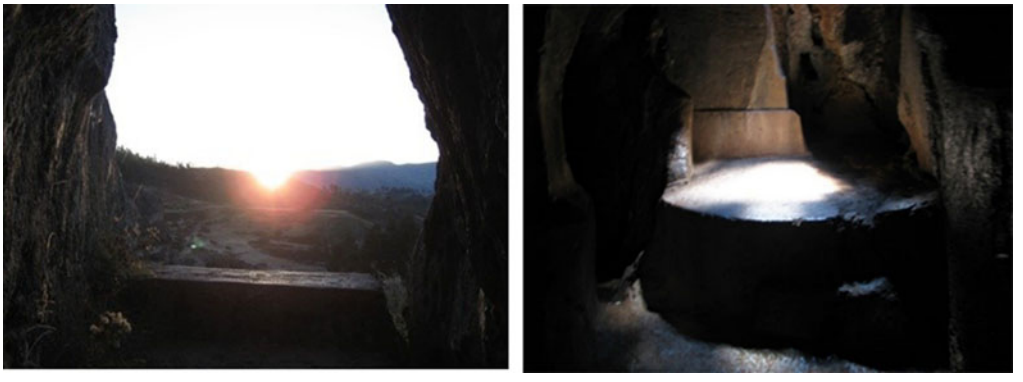

Figure 2. a) June Solstice Sunrise b) Illuminated altar (Author's photos)

(Gullberg, S. R. 2020). Lacco's southwest cave contains a small altar and a light-tube aligned for illumination. Fig. 1b looks outward through the light-tube at the crescent Moon.

Lacco's northeastern cave opening is aligned for June solstice sunrise. The sunrise position on the horizon daily draws nearer from the right until at the time of the solstice it stops, centered on the opening of the cave (Fig. 2a). Light from the Sun illuminates an altar and reflects into much of the rest of the cave (Gullberg, S. R. 2020).

Lacco's southeast cave has carved steps that descend into the outer chamber with a serpent carved into the entrance wall. The inner chamber includes an altar and a vertical light-tube. The cave is called the Temple of the Moon but was found as well to illuminate the altar at the time of the zenith Sun (Gullberg, S. R. 2020) (Fig. 2b).

Huaca 44

Huaca 44 is a small huaca located between Kenko Grande and Lacco. It includes two large carved circles that could be used to indicate the direction for each of the six primary solar horizon events. Tangential lines drawn traced between the larger and smaller circles indicate the directions for viewing June Solstice Sunrise, December Solstice Sunset, December Solstice Sunrise, and June Solstice Sunset. A line traced across the two indicates the directions for an Equinox Sunrise and an Equinox Sunset (Gullberg, S. R. 2020) (Fig. 3a).

The Palace of Q'espiwanka

There may have been as many as 16 towers on the Cusco horizon erected for sunrise calendrical purposes, but they were all destroyed during the Spanish extirpation of in-

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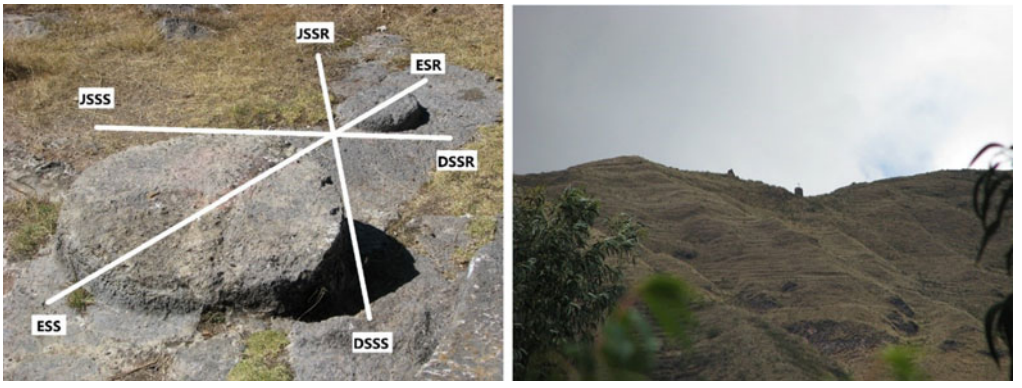

Figure 3. a) Huaca 44 b) Pillars (Author's photos)

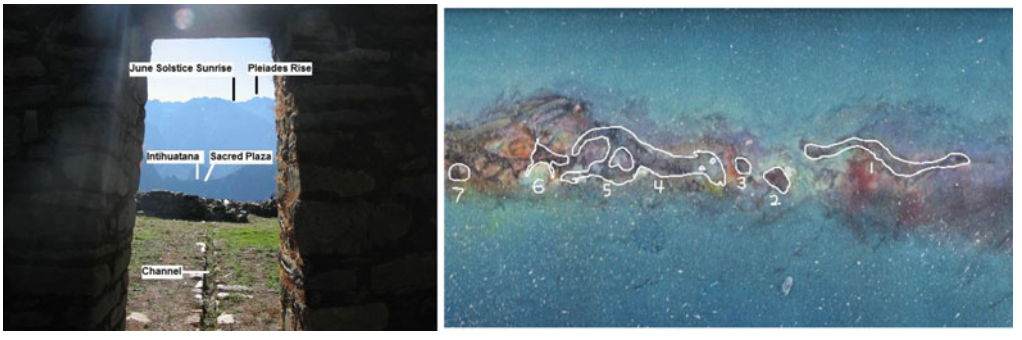

Figure 4. a) Llactapata b) Dark 'constellations' (from Author's photo and painting by Jessica Gullberg)

digenous religion. Near the north of the Sacred Valley, however, two such pillars survive on the Cerro Saywa ridge above the present village of Urubamba. The pillars mark the rise of the June solstice Sun when viewed from a sacred granite boulder on Huayna Capac's palace grounds called Q'espiwanka. As the sunrise moves on the horizon from right to left it rises first over the right pillar giving warning and then continues to the left pillar by the solstice (Gullberg, S. R. 2020) (Fig. 3b). This extant example helps to support that similar pillars once surrounded Cusco.

The Royal Estate of Machu Picchu and Nearby Llactapata

The greater significance of Machu Picchu and its surrounding area began to emerge with research conducted at Llactapata in 2003 (Malville, J. M. 2006). The Llactapata Ridge lies five kilometers from Machu Picchu across a deep gorge below. Well over one hundred structures are engulfed there within the cloud forest. The Llactapata Sun Temple, however, is now kept clear and exhibits solar orientation. The Sun Temple, the River Intihuatana at the base of the gorge, and the Sacred Plaza of Machu Picchu all lie on an axis of the June solstice sunrise/December solstice sunset.

A ceremonial channel built from the Sun Temple's central door points across the River Intihuatana to the Sacred Plaza (Gullberg, S. R. 2020) (Fig. 4a). Beyond, on the horizon, is where the June solstice Sun rises, and as well the nearby heliacal rise of the Pleiades. The observed brilliance or dullness of the Pleiades at this time is used to this day to forecast crops and planting with regard to an impending El-Niño drougt (Orlove, B. S. 2000).

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Incan Use of the Milky Way

The Incas recognized "dark constellations," or the shapes of beings formed by dark clouds in the visible band of a section of the galaxy prominent in the Southern Hemisphere. They saw great cosmological characters meant to guide them in their daily lives. Most are animals that figure prominently in Andean cosmology and myth (Urton, G. 1981), (Gullberg, S. R. 2020). Machacuay, the serpent, leads the procession of dark constellations in the Milky Way. The serpent travels head before tail across the sky (Urton, G. 1981). Hanp'atu, the toad, follows closely behind Machacuay. Toads were thought of as bad omens created by the devil. Hanp'atu is a much smaller and is po- sitioned to the left of the snake (Urton, G. 1981). Tinamou are indigenous birds of ancient lineage. Yutu, the Tinamou, is what Western astronomy knows as The Coalsack and follows Hanpatu in the Milky Way (Urton, G. 1981).Yacana, the llama, figures prominently in Inca tradition and was thought to animate llamas on the Earth (Gullberg, S. R. 2020). Yacana dominates the section of the Milky Way used by the Incas for dark constellations and is situated between Centaurus and Scorpius. The prominent stars Alpha and Beta Centauri are thought to be its eyes (Urton, G. 1981). Below Yacana is a smaller dark constellation called Uñallamacha, a baby llama suckling its mother (Urton, G. 1981). After Yacana and Uñallamacha is another small constellation called Atoq, the fox. The Sun enters Atoq during the December solstice. Urton (1981) explained that the Milky Way and Atoq catch up and rise with the December solstice Sun in the southeast during the same period of time that terrestrial baby foxes typically are born, around 15–23 December. The final dark constellation is a second Yutu. This additional Tinamou completes the celestial procession (Urton, G. 1981, Gullberg, S. R. 2020), (Fig. 4b).

3. Conclusions

Cultural astronomy is a fascinating field and it adds great insight to what is known about early cultures, most of which used astronomy. The University of Oklahoma offers well-developed online programs with graduate and undergraduate degree opportunities, certificate programs, and individual courses. The Inca examples presented here are just a few of a vast many that can be used to capture the attention of non-astronomers and further inspire them. Archaeoastronomy can be a great opener with the public. It intrigues them and can inspire greater curiosity about much of astronomy and astrophysics in general.

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