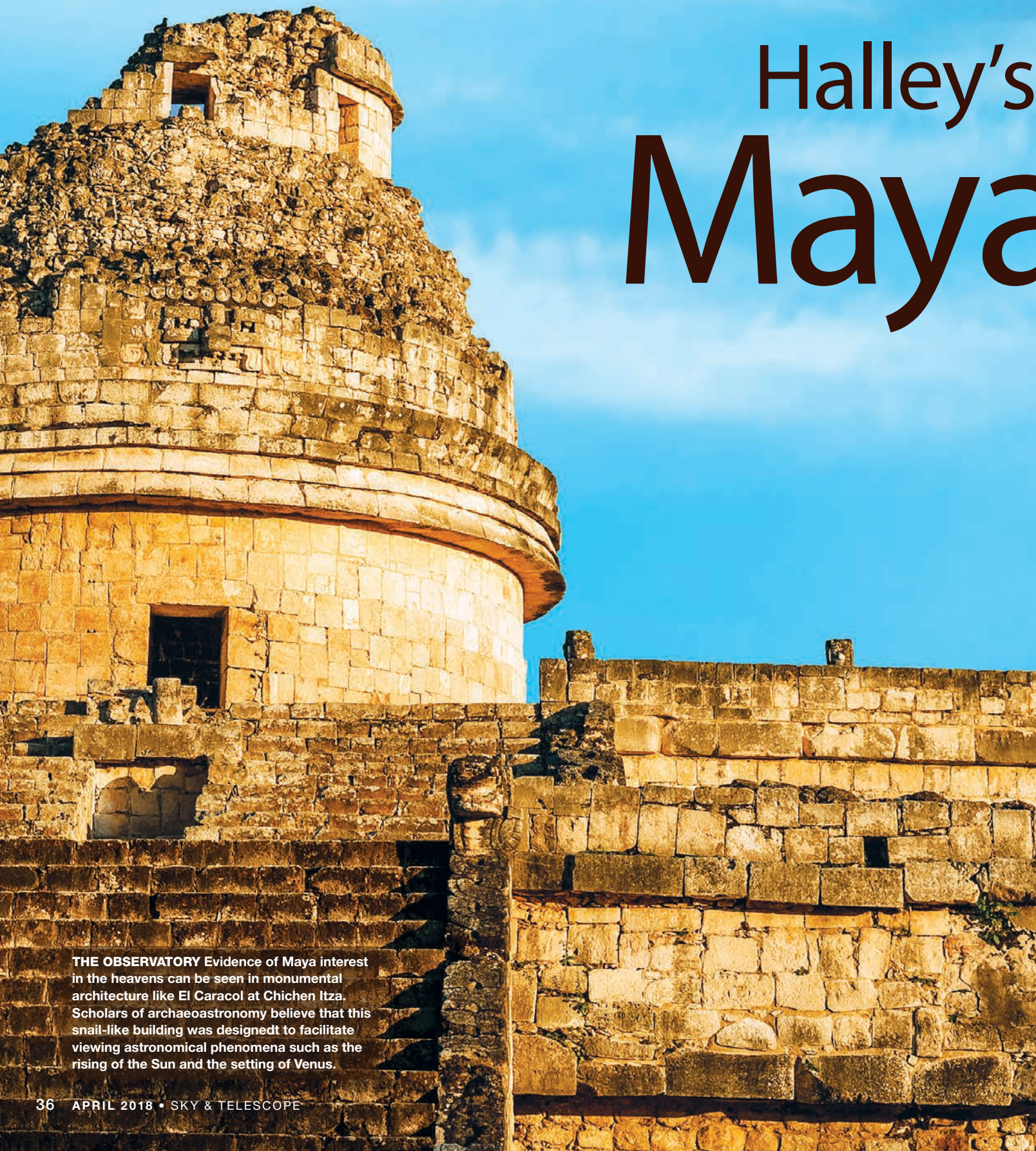
Halley's Maya



THE OBSERVATORY Evidence of Maya interest in the heavens can be seen in monumental architecture like El Caracol at Chichen Itza. Scholars of archaeoastronomy believe that this snail-like building was designedt to facilitate viewing astronomical phenomena such as the rising of the Sun and the setting of Venus.

Comet & a Kings

Did a spectacular, once-in-a-millennium meteor shower prompt the crowning of a king?

It's the evening of April 10, AD 531, in the city of Caracol, a regional political center located within the foothills of the Maya Mountains. The Moon set a few hours earlier, and a blanket of stars, concentrated overhead into a wispy Milky Way, is prominent in the pre-morning twilight. Suddenly, a brilliant shooting star streaks across the sky. Almost immediately, another star falls from the heavens, and then another.

What follows is one of the most impressive celestial displays in living memory. Unbeknownst to those witnessing the meteor shower from Caracol, the Earth is passing through a giant cloud of interplanetary detritus left behind by Comet 1P/Halley, our most famous recurring icy visitor, in a series of near passes in the preceding centuries. For two hours, bright streaks of light rain down from the heavens above the Maya Mountains, producing one of the most intense meteor showers of the first millennium.

For the residents of Caracol, this shower wasn't just a once-in-a-lifetime spectacle. The heavens had spoken and political change was in the air. Four days after the shower, the people recognized K'an I, known as Lord Jaguar, as the new king, succeeding his father, Yajaw Te' K'inich I. The royal ascension was accompanied by familiar ceremonies during which the new king's blood was a sacrificed to the gods as the sacred Maya beverage *saka*, made of maize and wild honey, was passed around.

We know about this series of events not from an ancient scripture, but thanks to a recent paper published in *Planetary and Space Science* by astronomer David Asher (Armagh Observatory) and Maya scholar J. Hutch Kinsman, who claim to have found the first evidence of meteor shower observation and recording anywhere in the Western Hemisphere.

The Maya Classic period ran from around AD 250–900. During this time, an empire encompassing some 50–75 city-states spanned the modern Central American countries of eastern Mexico, Guatemala, Belize, El Salvador, and Western Honduras. However, despite the range and longevity of this New World civilization, piecing together its story has proven tricky. All but four of the Maya's ancient books, known as *codices*, were destroyed by the Spanish after their arrival in the 16th century. Adding together the content of the surviving codices, plus all hieroglyphic inscriptions recovered from stone monuments (*stelae*), panels, painted murals, and portable objects (such as bones, shells, and ceramic vases), provides

▲ **DECIPHERING THE PAST** Scholars have carefully transcribed the glyphs on ancient Maya monuments, many of which have been lost to looters and developers. This drawing records what remains of Monument 6, which was found in Tortuguero (present-day Tabasco, Mexico).

OBSERVATORY: VENTDUSUD / GETTY IMAGES; MONUMENT 6: DRAWING BY IAN GRAHAM; © PRESIDENT AND FELLOWS OF HARVARD COLLEGE, PEABODY MUSEUM OF ARCHAEOLOGY AND ETHNOLOGY, PM #2004.14.13.1

just a couple of thousand date entries across the entire seven centuries of the Classic period. Events recorded on these dates mark not just the accession of kings, but also the births and deaths of important people and conquests of one city-state over another. We can also find astronomical information relating to Venus, and both solar and lunar eclipses, in these records. However, scholars have found no evidence of any meteor showers among the historical remnants.

Asher, a solar system modeler with an interest in the history of astronomical observations, considers this lacuna a bit strange, as records of meteor showers have been recovered from ancient Chinese, Korean, Japanese, and various European civilizations. In addition, based on their records of lunar and planetary movements, the Maya certainly had the capability to predict such celestial phenomena. "Did the records just disappear with much of the Maya book records," Asher wondered, "or are there still clues we are missing?"

Asher has experience with meteor showers, having used the spectacular 1966 Leonid outburst, the biggest and most impressive of the 20th century, to predict the arrival time of subsequent displays in 1999, 2001, and 2002. Together with Robert H. McNaught, he achieved this with a computer program developed to model the trails of material shed by a comet and calculate when Earth's travels around the Sun would cross them in the future. When they input the data for Comet Tempel-Tuttle, the parent comet for the Leonids, the shower predictions were accurate to a few minutes.

Asher's interest in the Maya and their historical records came about only relatively recently following a chance encounter with Kinsman, a man who spends his time looking to the past rather than upwards. (Kinsman originally studied physics but has focused on the Maya for the last 20 years.) At their first meeting, Kinsman brought up the mysterious absence of shooting star records in the Western Hemisphere. ("It was a fascinating lecture," recalls Asher.) By 2015 the two scholars had begun working together to address the missing Maya meteors.

Asher's experience with the Leonids proved that with sufficient knowledge of a comet's past location one could predict when the Earth would pass through its remnant trails later on. And if they knew the exact dates of meteor outbursts visible to the ancient Maya, perhaps they could spot indirect evidence of their impact in the recovered Maya events calendar. In terms of which comet to choose, the close proximity of Halley to Earth's orbit during the Maya mid-Classic period made a strong argument for looking for evidence related to its Eta Aquariid showers, which

◀ **EXPANSIVE CULTURE** The Maya civilization spread across a large piece of Mesoamerica, including the Yucatán Peninsula and the mountains of the Sierra Madre region (present-day Mexico, Guatemala, and Belize). The city-states of the Maya Classic period (c. AD 250–900), which boasted populations as large as 120,000, produced most of the stone monuments and historical records that we have today.

MAP: LEAH TISCIONE / S&T

were recorded by ancient Chinese astronomers as far back as 74 BC.

Asher and Kinsman applied the Leonid model to simulate meteoroid-sized particles attributed to Comet Halley's passages from as early as 1404 BC in order to identify years when meteor outbursts might have been seen on Earth. After validating their approach by post-predicting observations in the ancient Chinese texts, they compared the same outburst dates to the surviving Maya record of notable dates.

They got 30 hits.

"Whilst some of them will be coincidences," Asher admits, "there are many more matches in or just after key meteor outbursts than you would expect to see by chance alone."

The recorded events that most commonly corresponded to Eta Aquariid displays were royal accessions, events that could easily be planned to coincide with or occur near the date of a meteor shower. For the shower in AD 531, Kinsman and Asher showed that the intensity of this burst resulted from Earth encountering particles released by Comet Halley during three previous passages (AD 295, 374, and 451). The relatively recent deposition of detritus by the comet meant there had been little time for dispersion, ensuring densely packed trails that could cause an intense outburst. The result was a shower Asher believes would have been spectacular, perhaps even to the extent of the incredible Leonid meteor storm of 1833, during which estimates have suggested 24,000 meteors were observable during an astounding nine-hour display. This celestial show was described at the time by Yale College Professor Denison Olmsted as "a constant succession of fire balls, resembling sky rockets, radiating in all directions from a point in the heavens," and if a similar shower had occurred in clear skies above the Maya city-states, it would have been impossible to ignore.

The calendar entry for AD 531 might itself provide additional evidence for a meteor-shower-inspired coronation, as it includes not just the ascension event, but also the number of days that had passed since new Moon. This lunar tracking isn't uncommon in the Maya records, but in the case of this entry, the age of the phase was inscribed incorrectly. Kinsman and Asher interpret this error to mean that the

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The Venus Table

BY S. N. JOHNSON-ROEHR

A large part of the Dresden Codex, the oldest and the best preserved Maya manuscript, is dedicated to astronomical and calendrical data. These data include solar and lunar eclipse predictions based on observable lunar phases, as well as tables for tracking the cycles of Venus, Mars, and Mercury.

Six pages of the Dresden Codex are dedicated to the observable phases of Venus, beginning with the folio shown here. Credit for deciphering the so-called Venus Table goes to Ernst Förstermann, director of the Royal Library (now the Saxon State Library), who in 1901 worked out that the numbers inked in red across several pages of the codex were identical, and that they added up to 584. Recognizing that this number was almost identical to the synodic period of Venus (583.92 days, the time it takes for Venus to return to the same position as seen from Earth), Förstermann determined that the red numbers — 236, 90, 250, and 8 — marked four significant points in the planet's cycle: its morning heliacal rising; its disappearance at superior conjunction; its first evening rise; and its disappearance at inferior conjunction.

▲▼ **SKY TRACKERS** Despite a paucity of records related to meteor showers that might indicate otherwise, the Maya were keen observers of the night sky. Some of their astronomical knowledge was recorded in the Dresden Codex, a Maya history and astronomy treatise inked on paper made from the inner bark of a species of fig.

◀ **STONE METEORS** Tortuguero's Monument 6 includes a glyph depicting the AD 562 star war between the cities Tikal and Caracol. The droplets streaming from the glyph for "star," which resembles a pair of cartoon eyes, may represent the Eta Aquariid meteor shower.

> "There are many more matches in or just after key meteor outbursts than you would expect to see by chance alone."

inscribed age of the Moon referred to the date of the intense Eta Aquariid event, not the ascension itself. That is, the calendar noted a lunar age of 8 days (the age of the Moon during the meteor outburst on April 10th), not 12 days (the date the king was crowned).

"It appears that the Maya were back-calculating mythological events using calculations of the sidereal year that appear to have accurately targeted the Eta Aquariid meteor shower," says Dr. Michael Grofe, an archaeoastronomy specialist from the Maya Exploration Centre who wasn't involved in the project. "Kinsman and Asher make a compelling argument that the Maya both observed and predicted the Eta Aquariid meteor shower, and that the dates of the accession of Maya kings and queens, among other notable events, were timed to coincide with this astronomical phenomenon."

While AD 531 provides the most convincing match, Asher and Kinsman's date matches provide other tantalizing possibilities. A modest outburst in AD 511 was followed nine days later by the ascension to the throne of a six-year-old queen, known as the Lady of Tikal. However, not all matches led to scenes of celebration. In AD 562 a major battle between rival cities Tikal and Caracol followed an Eta Aquariid outburst by slightly less than three weeks. The battle, which resulted in Tikal's conquest and subsequent disappearance from the historical record for the next 120 years, is depicted in the record with a hieroglyph that looks a lot like a star showering Earth with liquid droplets. This evocative glyph led archaeologists to refer to this and similar devastating battles as *star wars*. Losing a star war often signaled the end, or at least the near erasure, of the defeated city-state. Archaeologists have noted that star wars tended to occur in the dry season (November to January) and typically began near the date of the appearance or disappearance of Venus. But could a star war also be prompted by a meteor shower?

An additional interesting match concerned not dust-induced meteors but Halley's Comet itself, which made its second-closest known approach to Earth on April 1, AD 374. About one month after the comet's passage, the Maya record shows the royal ascension of Teotihuacan ruler Spearthrower Owl (Atlatl-Cauac), whose hieroglyph and iconic representations clearly depict an owl holding an *atlatl*, a spear-throwing tool with stars, or "celestial darts," attached. It may be that Spearthrower Owl, who was responsible for the establishment of non-Maya rule over Tikal and other Maya city-states in AD 378, based his ascension on the passage of Halley's Comet in AD 374.

"The scale of some of these events organized close to major showers supports the idea the Maya were able to calculate the length of the sidereal year, and in all probability kept track of and observed Eta Aquariid meteor showers and outbursts," says Kinsman. While some of the connections seem speculative, we are gaining more knowledge of the Maya daily through the study of their hieroglyphs, monuments, and codices. "We hope this collaboration can run and run," adds Asher, who now wants to apply the same technique to other comets and meteor showers that could have commanded the ancient Maya from the heavens. Short of revealing clear textual or archaeological evidence, this type of collaboration represents the best chance of understanding observations of meteor showers by the Maya.

■ **JAMES ROMERO** is a UK-based planetary and solar system science writer who has written for *Science News* and *New Scientist* magazines. A geology graduate and very amateur astronomer himself, he also organizes large public science festivals in the UK at Imperial College London. You can follow him on twitter **@mrjamesromero**.

FURTHER READING: For a more detailed discussion of Maya records and the Eta Aquariid outbursts, see the original paper published in volume 144 of *Planetary and Space Science* (**arxiv.org/abs/1707.08246**).