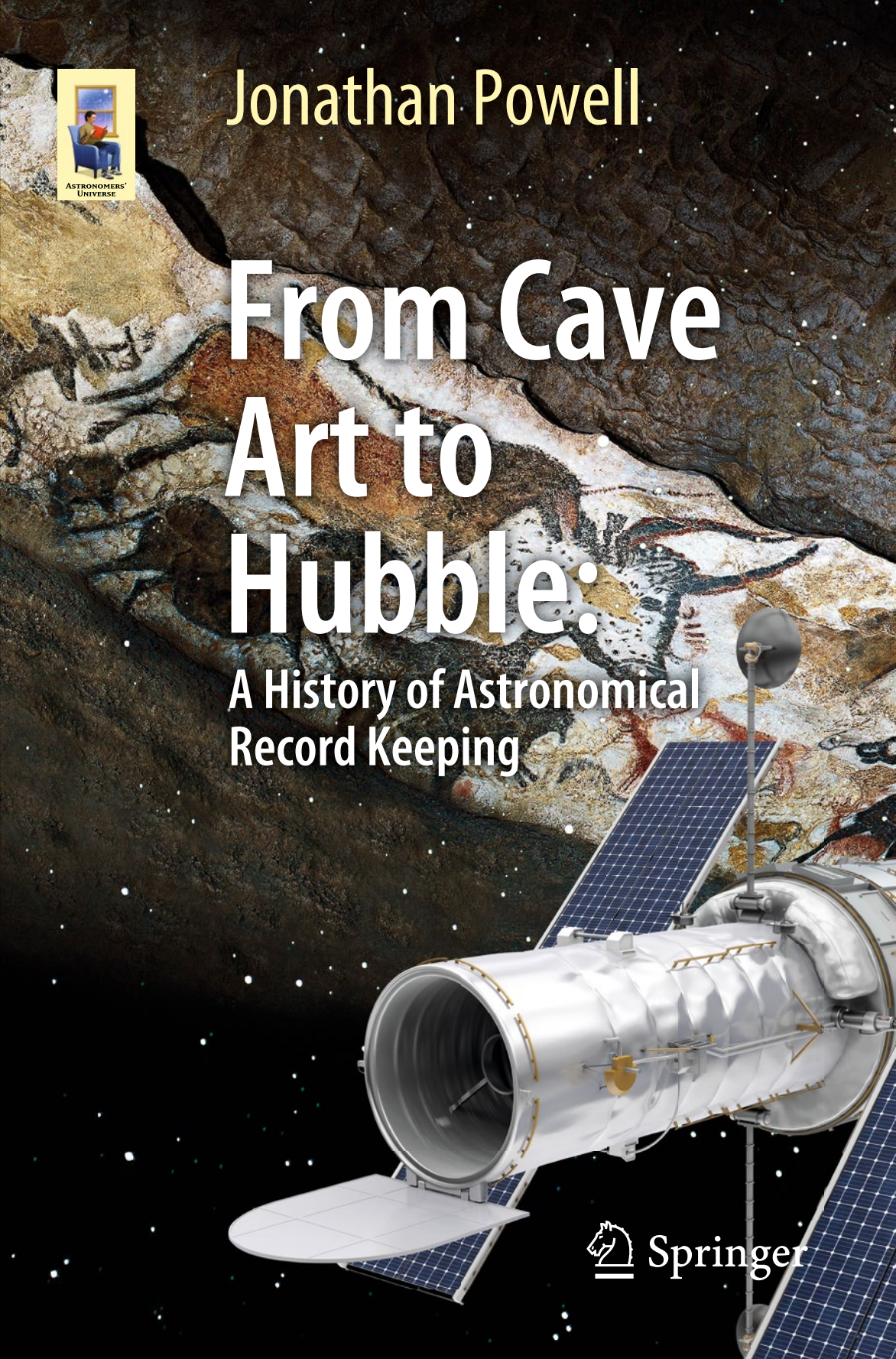
Astronomers' Universe
Jonathan Powell
From Cave Art to Hubble:
A History of Astronomical Record Keeping
Springer

Astronomers' Universe

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From Cave Art to Hubble

A History of Astronomical Record Keeping

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1. Introduction

Recording the Night Sky

Throughout history, the desire to document happenings and events has been an integral cornerstone in humankind's advancement to acknowledge, understand, and preserve the very fiber of what the eye beholds, which in turn contributes to our ultimate survival and existence. This fiber remains intertwined between our past and present, with the present allowing our future selves to grow and nurture, learning from what past knowledge has been acquired.

Without this kernel of guidance through documentation of the past, there would be no root from which to develop, no steering wheel, no beam of light to shine forward into the enveloping darkness of an uncertain future. History is a vital link in an extensive chain that binds humankind, its thoughts, its reactions, and its judgements. This is in some cases a necessary evil but also, by the same token, both a positive attribute and ultimate tribute, the veritable recording of life's tapestry, which in turn unfolds over time, revealing a picture whose sum total is greater than the individual mosaic-like artwork that forms it.

From the seemingly simple artwork that adorns many cave walls throughout the world to the high-end spectrum of modern recording capabilities, the documenting of the night sky has created a catalog of our history on Earth, a history that generations of custodians have seen fit to record as an often-permanent record of their time on Earth. As much as fossils give vital clues to understanding the creatures that once roamed the land, artwork can yield very much the same results if looked upon and studied sufficiently. Interpretation is the key that unlocks the past.

Let us not forget the number of times a species of which nobody knew the existence of is discovered, adding to the ever-increasing back catalog of animal life that lived on land, dominated the skies and swam in our oceans. Every time there is a new discovery, another part of the jigsaw is acquired – a jigsaw that will

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probably never be completed, as new finds add an extra dimension to our understanding, changing our perceptions, as much as they deepen and enhance our knowledge of the past. It might once have been said of early cave art and engravings, that these were – simple cave drawings by a primitive and intellectually deficient collection of our human ancestors. Perhaps at first this may well have been the way in which such findings were viewed, but as the decades have passed, new light has been thrown on the cave drawings, a light that has shone beyond the ignorance and often arrogance of a society that at the time was possibly too quick to dismiss, too hasty in judging, and ultimately wrong in determining the meaning behind such work, and those who created it.

A precedent exists for not being as dismissive as those who went before us, as such simple drawings can in fact reveal much more than initial viewing may suggest. It is hard to believe that as the decades pass, ground-breaking advances in many areas of science will not continue and, in retrospect, the discoveries of today merely serve as the notches of forward progression towards a better way of understanding, a fresher way of comprehending, and a simpler and more satisfying way of conquering that which serves to halt progress most – in many cases, humankind itself.

Many years from now, what we believe to be cutting-edge will be so dated and antiquated that our future selves to may look back with bafflement as to why what seems so obvious at that point didn't seem so in the past. Fundamentally, this applies to cave art and the causal link between the intellectual level and reason the drawings were made by the people who made them, and the actuality and reality that have been bestowed amongst our ancient relations.

Although modern technology used to record the sky is ultimately more comprehensive, more intense, with possibly for some an elitist edge that precludes everyone's involvement, and cave art perhaps a more collective endeavor, the parallels between the two forms are unequivocally linked.

From Cave Art to Hubble attempts to address all the various methods used to record the night sky throughout history. Although the book strives to cover the array of potential documenting applications, be it in the form of art, the work of a scribe, or one who weaves patterns on fabric to the number cruncher at

the receiving end of a data transmission, the aim is ultimately to establish one determining link.

First, we will look at a lone observer from ancient times simply peering up into the night sky with just their eyes. Then we will look to the present day, with a lone observer doing exactly the same. What they see before them in relative terms isn't all that different, for in front of them is a black velvet canvas with a vast array of stars, the same then as it is today, with perhaps the Moon for company. But although it is seemingly the same sky, the concept of what is being observed has altered vastly – virtually the same stars, but with a very different reckoning now as to what they are, how they were formed, and in relation to other stars, our very own place in the cosmos.

As we have learned and grown in scientific stature, our ability to record and interpret has evolved with it. We can see from our ancestors how the recording of the sky was as important to them as it is to us today, and why it is necessary to continue that growth in how we perceive the sky. The very essence of our existence and the ability to understand and advance is underpinned by our own comprehension of the universe, and while a good many theories, explanations, and ultimately confirmed facts are established, the sum total makes for just a fraction of the overall picture that perhaps someday will be concluded. Who would have dared to challenge some of the early beliefs surrounding the makeup of our own Solar System? And yet, through progress and proof, acceptance has also often then entered the equation – acceptance that one notion was wrong and another right, an explanation with cast-iron proof.

We are still very much finding our way in the cosmos, still on a very long path, and still looking for clues and guidance towards unlocking so many mysteries, the answers many of which lie in the stars. Early humankind recognized the importance of preserving their own sightings in the night sky, and over the centuries, though the ways of recording events in the heavens has changed, the basic instinct that exists to relate and interpret what has been seen remains the same.

Even though from the depths of our oceans to the deepest rainforests many places right here on Earth remain uncharted, surely the greatest adventure of all lies above us. And what better way to set sail than when accompanied by the recollections and findings of others throughout the centuries, offering one of the biggest, ongoing learning curves that humankind could embrace, and

by advancing the way in which we document the skies, the sum total of all our findings could potentially offer answers to questions that have been asked.

Does the answer lie within? Does all the cave art, stone tablets, parchments, letters, woven fabrics, telegraphed communications, radio waves and microchip data, provide the answers to so many questions that already exist, and it's just that we can't see it, or do we not know enough to determine it or equate in a context that makes it comprehendible?

The quest for knowledge continues by reaching farther and farther into the depths of space, studying astronomy and cosmology; the further we look, the farther back we go in space and time. We edge forwards towards the very past that brought us here to the present.

However, we must not be complacent. There are so many potential 'game-changers' as we push forward, and the history that we have recorded down the centuries is ultimately cross-referenced with the history of the cosmos that is being uncovered as we peer deeper and deeper into our past, by looking into more remote parts of space.

A Landmark Day

When examining all the methods used to record the night sky, several universal truths exist. Firstly, every format has its merit and subsequent time marker stamped by what method was used, by whom, and for what purpose. Secondly, not all of the events recorded in the night sky were of the "now" and, particularly when considering views of the stars and constellations, were recordings of past events. Given the great distance that light travels before being finally captured, a lot of what we see on a nightly basis happened long ago, when our ancestors were custodians of Earth during their "tenancy." Thirdly, and most importantly, the further we look into space, the farther back we see in time, which ultimately creates a staggering paradox. We look further to gain more knowledge and understanding of the universe, but in essence, like an archaeologist, the further we plough the depths of space, the deeper we reach into our own past.

Fig. 1.1. Black hole in M87. Event Horizon Telescope. (Courtesy of NASA)

One such event in 2019 summed up what *From Cave Art to Hubble* is all about, the very core of its structured aim. For in April, the eyes of the world turned to Messier 87 as astronomers released the first ever image of a black hole. This was a monumental moment in science, as after centuries of theories and debate, we at last had an actual image to which black holes could be tagged (Fig. 1.1).

A year previous to this ground-breaking image, news broke of research that suggested that as many as a dozen black holes may lie at the center of our own galaxy, supporting a widely held theory that "supermassive" black holes at the centers of galaxies are surrounded by many smaller ones. A Columbia University-led team of astrophysicists made the discovery of the black holes in 2018, which are gathered around Sagittarius A∗ (Sgr A∗), a supermassive black hole right at the center of the Milky Way. Sagittarius A possesses four million times the mass of our own Sun and is located 26,000 light years from Earth.

A year later and scientists had their first image of what turned out to be a gargantuan black hole, with a mass equivalent to 6.5 billion times that of our Sun. The galaxy surrounding it, Messier 87 in the constellation of Virgo, is equally huge. Known as a supergiant elliptical galaxy, it is one of the most massive galax-

ies in the universe and hosts a large number of globular clusters. An international scientific team heralded the image as "seeing the unseeable," a spectacle 55 million light years from Earth. The diameter of the black hole is approximately 39 billion km.

A black hole is an incredibly dense region of space from which nothing can escape, with this image showing us what in essence is a one-way door leading us out of our universe – a place that due to its massive gravitational field sees clocks run slower the nearer one advances toward it, although the actual slowing affect is regulated and dependent on the curvature of spacetime around the black hole.

The idea of a black hole was first conceived in 1783 by amateur astronomer John Michell (1724–1793). Michell, an English natural philosopher and clergyman, published a paper for the *Philosophical Transactions of the Royal Society of London*, which was read aloud on November 27, 1783. The paper proposed the idea that there were such things as black holes, which Michell referred to as "dark stars." Michell, whose other interests included a wide range of topics in the scientific field, including geology, optics and gravitation, proposed that light consists of miniscule particles. He reasoned that such particles, when emanated by a star, would be slowed by its gravitational pull, and in turn surmised that it might be possible to determine a star's mass based on the reduction of that speed. As a result, it may well be possible that a star's gravitational pull might be so strong that the escape velocity would exceed the speed of light.

At the time of Michell's paper and despite a similar idea being proposed by French mathematician Pierre-Simon Laplace (1749–1827) in his 1796 book *Exposition du Systeme de Monde*, many of Michell's contemporaries did not buy into his theories on black holes. In actuality, both Michell and Laplace were simply far ahead of their time – but how wrong their contemporaries were and how foolish to dismiss such notions out of hand!

Albert Einstein's (1879–1955) theory of general relativity was formulated in 1915. Black holes were an unprecedented test of whether Einstein's ideas about the very nature of space and time hold up in extreme circumstances, and they did, as his general relativity – possibly one of the most comprehensive theories ever formulated – had its ultimate confirmation.

Along with other great scientists who made invaluable contributions to the theoretical work surrounding black holes, one cannot fail to mention the tireless work of Stephen Hawking

(1942–2018), who, born exactly 300 years after the death of Galileo Galilei (1564–1642), devoted his entire life to exploring various theories on cosmic phenomena, including in 1974 his theory that a black hole does in fact emit something when you throw quantum mechanics into the equation. He hypothesized that black holes had an "apparent" horizon, across which matter and light could move, while leaving behind particles, now also known as Hawking radiation.

Forwards to the Past

Technology continues to develop with gathering pace, and no matter how we record the night sky in the future, there will always be more than just a tenuous link to the past. For the documenting of such events, while important, only validates one half of whatever image is captured. For here, as we peer into the past, the unraveling of the universe in which we live also marks the passage and development of humankind's collective ability if a general consensus and understanding is mutually recognized, to pursue greater, more all-encompassing breakthroughs, and like our ancestors who saw and painted on a cave wall in centuries past, impart the knowledge and wisdom of discovery so that future generations can learn, build, and grow in unison.

The biggest obstacle is often the one we place in the path of ourselves. Whereas it is hard to estimate exactly where technology will take us next, the excitement lies within the possibilities that the likes of Michell were so keen to suggest, and the marriage of making those theories and then providing evidence of their actuality. The black hole image struck such a chord with many who in their own scientific disciplines believed, and yet who had not at the time of postulating reached the point where proof is provided; but as with time, the truth shall set them free.

While that image of the black hole is a huge reckoning moment for humankind, it is but one more milestone ahead of many more milestones to come, as we barely make the smallest of impressions on the world around us. But small or not, it is our impression, and a definitive sign that our fate to a certain extent lies with our drive, passion, and ultimate quest to push back the boundaries of space and time, and for ourselves, to see the past from perhaps whence we all came and will all one-day return.

2. Cave Paintings That Recorded the Night Sky

Primitive Artwork

One of the most striking and imaginative insights into the life and times of ancient civilizations comes in the form of artwork, sketches, and paintings left on the walls of caves and other dwellings. For here, sometimes in a very uncomplicated format, or in other cases quite elaborate, many events were recorded in graphic form. Whereas the written word would in many cases not be challenged in terms of meaning or the offer of multiple interpretations, some cave paintings have caused much debate as to what the artists were trying to convey through their medium.

Aside from the possibility that cave art was just a means of decoration, the very fact that the artist took the time to create them did, without them probably knowing, create a pictorial representation of the times in which they lived. So, whether the artwork was for leisure or purpose, the same outcome was achieved, in so much as a very vivid piece of history was given to future generations, a valuable portal to the past. Indeed, barring fossils, it is the only portal of its kind. But, is there a meaning behind the artwork?

Some scientific quarters claim a "key" or a "code" may exist within the artwork and that the paintings may have been a way of transmitting information. Other, perhaps more realistic, explanations lean towards a religious or ceremonial purpose. When considering the possibilities, it does seem hard to believe that any artwork was merely for decorative purposes. Perhaps there was more of a need to convey and confirm to others at that time that the world in which they lived was perceived in the same way, a common ground if you will, where merely pointing to the picture of an animal would create unity in the mutual understanding of what had been drawn and what it represented. Indeed, the art may well depict life experiences or in some way portray a storybook, which would easily act as a means of representing a sequence of events through drawings.

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Prehistoric men may have painted animals to "catch" their soul or spirit in order to hunt them with more ease, or perhaps the vision painting of the animal on the wall was merely some way of paying homage to the surrounding nature and environment in which they lived. The act of drawing would, in turn, fulfill the basic need of expression that is innate to all human beings.

Another theory proposes that animal images were in fact actual records of hunts that served the dual purpose of making an inventory of kills, as well as noting down for future reference animal migrating patterns. French archaeologist and paleontologist Henri Breuil (1877–1961) was famous for his studies of prehistoric cave art, particularly those discovered at Altamira, in what is now Spain, and Lascaux, in what is now France, interpreting rock paintings as being hunting magic, meant to increase the number of animals killed by hunting parties.

Yet another theory suggests that cave art was a method that early humans used to help cope with the constant struggle for survival – surely one of the earliest forms of self-help!

Whatever their purpose and whether or not their creation was meant to determine something greater and more powerful than the images themselves, one cannot ignore the sheer depth of creativity that was demonstrated by the artist, and perhaps the pleasure and pain they felt at the time of their concept.

The Pictograph

Cave paintings are a form of rock art. Rock art itself is a term in archaeology for any manmade markings on natural stone, most often referring to markings and paintings on rocks made by Paleolithic and Mesolithic human beings. Rock art itself can be found across the globe, the product of many different cultures. Cave paintings fall under the category pictograph or pictogram, a symbol representing a concept, object, activity, place, or event by illustration. Pictography allows this expression to develop further, with a form of writing in which ideas are relayed through drawing. The drawings and their ultimate survival over the ravages of time, not forgetting the 'canvas' of stone on which they were made, is attributable to the use of mineral pigments, most commonly manganese, hematite, malachite, gypsum, limonite, clays, and various oxides. The red colors within a painting were made with iron oxides (hematite), whereas manganese dioxide and charcoal were used for the black.

What is believed to be the world's oldest drawing is contained on a 38.6-mm-long flake of silcrete (a fine-grained cement of sand and gravel), comprising a few reddish lines drawn on one smooth, curved face using an iron-rich pigment called ochre. Working at the Blombos Cave in the Blomboschfontein Nature Reserve, about 300 km east of Cape Town, South Africa, an archaeologist noticed the markings while analyzing stone flakes and debris excavated from a 73,000-year-old layer of the site. According to Professor Christopher Henshilwood, an archaeologist at the University of Bergen, the lines on the flake might have been bolder and brighter when the drawing was new, but over time they've probably lost some pigment through weathering and wear. The design, which features six parallel lines, with three curved lines cutting across them at an oblique angle, would seem to indicate a complex piece of work, and probably a fragment of something originally drawn on a larger surface and later broken. This fascinating find involving cross-hatching is believed to be the earliest known drawing made by a human.

The most basic pictography would have seen the artist using wet clay or charcoal, applied to the wall by finger. The production of crayons or paints would have required minerals to have been finely ground and combined with binding materials. Apart from fingers, twigs were used as well as moss, horsehair brushes, and also bone or reed tubes through which the paint was literally blown against the wall.

The oldest known 'painting kits' used in the Stone Age were also unearthed at the Blombos cave in South Africa. Two sets of implements for preparing red and yellow ochres to decorate animal skins, body parts, and cave walls were excavated. The stone and bone tools were used for crushing, mixing, and applying the pigments, with the shells of giant sea snails utilized as primitive mixing pots. The sea snails were indigenous to the area, as the Blombos cave is situated on the southern cape of South Africa, near the Indian Ocean. Other bones, including the shoulder blade of a seal, were among the ingredients for making the pigments. It is thought that the bones were probably heated in a fire, and the marrow fat then used as a binder for the paint. Water or urine was added to make the paint more fluid.

According to Henshilwood, the cave artists used small quartzite cobbles to hammer and grind the ochres into a powder, which was then put into the shell and mixed with charcoal, burnt and broken bone, with a liquid or liquids then added. One of the most revealing finds came in the form of a front leg bone of a dog or a

wolf with one end dipped in ochre, leading the team to believe that it was in fact used as a primitive paintbrush!

One of the most common rock art elements found around the globe was that of the human hand. One such type of pictograph using the human hand was a technique that had been around since Neolithic times – simply spraying around the hand, resulting in a negative image. The more common positive print was often made with pigment applied to the hand and transferred to the rock.

The subject of the artwork varied greatly, but included the Aurora Borealis. Some of the drawings made by the Cro-Magnon people on the walls and ceilings of caves in southern France most probably depict the northern lights. These drawings date back 30,000 years (Figs. 2.1 and 2.2).

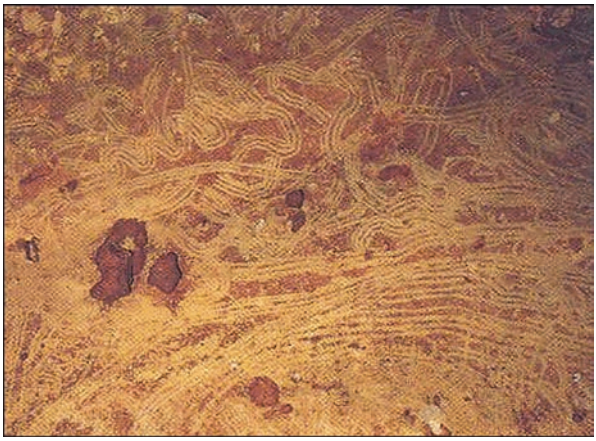

Fig. 2.1. Macaronis aurora drawings (Courtesy of NASA.)

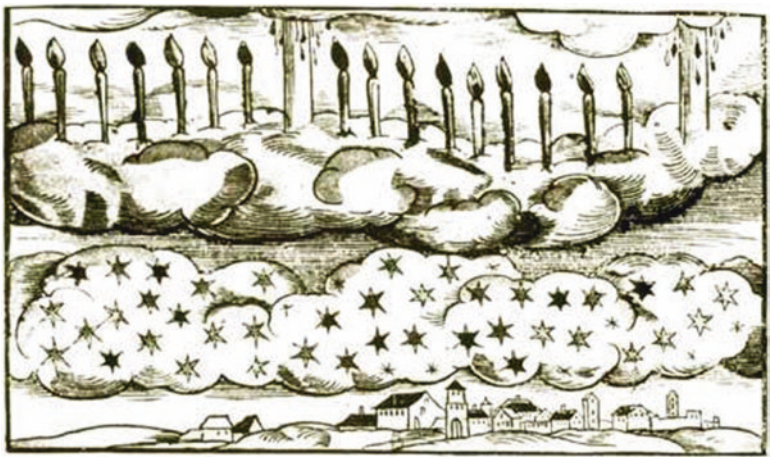

Fig. 2.2. Aurora drawings from 1570 (Courtesy of the Royal Edinburgh Observatory)

Knowledge of the Skies

In November 2018, researchers at the University of Edinburgh published findings that suggested prehistoric cave dwellers had quite a sophisticated knowledge of the skies, in particular the constellations. This would seem to suggest that there was much more to the artwork than just drawings of humans, animals, and the hunting that took place to find food to fuel everyday life.

The researchers, including Dr. Martin Sweatman, who helped lead the team and who co-authored the resulting scientific paper, studied a number of caves containing such artwork in Turkey, France, Spain, and Germany. The artwork showed a consistent set of symbols, keys if you will, revealing how ancient civilizations actually tracked astronomical events. With a distinct parallel between the animal-based shapes of our constellations and astrological signs, there is also a correlation between the animals and the placement of stars at a specific time. The researchers looked at examples of Paleolithic and Neolithic art throughout the four countries in order to decode the specific symbols that had been chosen to represent constellations and individual stars.

Dr. Sweatman, a professor at the University of Edinburgh, along with a team of researchers that incorporated teams from the University of Edinburgh and the University of Kent, then set about chemically identifying the paints that had been used, employing *Stellarium* software to compute the position of constellations at the relevant solstices and equinoxes. The results from the radioactive carbon dates and the *Stellarium* calculations revealed some consistent findings. The cave art reveals that, in essence, humans from as long as 40,000 years ago appeared to have accurately kept track of time by watching how stars slowly change their positions in the night sky. This phenomenon, known as precession of the equinoxes, is caused by a gradual shift of Earth's rotational axis. The discovery of this motion was previously credited to the ancient Greeks thousands of years later, but upon deciphering the cave art, we know this dates back considerably further. Indeed, generally credited to Hipparchus of ancient Greece in the second century B. C., the researchers' findings show that the same constellations, and indeed precession, were known some 35,000 years earlier.

At every site visited, the cave artists practiced a method of timekeeping based on astronomy, despite the fact that the paintings were found in four different countries and separated in time by tens of thousands of years.

The findings confirm a greater level of understanding among our primitive ancestors than was previously thought. What was being depicted with a concurrent theme throughout the examined cave art was a method of record keeping that, by its limited complexity, revealed that ancient humankind actually had much better understanding of the night sky than they were originally given credit for. Furthermore, the understanding of the skies would also suggest a greater than expected knowledge of the seas, with stars and constellations used as navigation tools, which, in turn, would have aided prehistoric human migration.

Such findings about the level of understanding would also give credence to the notion that, as a parallel, early cave art actually shows such a level of advancement with regard to understanding of the night sky within the last ice age; on an intellectual comparison, there is very little difference between those who existed then and modern-day humankind.

Gobekli Tepe

Working alongside colleague and co-author of the scientific paper Alistair Coombs, Sweatman decoded artwork at Gobekli Tepe, an ancient Turkish archaeology site, 6 miles from Urfa, an ancient city to the southeast.

The site was first extensively examined by University of Chicago and Istanbul University anthropologists in the 1960s. As part of a survey that swept through the region, they visited Gobekli Tepe (which means "belly hill" in Turkish), sighting some broken slabs of limestone and assuming that the mound was nothing more than an abandoned medieval cemetery. Later, Klaus Schmidt, a German archaeologist, revisited the site, taking more of an interest in what was found at the location. Schmidt discovered massive carved stones about 11,000 years old, crafted and arranged by prehistoric people who had not yet developed metal tools or even pottery.

The megaliths, which predate Stonehenge by some 6000 years, led Schmidt, who had been working at Gobekli Tepe for more than a decade, to claim that this was the site of the world's oldest temple. With Gobekli Tepe considered to have dated from roughly around 11,000 в. с., based on the insights into the astronomy observed at the site.

Sweatman and Coombs claim that an ancient stone pillar at Gobekli Tepe, referenced as Pillar 43 of Enclosure D, depicts on its west-facing side the commemoration of a devastating meteor impact in North America that led to the Younger Dryas Event, a period of sudden climate cooling that triggered a mini ice age across the northern hemisphere. The date carved into the stone, widely known as the Vulture Stone, can be deciphered as 10,950 в. с., within 250 years of the impact. The date was written using the precession of the equinoxes, with animal symbols representing star constellations corresponding to the four solstices and equinoxes of that year.

Ice core samples taken from Greenland add weight to the evidence that suggest a comet may have led to the onset of the Younger Dryas Event, which lasted approximately 1000 years and had a distinct global cooling effect.

Lascaux

Situated near the village of Montignac, in the Dordogne region of France, is a complex of caves known as Lascaux (French, *Grotte de Lascaux*), where over 600 parietal wall paintings cover the interior walls and ceilings. Alongside the 600 paintings are 1500 engravings. The paintings represent primarily large animals with flora and fauna corresponding to fossil records dating from the Upper Paleolithic time. This time period is the third and last subdivision of Paleolithic, or the Stone Age, broadly incorporating the period between 50,000 and 10,000 years ago (the beginning of the Holocene epoch), before the advent of agriculture.

Unlike other caves, Lascaux, whose protective layer of chalk had made it watertight, had been completely sealed for so long that even today debate remains about how the prehistoric artists entered the caves to draw upon and engrave its walls.

The entrance to Lascaux was discovered on September 12, 1940, by a teenager named Marcel Ravidat (1923–1995), who upon making the discovery returned to the scene with three friends, Jacques Marsal, Georges Agnel, and Simon Coencas. Here, in an attempt to rescue their dog, who had fallen into a hole while chasing a rabbit, the teenagers entered the cave through a 15-m-deep shaft at the end of which was revealed the now famous gallery of ancient artwork. The hole that the dog had fallen down had been

created the previous winter, when a tree in the oak woods was uprooted by a storm, tearing away several feet of Earth.

The story of Marcel Ravidat's black and white dog, named Robot, falling down a hole doesn't appear to be the only explanation as to how the caves were discovered. Other sources believe Marcel, at the time, an 18-year-old apprentice garage mechanic, along with his friends, were actually out searching for a fabled underground passage that led to a nearby chateau!

The galleries have since been given names, including the Hall of Bulls, the Passageway, the Shaft, the Nave, the Apse, and the Chamber of Felines. The artwork and drawings at Lascaux are the combined effort of many generations, and because so many have contributed to the vast number of works, much debate still surrounds the dating and whose input we are actually witnessing.

The Shaft scene features a dying man with a horse, bison, bird, rhinoceros, and geometric shapes surrounding him. Though this mural was once interpreted as an abstracted narrative about life and death, the findings of Sweatman and Coombs suggest that the scene does in fact commemorate a comet strike on Earth that occurred around 15,200 B. C. Sweatman and Coombs believe the artwork depicts a major damaging event, in which debris that heralded from the direction of Capricornus, namely remnants of a comet that fuel the Taurid meteor stream, impacted on Earth. The interpretation supports the theory of "coherent catastrophism," which, according to Sweatman, describes how a large comet became trapped in the inner part of our Solar System many thousands of years ago, creating a stream of debris that intermittently collides with Earth, albeit on an irregular basis.

3. Other Ways the Ancients Kept Astronomical Records

Ach Valley Tusk Fragment

Besides the speculation and conjecture that many cave drawings have sparked, such artwork is not the only form of potential record that exists from ancient times. One piece of art in particular that has caused similar debate is known as the Ach Valley tusk fragment.

Although the cave drawings have shown that astronomical phenomena that we can all relate to, the problem remains as to identifying the motive as to why it was recorded and establishing which event it may be symbolizing. Indeed, there is a danger of overcomplicating by trying to parallel any event in the night sky with such art, but whereas in modern day astronomy liberally photographing parts of the sky may be done simply for sheer interest or to test the capabilities of a camera, the motive from bygone years did not have a casual motive attached; it seems to have been done for more of a definite reason, like an eclipse, or the appearance of a bright comet, something that stirred whoever drew the art to record it.

Therefore, it would stand to reason that all recorded artwork of this nature had to have a given connection to an event, a happening, something that may have instilled a combination of fear and curiosity to the point where the event needed to be recorded. However, as a counterbalance to that argument, one may point out that there are numerous drawings and artwork that depict everyday life, including animals, certainly an aspect of life that did not occur on a random basis, like the outburst from a supernova.

The Ach Valley tusk fragment moves this argument onto a different level, as its creation and what it is supposed to represent throw light onto a different dimension on how the night sky was viewed, and proved that besides drawings, sketches, and colorful cave art, there are other ways to capture the night sky.

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Discovered inside the Geibenklosterle cave in the Swabian Alps of southwestern Germany, the Ach Valley tusk fragment bears the image of an upright figure thought to represent the constellation of Orion the Hunter. Could it be that this artifact carved into a mammoth ivory fragment during the Ice Age is actually the representation of a constellation, and not just the depiction of a person from that era? Is it perhaps not just an excellent example of skill and workmanship from the Ice Age – how one being was able to capture another in such distinct detail? If it is a carving of Orion, it would make for the oldest known depiction of a star map, with an age in excess of 32,000 years.

The carving measures 38 mm × 14 mm × 4 mm and was discovered inside one cave that makes up an entire complex of caves that were inhabited during the Upper Paleolithic epoch, which lasted from about 50,000 to about 10,000 years ago. Excavations at the site revealed six different layers that correspond to six different periods of habitation by separate cultures, including the Aurignacian culture, of which little is known, aside from the established fact that its people were inhabitants of the cave about 32,000 years ago, and that, as a people, they were master carvers of mammoth ivory.

Associated with European early modern humans (EEMH), it is believed the Aurignacians originated from the earlier Levantine Ahmarian culture, considered to be the likely source of the first modern humans who migrated to Europe to form the Aurignacian culture, with the people known as Cro-Magnons. This term derived from the Cro-Magnon rock shelter in southwestern France where the first EEMH were found in 1868.

The Aurignacians were characterized by worked bone or antler points with grooves cut in the bottom. They used flint tools, including fine blades and bladelets, with a distinctly more refined approach to their workmanship. This, along with a great level of self-awareness, led archaeologists to consider the makers of the Aurignacian artifacts to be the first modern humans in Europe.

Beside the Ach Valley tusk fragment, figurines have been found depicting faunal representations of the time period including now-extinct mammals, such as mammoths, along with anthropomorphized depictions that may be interpreted as some of the earliest evidence of religion.

In the Vogelherd Cave in Germany, many 35,000-year-old animal figurines have been discovered, with one of the carvings, a horse, found among six tiny mammoth and horse ivory figures,

having been sculpted as skillfully as any piece found throughout the Upper Paleolithic. Other finds included bone flutes, harpoons and barbs, pendants, beads, ivory and stone spear points, arrow points, clubs, and scrapers. However, arguably the most impressive finds were the intricately carved statuettes, some of which consisted of women that became to be known as the Venus figurines. These figurines emphasize the hips, breasts, and other body parts associated with fertility. Feet and arms are lacking or are minimalized. Interestingly, there are fewer sculptures depicting men or figures of uncertain sex.

One such Venus figurine is known as the Venus of Hohle Fels, carved from mammoth ivory and unearthed in 2008 in Hohle Fels, a cave near Schelklingen in Germany. It has been dated to between 35,000 and 40,000 years-old, belonging to the Aurignacian period. The figure is the oldest undisputed known example of a depiction of a human being. In terms of figurative art, only the lion-headed zoomorphic (animal-shaped) Lowenmensch (lion-human) figurine is older, discovered in Hohlenstein-Stadel, a German cave, in 1939.

With such great workmanship evident from the Aurignacian period, there remains little doubt of the age of the Ach Valley tusk fragment and the peoples who sculpted the work. But where is the link to establishing the piece as being associated with the constellation of Orion? The theory was proposed by Dr. Michael A. Rappengluck, a well-respected academic with a background in astronomy and archeoastronomy, who, via a research paper, suggested that astronomer-priests in European Upper Palaeolithic cultures could 'see' constellations in the night sky, recording the findings in cave art, calendars, and sculptures such as the Ach Valley tusk fragment. Dr. Rappengluck's proposal was not a new one, with other academics also suggesting such a correlation.

Several factors when analyzing the Ach Valley tusk fragment would lend support to Dr. Rappengluck's proposal. Firstly, it is not a broken fragment but a complete fragment in itself, not part of a greater work. The carving clearly portrays a man-like figure with outstretched arms, a pose that is a match to the stars of Orion.

The notches on the back side of the Orion figure are a primitive pregnancy calendar for predicting when a woman will give birth. In total, there are 86 notches, which is the number of days to be subtracted from the day count of one year to arrive at the average number of days in the human gestation period, 86. The number is also the number of days that Betelgeuse, one of Orion's two most prominent stars, is visible to the naked eye each year. However,

the premise of notches and numbers must be an open item for consideration when debating the likelihood of an association between the carving and Orion, for it dictates that the Aurignacian culture could count and had a basic grasp of arithmetic with a general understanding of its mechanics, and also that they knew how many days there were in a year. One of Dr. Rappengluck's claims was that the 86 notches on the carving represents the number of days that one of Orion's principal stars, Betelgeuse, is visible, this forming a link between the sky gods and human fertility.

The tusk fragment figure has arms raised and legs spread apart, with what appears to be a sword hanging between his legs. His left leg is shorter than his right leg, exactly as the constellation depicts Orion, with the tiny waist of the tusk fragment mirroring the bright stars in the belt of Orion. In order to simulate the stellar positions of the stars in Orion over the past thirtieth centuries, Dr. Rappengluck used advanced planetarium software to "wind back" the years to where the stars in the constellation would have been at the time the fragment was actually carved. The results showed a perfect match between the planetarium software and the carving.

The correlation, striking as it appeared, was still not absolute proof, and perhaps one of the factors for unraveling the whole idea lies within other artifacts found in the Geibenklosterle cave. Among the findings were hundreds of small, carved figurines of mammoths, bears, and other animals. One animal depicted was what appeared to be a bison, displaying such lavishly attended to details as horns and beard, but it's the size of the carving that demands more scrutiny.

Measuring only 25.5 mm × 14.5 mm × 6 mm, the carving is comparable to the dimensions of the human-like figure allegedly representing Orion, which begs the question, why were no similar comparisons made between the bison figure to represent another notable constellation, that of Taurus, or indeed, any other constellation? Furthermore, given the range of objects detailed in the find, surely there should be at least several more parallels drawn between objects discovered and phenomena observed in the night sky by the people who made the carvings?

Aside from the lack of other parallels made between findings and the night sky, a question mark can be firmly placed against the identification of Orion's sword. Astronomers viewing the night sky with no optical aid, even today, must envisage such a sword as there are no clear observational criteria to point out such a thing,