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Beneath the Night

How the stars have shaped
the history of humankind

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The next time it's a cloudless night, step outside and find somewhere dark. It should be well away from streetlights, trees and buildings so that you can get the best possible view of the night sky – but don't raise your gaze immediately. It will take thirty or forty minutes for your eyes to fully adjust to the dark. During that time, they will become from ten thousand to a million times more sensitive to light. Perfect for stargazing!

Once the time has elapsed and you have found your spot, look up. Depending on the atmospheric conditions and the sensitivity of your eyes, you will be able to see some three or four thousand stars, each one a distant sun in its own right. Each one a possible home to a family of planets.

In most people, this experience tends to bring about feelings of tranquillity and reverence, and often a sense of their own insignificance. Even having spent my entire life studying the night sky, the sight of it never fails to fill me with awe and excitement. As I've sought to understand the stars and come to terms with the sheer vastness of it all, I've lately come to realise that it is not the number or the nature of the stars that is the most enchanting thing about them. It is that, compared to our brief lives, the stars are immortal.

Shakespeare saw the same stars in the same patterns that we do. So did Galileo, Columbus, Joan of Arc, Cleopatra, and the first man-ape to look up in curiosity. From space

age back to stone age, to be beneath the night is to witness something that every other human who has ever lived has also seen. It is our common heritage.

This book is a history of our relationship with the night sky. More than a book about our understanding of astronomy, it is the story of how our fascination with the heavens has shaped society, culture and religion as well as science. Beyond enabling our scientific understanding of the universe, the stars have inspired our poets, artists and philosophers; given us a place to project our hopes and fears; revealed our true origin and hinted at our ultimate fate.

The very fact that we look to the night sky in our search for meaning is one of the indelible hallmarks of our humanity. As this book will show, to tell the story of this nocturnal fascination is to tell the story of what it is to be human.

There is no definitive theory as to how or why humans began to relate to the night sky. But there is a growing body of evidence from a number of different disciplines that suggests it is at least plausible to believe our fascination with it started almost as soon as recognisably modern humans evolved, almost seventy thousand years ago.

The modern impetus to look this far back in prehistory comes from the work of an American journalist turned archaeologist called Alexander Marshack. As with much of the rest of the world at the time, Marshack's fascination with space began on 4 October 1957, when the Soviet Union succeeded in making a rocket powerful enough to launch the world's first spacecraft, Sputnik One. What makes Marshack stand out from many of his contemporaries, however, is that he wasn't just fascinated by the technological achievements of

the Space Age. His interest was primal: he wanted to know what had driven humans to want to 'touch' the night sky.

Five years later, in the autumn of 1962, President John F. Kennedy made his now famous speech at Rice Stadium in Houston, Texas, in which he committed the USA to landing a human on the Moon's surface before the decade was out. Marshack set out to write a book similar to that which you're reading now, in an attempt to explain how – and, crucially, *why* – humankind had reached the point in history where it was possible to bring such a mission into reality. But as soon as Marshack began his research, he found it 'an almost impossible task'.[1]

He spent much of 1963 travelling across America interviewing people involved in the burgeoning field of space exploration. His interviewees included many of the pre-eminent experts of the time, such as President Kennedy's science adviser Dr Jerome Wiesner, NASA's chief administrator James Webb, representatives of the National Academy of Sciences and the Air Force, and numerous academics. He also spoke to their counterparts in the Soviet Union. But no one could give him a definitive answer to the simple question of *why* humankind was exploring space. It was as if the urge to do so was a basic human compulsion.

And, indeed, examples of this particular compulsion resonate through history. In 1596, the great German mathematician and astronomer Johannes Kepler wrote:

We do not ask for what useful purpose the birds do sing,
for song is their pleasure since they were created for singing.

Similarly, we ought not to ask why the human mind troubles to fathom the secrets of the heavens … The diversity of the phenomena of Nature is so great, and the treasures hidden in the heavens so rich, precisely in order that the human mind shall never be lacking in fresh nourishment.[2]

Even further back, around 2,400 years ago, the Greek philosopher Plato wrote his classic work *The Republic*. In Book VII, he hypothesised that our eyes were formed for the study of the night sky, but that rather than letting its sheer beauty beguile us, we should exercise our minds to understand the order behind the celestial arrangements. Again, Plato's implication is clear. The reason we should study the night sky is the same one that British explorer George Mallory gave when asked why he wanted to climb Mount Everest: 'Because it's there.' Kennedy even used Mallory's quote in Houston for the reason why America should land on the Moon.

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To try to explain the emotional draw of the night sky, Marshack first tried to identify when our fascination with it began. This search took him back to the time before civilisation and agriculture, before history itself, to when humans lived in hunter-gatherer communities tens of thousands of years ago. Instead of a book about space, he ended up writing one about the prehistoric origin of human science and culture – and the pivotal role that the night sky played in our awakening. As his wife was quoted as saying in his 2004

New York Times obituary: 'He was so intrigued that he left the space age and went back to the ice age.'

The ice age in question was the one that gripped the world from 2.6 million years ago to just twelve thousand years ago. During that time, most of northern Europe was submerged beneath the arctic ice sheets, and the glaciers of the Alps reached far beyond their modern boundaries. It was also during this period that various species of humans emerged as distinct from the other great apes. This process began in Africa around 2.3 million years ago with the appearance of *Homo habilis*, and culminated approximately 200,000 years ago with the arrival of our own species, *Homo sapiens*. However, the tipping point for our story did not come until another 130,000 years after the arrival of our species, when something truly special happened: we began to think differently.

No one knows why this should have happened. It could have been some random mutation in our DNA that suddenly allowed our brains to perceive the world in more abstract ways, or it could have been a gradual process that began much earlier with the appearance of *Homo sapiens*.[3] Whatever the trigger, by seventy thousand years ago, the so-called human revolution was complete.[4] And despite the tens of thousands of years that have since elapsed, it is thought that there is no essential difference between current humans and our ancestors from that period. Their brain power was the same as ours, their ability to reason was the same as ours, and so too their curiosity and capacity to dream. All these primitive humans lacked was the knowledge that we have now accumulated. But the fossil record shows that they were learning fast.

By around forty thousand years ago, a human population of some five million (as compared to today's eight billion) had spread from Africa across the globe. Archaeologists identify this period as the Upper Paleolithic. It extends from around fifty thousand to ten thousand years ago. As hunter-gatherers, the humans of this era obtained their food by the collection of wild plants and the trapping of wild animals. In the artefacts left behind we can see the development of logical thought that leads to technology: oil-lamps, boats, bows and arrows, sewing needles. And there are more than tools on offer.

Art was also born in this period. The earliest undisputed pieces that display creative thinking date to around forty thousand years ago and were found in the Hohle Fels ('hollow rock') cave near Schelklingen, in the Swabian Jura region of Germany. They include figurines such as the Venus of Hohle Fels and a 'flute' made from a hollow vulture bone. In the nearby Stadel cave, a similarly ancient ivory figurine of a lion was found. Carved from the tusk of a woolly mammoth, what sets it apart is that the lion is standing on its hind legs in a human pose. So, the lion-man of Stadel suggests that the artist had an imagination that could conceive of things that do not exist in reality – in this case a lion-human hybrid.

But what captured Alexander Marshack's imagination was a ten-centimetre-long piece of fossilised baboon bone that had been found in the ruins of Ishango, an ancient Congolese village on the shores of Lake Edward. Unearthed in 1960 by Belgian archaeologist Jean de Heinzelin de Braucourt, it was around twenty thousand years old and notable because it had been carved in a rather unaesthetic

way with a multitude of notches. Although they are hardly a work of art, neither do they appear to be random. They are grouped into three distinct regions. The first contains sub-groupings that hold 11, 13, 17 and 19 lines; the second grouping reads 3, 6, 4, 8, 10, 5, 5 and 7; while the third reads 11, 21, 19 and 9.[5]

Describing the find in *Scientific American*, de Heinzelin pointed out that the first group are prime numbers between 10 and 20.[6] The third group represent a mathematical pattern: 10+1, 20+1, 20-1 and 10-1. But the second group defied his ability to find order. Despite this failure, he speculated that it could have been carved by someone who was playing some sort of arithmetical game. Marshack balked at this interpretation. To him, the scratches looked more like tally marks – but tallies of what?

Marshack remembered a paper he had read about modern hunter-gatherer societies, such as the Kalahari bushmen of Africa. In that work, the authors described how those societies have some knowledge of reckoning the passage of time by using the stars and/or the Moon.

The night sky is perfect for this purpose. Firstly, the days are related to the Sun and the way its movement heralds day and night. The year and its seasons are clearly related to the stars and the way the constellations change their position over a twelve-month period. The month, in its simplest form, refers to the time it takes for the Moon to complete a four-week cycle of its phases. The waxing phase from new moon to full moon takes about fourteen days, punctuated one week in by a half moon. The same, in reverse, is true of the waning phase.

The similarity of the words month and Moon is no coincidence, either. Although the etymology of the words is complex, they do share an origin in the Latin word *metiri* (to measure). This would suggest that the Moon has been well established as a yardstick for the passing of time for more than two thousand years.

Marshack wondered if this usage extended back into the Upper Paleolithic. Specifically, he wondered if the Ishango bone was a tally of the phases of the Moon. If so, that would make it the world's oldest known calendar and would suggest that the earliest known relationship that humankind had to the night sky was one of practicality: they used it as a clock.

It would also mean that we began our relationship with the night sky almost as soon as we possibly could: during the great human revolution when our ancestors first thought about the world around them, about how to live in it and the meaning of their place in it.

Marshack set to work to test his hypothesis and came up with a convoluted system that did indeed appear to correlate the scratch marks to the phases of the Moon. But to do so meant assuming that whoever carved the bone had grouped the lunar observations into two sequences of sixty days, and one of forty-eight days, when there was no clear reason why someone would do this. As a result, while his interpretation of the Ishango bone is a compelling idea, it could hardly be seen as conclusive. Indeed, since Marshack other researchers have suggested alternative interpretations that range from the extraordinary (a stone age 'slide rule') to the mundane (a tally of goods).

Seeking further evidence for his theory, Marshack sought out other similarly notched artefacts from the Upper Paleolithic period, eventually publishing his findings in *The Roots of Civilization* in 1972. Though his work was controversial, with a common criticism arguing that it was too speculative, he has nonetheless been an inspiration to subsequent researchers, who continue to look at artefacts and other markings for possible astronomical interpretations. And while it is clear that proving this point from the archaeological data alone is a difficult task, the general feeling persists that Marshack's theories do have some merit, and other artefacts found since have only added further weight to his argument.

One of these is an elephant's tibia found at the prehistoric site of Bilzingsleben, in Thuringia, Germany. It had been carved with a total of twenty-one parallel lines in two groupings. One grouping contains seven lines, the other fourteen, but the bone is broken. The palaeontologists who found it, Dietrich and Ursula Mania, proposed that the missing piece could contain a mirror of the first group of marks, bringing the total number to twenty-eight, a number that immediately reminds us of the lunar month. If so, the bone could mark the seven days from new moon to waxing half moon, then the fortnight through full moon to waning half moon, and the final seven days that lead back to new moon. Even though this interpretation is highly speculative, such an artefact would not usually stand out from any of the other putative lunar calendars if it were not for the fact that it is much older. Rather than tens of thousands of years, the elephant bone has been dated to

between 350,000 and 250,000 years old.[7] Mind-blowingly, this places it before the human revolution, before even the evolution of *Homo sapiens* and back into the time of *Homo erectus*, an earlier species of human.

While by no means conclusive, the Bilzingsleben bone and the artefacts studied by Marshack certainly offer tantalising evidence for the notion that Palaeolithic people kept track of the night sky. But accepting this leads to a larger mystery: why? What motivated these early humans to do this?

The various answers to this question suggested by scholars over the decades usually fall into one of two categories: practical or religious. According to the practical school of thought, the night sky was studied because it could be used to mark the passage of time. At the opposite end of the spectrum, the religious theorists postulate that the emotion of awe we feel when we look at the night sky transforms into a need to worship it. So we study the various movements of the Sun, the Moon and the other celestial objects to venerate them as gods.

However, neither suggestion really works: both impose a false dichotomy between religious and practical motivations that fails to capture the broad range of human thinking. Remember that those early *Homo sapiens* had the same brain power that we do. Their minds were capable of every emotion and desire that flows through us today.

So let's reframe the question. Considerable effort is needed to observe and painstakingly record the night sky for nights, weeks, months, even years on end. This is true today, and would have been truer still in a hunter-gatherer society where free time was at a premium. There must, therefore,

have been some strong *societal* advantage to doing so. What might that have been?

For an answer, we can turn to the modern-day hunter-gatherer societies and the work of the ethnographers. Ethnography is the observation of a society's culture. Since it is impossible to travel back in time to the Upper Paleolithic and observe the hunter-gatherer tribes that roamed the Earth, the next best thing is to observe those who still live like this today. If these modern hunter-gatherer societies use astronomical knowledge for societal benefit, it would provide a compelling argument in favour of the theory that so too did the hunter-gatherers of the Upper Paleolithic.

There are an estimated one hundred uncontacted tribes in the world, mostly found in Amazonia and New Guinea.[8] They mostly manage to avoid contact with the outside world and often meet any encroachment with hostile force. So ethnographers are forced to choose others who are more receptive to contact, yet have shunned the trappings of the modern world. Of these, there are many dozens.

Next, ethnographers split hunter-gatherers into two subgroups: simple and complex. Simple hunter-gatherer groups are those with low population densities. They are completely egalitarian, with no social hierarchy and with all resources being completely shared. Their counting systems do not extend beyond a few tens.

Complex hunter-gatherer groups tend to arise when the density of people increases. In these societies, there is an emerging hierarchy, usually to do with surplus of food; those families who produce the most have a higher status than the others. There is also a tendency in these groups for families