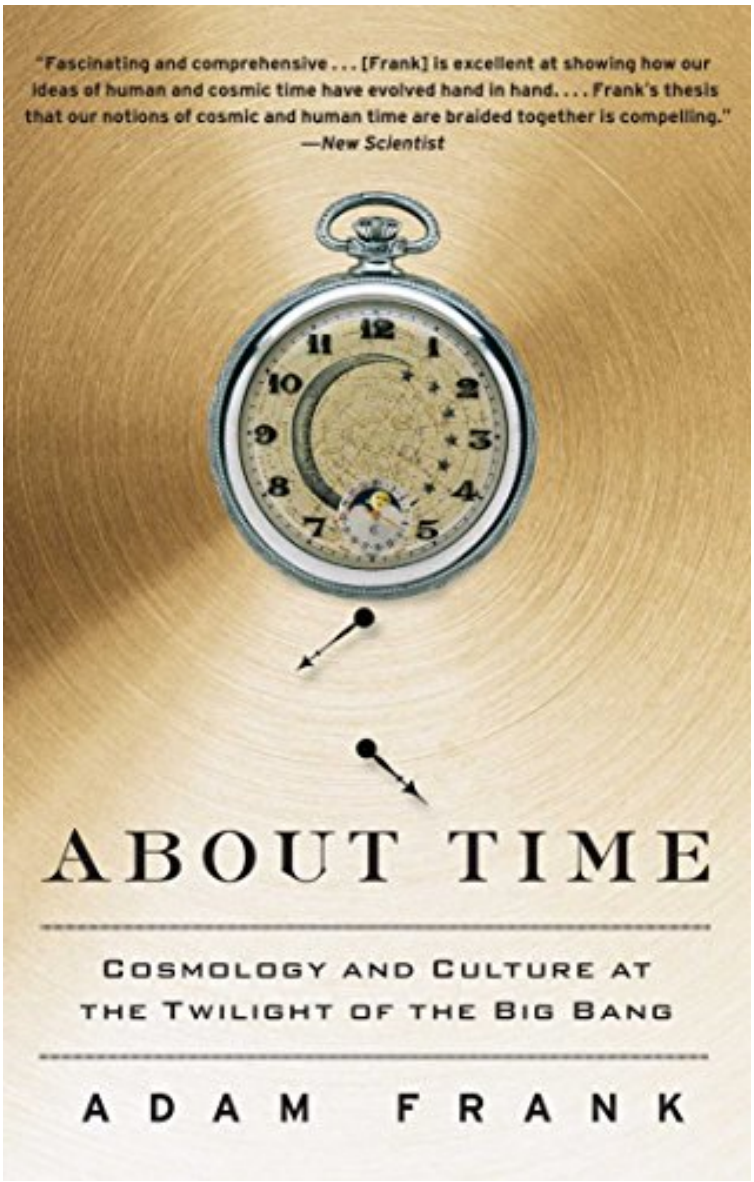
About Time: Cosmology and Culture at the Twilight of the Big Bang (English Edition)



Par Adam Frank
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(Mobile pdf) About Time: Cosmology and Culture at the Twilight of the Big Bang (English Edition)

Par Adam Frank : About Time: Cosmology and Culture at the Twilight of the Big Bang (English Edition) before purchasing it in order to gage whether or not it would be worth my time, and all praised About Time: Cosmology and Culture at the Twilight of the Big Bang (English Edition):

Description :

Prsentation de l'diteurThe Big Bang is all but dead, and we do not yet know what will replace it. Our universes beginning is at an end. What does this have to do with us here on Earth? Our lives are about to be dramatically shaken againas altered as they were with the invention of the clock, the steam engine, the railroad, the radio and the Internet. In The End of the Beginning, Adam Frank explains how the texture of our lives changes along with our understanding of the universes origin. Since we awoke to self-

consciousness fifty thousand years ago, our lived experience of timefrom hunting and gathering to the development of agriculture to the industrial revolution to the invention of Outlook calendarshas been transformed and rebuilt many times. But the latest theories in cosmology time with no beginning, parallel universes, eternal inflationare about to send us in a new direction. Time is both our grandest and most intimate conception of the universe. Many books tell the story, recounting the progress of scientific cosmology. Frank tells the story of humanitys deepest question when and how did everything begin?alongside the story of how human beings have experienced time. He looks at the way our engagement with the world our inventions, our habits and morehas allowed us to discover the nature of the universe and how those discoveries, in turn, inform our daily experience. This astounding book will change the way we think about time and how it affects our lives.ExtraitChapter 1TALKING SKY, WORKING STONE AND LIVING FIELDFrom Prehistory to the Agricultural Revolution ABRI BLANCHARD: THE DORDOGNE, FRANCE 20,000 BCE The shaman stands before the opening of the cave and waits. Night is falling now and the piercing cold of autumn easily penetrates her animal-hide cloak. Outside, beyond the sheltering U-shaped bay of low cliff walls, the wind has picked up. These winds originated hundreds of miles to the north at the blue-white wall of glaciers that cover much of northern Europe.1 Winter is coming and the shamans people will have to move soon. The hides and supplies will be gathered and they will begin the trek toward the low-hanging sun and the warmer camps. But tonight the shamans mind is fixed on the present and she waits. It is her job to read the signs the living world provides. It is her job to know the turnings of Earth, animal and sky. The shamans people depend on this wisdom and so she waits to complete the task her mother suggested before she died. She waits, massaging the reindeer bone fragment in one hand and the pointed shard of flint in the other. Now she sees it, the glow over the eastern horizon. The great mother rises. The shaman waits to see the moons facepale, full of power. There, see! She is complete again. From the crescent horns of many days ago, she has now returned, completed, to life. The full circle of the moons face, promising rebirth and renewal, has returned. The shaman holds the bone fragment before her in the gray light. With her index finger she traces out the long serpentine trail of her previous engravings on the bone. Then at the end of the trail she makes tonights mark with the flint-knife, carving the shape of tonights full moon into the hard bone. Two rounds of the moons dying and rebirth have now been traced out. The shamans work is complete. The round of life and death in the sky, like the rounds of womens bleeding, have been given form, remembered, noted and honored. She returns the bone to its place beneath the rocks where she keeps the other shamanic tools her mother gave her so long ago. Now she has added to the store, a marking of passages, that she will use and pass on to her own children.2 WANDERING TIME: THE PALEOLITHIC WORLD The origins of human culture are saturated with time but we have only recently learned to see this truth. The evidence of the age when we grew into an awareness of ourselves, the cosmos and time itself had always been just out of reach. For most of our remembered history, the clues to the birth of culture and cultural time lay forgotten, buried a few feet below the ground. Then, in the late 1870s, the discoveries began and we started to remember. We first encountered the great awakening of our consciousness in 1879 in Spain when the nine-year-old daughter of amateur archeologist Marcelino Sanz de Sautuola led him to a cave at Altamira. Venturing inside, he found its walls covered in vivid paintings now known to be twenty thousand years old. As archeologists began systematic explorations, new caves were discovered, many of them also covered in paintings. The caves are a bestiary: bear, bison and mastodon appear on the walls along with other species. Sometimes these animals appear alone. Other times they are in herds. Sometimes we appear toohuman figures set against the herd, spear at the ready. These paintings gave voice to a heretofore silent past, showing that early humans were anything but savages incapable of representation, abstraction or response. This vivid prehistory, the time before written records, was set into a temporal sequence through painstaking work across the twentieth century. Radiocarbon dating allowed scientists to see when each cave was inhabited and when the paintings were laid down. As the sequence became complete, scientists came to understand how rapidly our ancestors had reimagined what it meant to be human. With that recognition, conceptions of evolution and the origins of the human mind were thrown open. Scientists began searching for some purchase on a new theory that could explain how the mind rapidly woke to itself and to time. Buried next to the painted walls, archeologists discovered artifacts worked by human hands. There were statues of women with wide hips, pendulous breasts and finely articulated vulvas, seeming to focus on the mysteries of fertility. Spear points, needles, flint daggers and hammers spoke of cultures skilled in the creation of a diverse set of tools for diverse needs. And on the floor of a cave at Abri Blanchard, a rock shelter in the Dordogne region of central France,3 archeologists found a small flat ovoid

piece of bone pockmarked with stokes and notches . . . just the right size to be held in the palm of the hand.4 The Abri Blanchard artifact would sit in a French museum for decades until amateur archeologist Alexander Marshack chanced upon it. Marshack was a journalist hired by NASA in 1962 to recount the long human journey leading up to the Apollo moon landing program. In his efforts for NASA, Marshack dug so deeply into the history of astronomy, he found himself at the very dawn of human time. He first became obsessed with the Abri Blanchard bone when he encountered it, as part of his NASA project, in grainy illustrations of forgotten archeology tracts. Eventually traveling to the imposing Muse des Antiquits Nationales near Paris, he found the small artifact all but ignored in a musty . . . stone chamber among accumulations of Upper Paleolithic materials, crowded under glass with their aged yellowing labels.5 Marshack dedicated years of intense study to the Abri Blanchard bone fragment, rejecting the accepted wisdom that the notched carvings were nothing more than early artistic doodling. He traced over the curved trail of finely etched crescents and circles again and again. Finally he discovered a pattern echoing his own interests and his ongoing studies of the moons impact on human life, time and culture. In 1970 he published a closely reasoned and convincing argument that the etchings on the bone fragment were one of the earliest tallies of times passage, a two-month record of passing lunar phases.6 Rather than random doodles, the creator of the Abri Blanchard fragment had been marking time in a systematic way, for perhaps the first time ever. In caves at other sites across the world, fragments of humanitys first encounters with time were also found. Sticks with sequential notches, flat stones engraved with periodic engravingseach artifact gave testimony to an increasingly sophisticated temporal awareness.7 It was in those caves, tens of thousands of years ago, that the dawn of time broke in the human mind.8 Scientists call this era the Paleolithicmeaning old stone age. The origins of human culture (and human time) occurred during the so-called Upper Paleolithic, from roughly 43,000 to 10,000 BCE.9 All human beings during this period lived as hunter-gatherers and left us no written records of their thoughts (writing would have to wait until around 4000 BCE). Through painstaking analysis and considerable imagination, however, scientists have pieced together the outlines of the Paleolithic human universe. Using the artifacts found at sites around the world and the narratives of contemporary hunter-gatherers, scientists have gained some understanding of these first modern humans. The Abri Blanchard bone fragment dates back from twelve to twenty thousand years ago, a time when the planet looked very different from the relatively warm, wet globe we now inhabit.10 It was an era when ice covered much of the Northern Hemisphere. France, as experienced by the unnamed paleoastronomer marking the moon at Abri Blanchard, was a realm of polar deserts, tundra and towering glaciers.11 Humans were scarce on the ground, and they struggled to endure the hostile climate. This was not the first time members of the genus Homo had endured climate change of this kind. Ice sheets had come and gone in the past, but something remarkable happened to Homo sapiens during the planets last deep freeze that would, in time, alter the face of the planet itself. Somehow the depths and deprivations of the last climatic winter drove our ancestors to make revolutionary leaps in behavior. It was early in this period that human beings began burying their dead. Later they invented art and music. Clothes were soon fashioned by sewing animal pelts together.12 People began to invent systems for counting and, most important, started to codify the passage of time.13 It is in this period that the modern mindwith its penchant for analysis and allegory, concretizing and abstractionemerged. Compared with earlier eras, the speed with which these radical changes swept through populations is startling and has led scholars to call the Upper Paleolithic the Big Bang of consciousness.14 Any understanding of the inseparable narratives of cosmic and human time must begin here, with the rapid expansion of consciousness that would one day embrace the very cosmos in which it was born. TIME OUT OF MIND: THE ORIGINS OF MODERN CONSCIOUSNESS The explicit recognition and representation of natures repeating patterns were radical developments in hominid evolution. Thus, to understand the emergence of time in the mind, we must first understand the emergence of mind. The hominid species that came before us faced challenges similar to those facing our ancestors. From the fossil record, it appears that the earliest versions of Homo sapiens may have overlapped for a brief time with both Homo erectus and Homo heidelbergensis.15 It is also clear that until a mere fifteen thousand years ago we were in direct competition with a group of hominids who were likely also the descendents of H. heidelbergensis, Homo neanderthalensisthe Neanderthals.16 This overlap with other species, particularly the Neanderthals whose brains were essentially the same relative size as ours, raises a pressing question: what spurred the Big Bang of consciousness in the Paleolithic era?17 It wasnt the environment that woke us up. In the long stretch of time before the Paleolithics cognitive revolution, the same challenges presented themselves over and over. Ice sheets grew and ice sheets retreated. Early hominid species adapted by changing behaviors as the

situation demanded. What was lacking, however, was rapid innovation and learning. The toolkit of the human species was impressive compared to that of nonhominid species: the domestication of fire, deliberately shaped stones for cutting and scraping.18 But the pace of innovation in the development of these tools and the mental processes likely used in their development seems positively glacial. The basic stone tools our ancestors used 1.5 million years ago look fairly similar to those used by their descendants a million years later. Almost no technological innovation appears over the course of thousands of generations.19 On the other hand, comparing the brute stone scrapers used in 100,000 BCE to the needles, harpoons, arrow points and axes developed in 20,000 BCE is akin to comparing a raft to a nuclear submarine. There are many competing theories for the rapid origin of the modern human mind. One of the most fruitful lines of research comes from evolutionary psychologists who, in the 1980s and 1990s, began thinking of the prehistoric mind as a kind of Swiss Army knife. From this perspective the mind is remarkably complex and does many highly specialized tasks that it can only have developed in response to very specific evolutionary pressures. Researchers Leda Cosmides and John Tooby have each argued that, like a Swiss Army knife, the mind has different bladesthat is, different cognitive modules.20 Each module adapted in response to specific challenges our hunter-gatherer ancestors faced 100,000 years ago. These modules come with their own data and instruction setsthey are content-rich. A Homo sapien child born fifty thousand years ago (or fifty years ago, for that matter) already had modules for hunting, social interactions, tool building and so on. Thus, each module comes hardwired with a considerable storehouse of data. There are compelling arguments supporting this claim. When a tiger leaps toward you from behind a rock, a mind built like a generalized computer sorting through all possible responses may not be the optimal evolutionary setup. A brain built like a Swiss Army knife, however, might very well provide the evolutionary adaptation to keep you alive. Given the notorious speed of hungry tigers, a Swiss Army knife mind with preloaded modules governing tiger recognition and the run-like-hell response would appear, on the face of things, to be a more successful evolutionary strategy.21 There is also compelling evidence for this type of hardwiring. According to some lines of research, we appear to be born with at least four distinct domains of intuitive knowledge. These content-rich modules govern language, human psychology, biology and physics. In each of these domains there is evidence that humans evolved with an internal guidebook of understanding, a degree of hardwiring imprinted by evolution, to help us deal quickly with communication, social interactions, the living environment and the behavior of the material world. Experiences of high school science classes may convince many people that they have no intuitive understanding of physics. Psychologist Elizabeth Spelke would disagree. Along with researchers such as Rene Baillargeon and others, Spelke has explored the notion of a preexisting folk physics innate to us all. Spelke has shown that even very young children have a clear understanding of the behavior of physical objects.22 Though childrens lives are built around (and depend on) interactions with other people, they can clearly distinguish the properties of people, other living things and inanimate objects. Most important, children seem to be born with concepts of solidity, gravity and inertia. From an evolutionary perspective, intuitive physics makes sense. From the flight of a projectile to the impact of two stones against each other, an intuitive grasp of physics serves as cognitive bedrock for learned skills such as tool making and weapon use. While the Swiss Army knife story of the minds evolution is powerfully suggestive, it is likely not the whole story. Archeologist Steven Mithen has argued that the architecture of the mindits specific cognitive structurehad to evolve in specific ways to drive the Big Bang of consciousness. In particular, Mithen sees the ability to move information between modules as the innovation that led to the modern mind and the all-important capacity for culturally invented time. Moving information between modules allows for metaphor and analogy, which are the essence of human creativity. When information is shared between modules, a lump of clay that is roughly in the shape of a human form becomes the spirit of a departed ancestor, some colored fluid splashed on a wall becomes a symbol for a bull felled in a fierce hunt, and markings engraved on a bone become a record of the moons phases. Mithen likens the developing mind to a building with different rooms, each housing a different cognitive module. The story of the minds evolution is a narrative of reworking its architecture. Only when the architectural plan of the human mind changed by removing walls between isolated modules could the rapid evolution of consciousness and culture begin. As Mithen puts it, In the [modern] mental architecture thoughts and knowledge generated by specialized intelligence can now flow freely around the mind . . . when thoughts originating in different domains can engage together, the result is an almost limitless capacity for imagination.23 This new architecture of mind did not, of course, emerge on its own. The fact that evolution instilled in us an intuitive physics means that one cannot ignore the physical aspect of the

developing mind. If, as Mithen imagines, channels are opened between modules to create culture, then there must also exist feedback loops where encounters with the worlds physical reality through culture amplify the opening of those channels. What we did with the stuff of the world that we found and shaped for our own usesbone, wood and reedchanged what we could do and what we could imagine. The mind that would eventually come to imagine and organize time was a product of the looped interaction between the physical world it encountered, the physical culture it created and the symbolic culture it imagined linking the two. It begins with the reindeer bone in one hand and the flint in the otherthe bones solidity in the palm, the rough feel of its edges on the fingers, the sharp bite of the flints point on the thumb. Then it rises in the mind to the realm of the symboliccarved notches on the bone fragment become a representation for shared experience that can be shown to others in the tribe. The leap between physical object and cultural creationthe idea of the bone and its markings as a symbolic notation of times passagecloses the loop. What began millennia ago continues today: the circulation between a physical encounter with the world, the cultural forms engendered by that encounter and the shape of consciousness determining how we think and what we experience. The evolutionary modules with their hardwired understanding of physics were a starting point. But what happened in the Neolithic was a braided process flowing between the outside world and the interior response. We can call this poorly understood but essential connection between the physical world and cultural invention enigmatic entanglement. Through this enigmatic entanglement, a remarkable dialogue between mind and matter was begunforever linking cosmic and human time together. CYCLES IN THE SKY: THE RAW MATERIAL OF TIME Human life is set against the natural rhythms of the sky. These celestial changes are the raw material of time. In the braided history of cosmological and cultural time there are four cycles most important to our development: the day, the month, the year and the periodic motion of planets. The Day The most fundamental astronomical period we experience is days journey into night and back again. Deeply imprinted in our biology as our circadian rhythms, the day/night, light/dark cycle sets the ebb and flow of our sleep and wakefulness.24 Concerning the day, we must recognize one vital point in order for our social history of time to make sense: the days length varies. The sun spends more time above the horizon during the summer than it does the winter. There is more daylightmore time to workin summer than in winter. Thus, the natural experience of the day, and the unnatural attempts to slice it up into precise divisions, runs into a conflict: what is one to do with the difference between the length of a summer day and that of a winter day? This conflict would eventually pit the facts of astronomy against the needs of culture. Should the days divisions be of fixed length or should they expand and contract with the season? This question is of no small importance if, for example, you are a guildsman paid a wage that depends on accountings of the days length. As we shall see, the astronomical/cosmological recognition of the day as a by-product of a spinning Earth emerged during a long transition. It is no accident that this transition accompanied the increasing economic need for an accurately metered day. The Month The next cycle imposed upon us by nature is the motion of the moon. The lunar cycle has two distinct aspects: a variable position in the sky (where you see the moon relative to the sun each day) and changes in its appearance (its phase). The synodic month, as the astronomers call it, begins with the phase called the new moon, which occurs when the moon crosses the sun in the sky. The synodic month lasts approximately 29.5 days.25 Since the moon shines only with reflected sunlight, a new moon is a virtually invisible moon. But as the days pass, the moon moves eastward in its orbit (relative to the suns position at noon) and we see the moons transformation from the sickle-shaped waxing crescent phase to the familiar D of the first quarter moon and then on to the full moon, the third-quarter moon and finally the waning crescent. Next to the day, the cycle of lunar phases defining the month is our most obvious and visceral experience of celestial time. Many moons was the preferred means of time reckoning for hunter-gathering cultures. Most early cultures kept lunar rather than solar calendars. Thus it was the round of the moons phases repeating themselves after approximately twelve or so cycles that defined a year. The moon provides an easily recognized measure of time cycles short enough to count but long enough to measure durations stretching across many days. It is a great loss to us moderns, with our skies lit up by electric light, that we rarely notice the moon and its passage through a cycle of phases. The Year The yearly cycle of the sunor seasonsis the longest repeating period imposed by the heavens that most people experience in a single life. Few of us are as intimate with the yearly changes in the suns position as we are with the daily solar turn of night into day. We may not pay close attention to those annual shifts, but we all feel the effect of the suns motion in the sky through the change of seasons. Everyone living in temperate climates knows the feeling of the sun beating down at noon on a summers day or of the feeble heat of the winter sun hanging low in the sky. Both experiences are

unconscious measurements of the suns movement through the sky over the course of a year. On its daily journey, the sun climbs higher into the sky during the summer than in winter. Here, higher means closer to directly overhead, a point astronomers call the zenith. The suns daily arc takes it from rising in the east to setting in the west. The changing height of the sun at noontime over the course of a year actually reflects a change in where it appears to rise and set on the horizon (though of course it is the Earths turning that creates this effect). Most of us are far too removed from the experience of the natural world to notice where on the horizon the sun rises and sets. Our ancestors, however, couldnt help but notice. Beginning in the depths of winter they watched morning after morningthe sun rising progressively further north on the horizon as the days passed. Then in the middle of summer the steady northward march of solar risings (and settings) would stop and reverse itself. The suns rising begins moving further toward the south on the horizon line until it reached a southern extreme and repeated the cycle once again. The seasons, the length of day and the strength of the suns warmth are all tied to this yearly cycle. The years shortest day (December 21 in the Northern Hemisphere) occurs when the sun rises at its southernmost point on the horizon; this is the winter solstice. The longest day comes when the sun is at its northernmost rising, called the summer solstice (June 21 on our modern calendars). The spring and fall equinoxes (September and March 21) mark days of equal length. The yearly cycle of long days turning to short days, warm months turning to cold months and growing seasons turning to seasons of decay has been the pulse of human life since we were hunter-gatherers. The direct connection between this lived, embodied experience of repeating celestial patterns made time and the sky intimate partners. But it was not only the sun that mattered; the stars themselves acted as the original cosmic metronome. Like a child being turned outward on a merry-go-round, we humans get a different view of the night sky in winter, spring, summer and fall as the Earth wheels around the sun in its orbit. The constellations we can see each night change with the seasons. By the era of the Greeks at least the ancients had mapped out the positions of the fixed stars on the starry sphere. They were smart enough to imagine the noontime sun set against that background of stars even if those stars were blotted out by sunlight during the day. In this way they knew the sun was tracking a path against those stars in a line called the ecliptic. They saw that the sun, the moon and even the wandering planets stayed close to the ecliptic as they moved across the sky. The twelve distinct constellations the sun passed through in its motion along the ecliptic were called the zodiac. The movement of sun, moon and planets against the fixed pattern of stars, along the ecliptic, was a cosmic dance that anyone could see before artificial light stole the night from us. The Periodic Motion of the Planets The final celestial period imposed on us is one that few other than astronomers would notice today. Each of the five visible planets (Mercury, Venus, Mars, Jupiter, Saturn) makes a slow march along to the ecliptic and against the background of fixed stars. Night after night each planet moves slowly through the constellations, speeding up and slowing down at different times in the year and for different durations. Each planet also steadily brightens and then steadily dims as it completes its motion against the stars. Strangest of all, each planet executes a loop in the skycalled retrograde motionhalting its usual eastward march in a short pirouette that takes on the order of a few months to complete. FALLING INTO TIME: THE PALEOLITHIC COSMOS The daily turn of night to day, the monthly cycle of lunar phases, the yearly journey of the sun through the zodiac and, finally, the strange wanderings of the planetseach of these celestial dance steps formed a raw physical encounter with time. It was seen on the sky and felt in the seasonal changes of warmth and cold. It is from this most basic experience that humans built their stories of the cosmos, its origin in time and its meaning for their lives. The world we inhabit today makes a clean separation between time in our daily experience and the scientifically defined time of our cosmology. No one today connects her 12:15 appointment at the dentist to the fractions of a second in which Big Bang cosmology plays out. Daily time is lived through the digital time on cell phones and our electronic calendars. Cosmological time is the domain of scientists, observatories and university graduate programs. This separation, however, is an illusion. The arc of cultural evolution has hidden the binding of human time and cosmic time from us, but in the Paleolithic world the separation never existed. The cosmos of our Paleolithic ancestors was of a whole, and that included time. The hunter-gatherer peoples of the Neolithic knew their place in the world, for they had yet to fully distinguish themselves from that world or its movement through time. Our understanding of the Paleolithic cosmos (and cosmology) relies on an understanding of myth. Myth, in this essential context, does not mean a false story (as in the urban myth of an old lady drying her poodle in a microwave oven). Myth, in the domains of cosmology, is far more essential and powerful. Every culture has its mythology, its potent narratives of origins and endings. To follow the roots of modern cosmological theorizing back in time to the imaginative territories of

prehistory we must turn to the universe of myth, for within it we will find the first responses to the mystery linking time and being. Myth came before all our forms of religion and before the practice of science.26 Its function was to recount sacred stories that set human beings into their proper context within the universe. In myth the experience of the world as sacred was codified into stories so old that they embrace the origins of both religion and science. As the great scholar of religion Mircea Eliade put it: Through myth, the World can be apprehended as a perfectly articulated, intelligible, and significant Cosmos.27 Thus it is through myth that the cosmos of Prehistory becomes apparent. Since our Paleolithic ancestors left no written records of their cosmological myths, archeologists must piece together their worldview from other materials. One important source is the repository of mythological narratives transcribed many millennia later, once writing was invented around 3000 BCE.28 These stories contain traces of the cosmological narratives of prehistory. The mythologies of existing hunter-gatherers, such as the Aboriginal people of Australia or the Inuit peoples of the Arctic, provide their own insights.29 From these sources a clear picture emerges of a cosmology that is dominated by ideas of a time without time, and the separation of elements once joined. The world of the hunter-gatherer does not split cleanly between man and animal, culture and nature. Instead those paired worlds remain integrated. The Mbuti people of Zaire, for example, identify the forest they inhabit as a person. It is not the environment but another sentient being, a giving parent or trusted kin.30 The Inuit of Greenland take a similar position with respect to the animals they hunt. The polar bear is not simply a lower animal but is, instead, a member of the tribe. Once it has been successfully hunted and killed it must be treated with the same respect as any other deceased member of the society.31 Just as the separation of man and nature does not exist for modern hunter-gatherers, it likely did not exist in the Paleolithic. As anthropologist Tim Ingold has written, For modern hunter-gatherers there are not two worlds of persons (society) and things (nature) but just oneone environmentsaturated with personal powers and embracing both human beings and the plants and animals on which they depend, and the landscape in which they live and move.32 This seamless continuity between humans and their environment is also reflected in their conceptions of time and cosmos. The link, however, comes with a twist. Paleolithic narratives of creation reflect the recognition that an immutable separation was imposed on humanity when we awakened in the Big Bang of consciousness. Thus hunter-gatherer myths will often speak of a lost paradise. In the before humans were immortal and lived in an ongoing balance with the world and the divine forces that shaped it. Human and animal could speak to each other and transformations from animal to human form were common. The most important aspect of Paleolithic cosmological myths was the Fall, which was the loss of a perfect, preexisting harmony between humans and the nonhuman world. Somehow, the myths tell us, that harmony was shattered. As Karen Armstrong put it, At the center of the world there was a tree, a mountain or a pole linking Earth with heaven, which the people could easily climb to reach the realm of the gods. Then there was a catastrophe; the mountain collapsed, or the tree was cut down and it became more difficult to reach heaven.33 In this myth, the preexisting Eden was a timeless place. It was complete and existed without change. People in the golden age lived either exceedingly long lives or forever. Thus the Fall was also the fall into time. In many myths, when the harmony was shattered, time and death entered the world together. But in these myths the golden age was not truly gone. Instead it remained as an archetypal, timeless state that could beand needed to berecovered. The Aborigines of Australia, for example, conceive of returning to the primordial cosmos in the Dreamtime. As Armstrong wrote, Dreamtime . . . is timeless and everywhen. It forms a stable backdrop to everyday life, which is dominated by death, flux, the endless succession of events, and the cycles of seasons.34 The myth of the golden age and the Fall are all but universal in early human cultures.35 Like the Australian aboriginal emphasis on Dreamtime, the point of these cosmological myths was not to recount history; it was to recover original time. As Armstrong puts it, Today we separate the religious from the secular. This would have been incomprehensible to the Paleolithic hunters. These myths had purpose. They show people how they could return to this archetypal world, not only in moments of visionary rapture but in the regular duties of their daily lives.36 Thus the time of origins existed not in the past, as we imagine it now in cosmology, but in this ever-present everywhen.37 For the hunter crouching low in the brush, waiting for the herd to pause, the time of creation and his experience now were never far apart. For the women filling baskets with wild grain, their actions and the primordial divine acts, which set the world in motion, were always closely paired. The daily time of Paleolithic people was set against a cosmos that was not out there but rather was close by. It was a cosmos without birth or final death or linear time. It was a universe alive with animate and divine powers that were always present, reenergizing the world each day with the return of the sun, each month with the return of the moon to fullness and each

season with shifts in light and warmth. But culture and its needs would change and the powers animating the universe would grow distant and more difficult to engage. Divine entities that were once proximate and personal slowly became remote and willful. It is in this understanding that the sky was the first retreat of the divine. The development of more complex cultures led to myths of the sky as the first and distant domain of the divine. Armstrong notes that the sky goda distant but powerful first causebegins to appear in this era. She observes, The sky towered above them [the Paleolithic people], inconceivably immense, inaccessible and eternal. It was the very essence of transcendence and otherness. The sky with its wheeling, repeating patterns was the first house of the father god, the original seat of divine power.38 The Paleolithic cosmos was a direct reflection of our first awakened experience of the daily experience of time. As hunter-gatherers, people followed the herds and watched as the seasons ripened the best edible plants. In the Big Bang of consciousness they had begun to watch the cycles of the world around them and from it they lifted out the idea of time. In this way time was a creation of culture, just as culture was a creation of the embodied mind. The enigmatic entanglement between experienced physicality and the symbolic, cultured imagination created a time that existed in both daily life and myth. But as the world warmed, humanity changed, and our universe would change with it. A new kind of time and a new relation to the world would emerge with the next great human revolution. Our focus and our consciousness would be re-created as the Earth was put to the plow. STAYING HOME: THE NEOLITHIC REVOLUTION The world would not remain locked in ice forever. Around twelve thousand years ago, the climate shifted, as it had countless times and countless millennia before. The planet warmed, the glaciers retreated and the Paleolithic era ended.39 But unlike previous interglacial periods, something new was born with the return of climatic spring. Our species learned a fundamentally new way of being human. As warm seasons lengthened and the ice disappeared, some bands of hunter-gatherers invented a new way of life. They stopped following the herds into warmer pastures. They settled down and began domesticating themselvesswitching from hunting and foraging to the deliberate cultivation of grains. They built houses that would last from one year to the next.40 They grouped these houses together to create villages that would endure for generations. All these changes fed upon one another and were possible because people had learned to till the land and reap its harvests. Cosmos and time were each, separately and together, essential facets of this revolution. In this Neolithic era (new stone age), a flowering of human creativity began. It was a time of profound change that would not be matched again until the age of the machine. The archeologist Colin Renfrew identifies at least seven key features of the Neolithic revolution:41 The development of food production through domesticated plants such as wheat, lentils, barley and flax The use of tools such as grindstones for processing these plants The domestication of animals such as sheep, goats, cattle and pigs The emergence of settled village life with permanent dwellings The appearance of ritual practices involving shrines and human representations The interment of the dead in cemeteries, sometimes featuring monumental tombs The development of long-distance procurement systems for raw materials such as obsidian Each of these cultural innovations required a fundamentally new way of organizing human activities, as well as a new way of imagining culture and its place in the cosmos. And, just as important, each one required a daily engagement with time unlike anything that had come before. According to some researchers the Neolithic saw the completion of a transition that had its beginnings in the Paleolithic. In the eyes of archeologists such as Renfrew, the artistic revolutions of forty, thirty or twenty thousand years ago were local and uneven. The astonishing cave art found in Spain and France were not universal phenomena spanning the entire human population. In comparison, after the great global warming, our self-domestication and adoption of agriculture rapidly swept across every continent. It was a revolution that transformed almost everyone, almost everywhere. Thus, the Paleolithic might be seen as a long series of skirmishes in a cognitive revolution that found completion in the Neolithic. What made this final step possible? The answer, which continues to shape culture down to the modern era, is our physical embodiment. We live in the world through our bodies and their materiality.42 What altered the human mind was not simply the introduction of new ideas in our heads but new encounters with the world through what we built with our hands. Many pivotal inventions were developed in the Neolithic era: planting and harvesting technologies, the construction and deployment of grinding wheels, the mastery of metallurgy. All of these changes represented fundamental shifts in the way people encountered the material world. It was, literally, the act of shaping the raw stuff of the world into these inventions that enabled new ways of thinking and new ways of organizing human activity. This process of material engagement completed the Big Bang of consciousness and is the root cause of all the innovations and revolutions that followed. Brute facts are where material engagement begins; new ways of being human is where it ends. The early farmers of

northern Europe circa 5500 BCE had surpassed the culture of their hunter-gatherer ancestors with new ways of handling material that superseded the natural world. Housing for hunter-gatherers, for example, had required no more than promoting and combining the existing suppleness of hazel, the stringiness of willow and the sheets of birch bark that grew ready-made.43 The timber-frame homes the new farmers built required nature to be torn apart and the world built anew. Changes in material engagement redefine culture by altering what are called its institutional facts. Institutional facts define the human world into which we are each born. From punch-clock jobs to jury duty appointments, its the institutional facts that define how culture organizes itself and then imposes that system onto our individual lives. But cultural organization derives its power in the mental realm of symbols. Thus the changes material engagement wrought meant more than just a farmer figuring out a new way to fashion a sharpened axe. These shifts in material engagement implied shared understandings within a community that were at once social and cognitivein that way they drove the creation of new institutional facts. For the farming villages, the materials that made this new life possible were reflected in the day-to-day organization of the community. A Neolithic farmer, looking back across her tilled fields and the chores that defined her day, was moving through an entirely new world. With the advance of material engagement came new ways of experiencing time. By kneading clay with the hands, pushing iron ore around in a fire and stretching wool across a wooden frame, people engaged with the material world in fresh ways, and time was an integral part of this process. How long did it take for clay to be baked into pottery? How many differently timed steps were involved in forging an iron plow? Just as each invention made new forms of culture possible, cultural imagination also developed alongside the technology. Because time always exists at the interface between the physical and the imagination, it would be closely tied to material engagement and the changes it drove in culture. Nowhere is the effect of material engagement on institutional facts more apparent than in Neolithic megaliths such as Stonehenge. Megaliths are massive, highly structured stone works. These imposing stone monuments, as well as massive earthworks, are associated with prehistoric cultures across the globe. The construction of megaliths is one hallmark of the change from a hunter-gatherer culture to an agrarian culture. The 260-foot-wide circular mound at Newgrange, about thirty-five miles north of Dublin, Ireland, for example, appeared sometime after the advent of farming in Ireland. The earliest structures at Stonehenge were constructed later but were still part of Englands Neolithic agrarian past. The construction of these monuments required the intense and coordinated effort of many individuals to transport materials across hundreds of miles. The megalith at Newgrange, for example, is fronted by a quartz facade composed of stones found on beaches near the coast of Dublin, many miles away.44 At the center of the enormous mound is a vaulted central chamber only accessible through a narrow eighty-foot-long passageway. The stone supports for this chamber and passageway also had to be dragged across many, many miles. In a similar manner, the imposing central blocks of Stonehenge, each weighing fifty tons, had to be transported as much as fifteen miles, possibly from quarries at Marlborough Downs.45 Thus, the decision to build these megaliths demonstrates entire communities willing to dedicate time and treasure in the effort to make symbols out of stone. And in that effort time and symbol were reborn. The construction of Stonehenge likely required more than thirty million hours of labor. So much work that the effort must have spanned generations.46 With this new form of material engagement passing from father to son, mother to daughter, the construction of megaliths was itself an agent for imagining new forms of culture and time. As a direct result of building the megaliths, the monuments became the axis around which a new type of living community would be born. The megaliths rebuilt culture and time through the very process of their labor and time-consuming construction. And time was always an essential aspect of the megaliths on both a physical and symbolic level. On the one hand, men would be called away from the farms to scramble over tilting stone slabs or bend low in sodden holes dug into the earth. On the other hand, concerns with time in a mythic, cosmological context was undoubtedly a core motivation for building many of these megaliths in the first place. There is ample evidence that Newgrange and Stonehenge were built to correspond to astronomical events such as the winter and summer solstices. Without a flashlight, the central chamber of Newgrange is darker than death. But for a few days each year near the winter solstice, the rising sun is perfectly aligned with the ancient passageway, allowing a shaft of sunlight to pierce the darkness. For these few minutes, the central chamber glows in warm ochrea promise of the light and life to come with the approaching spring. Newgranges builders constructed their monument with its solstice-illuminated chamber for cosmic rituals whose meanings may now be lost to us but whose astronomical orientation cannot be missed. Thus this solar alignment of Newgranges entrance is one potent example of a concern with the raw facts of the sky and its movements. The megaliths were,

however, more than prehistoric calculators. In addition to its many astronomical orientations, Stonehenge may also have been a burial site for chiefs and tribal elders.47 In this way ritual and religion must have been central to the symbolic demands of megalith construction. Their builders were clearly aware of cosmic time and willing to dedicate effort and riches in creating monuments that called to the vaulted sky and its repeating patterns. TIME AND AGAIN: ETERNAL RETURN AND THE NEOLITHIC COSMOLOGY The cosmology of a farmer did not look like that of a hunter-gatherer. The material engagement of hunter-gatherers was so fundamentally different from what people in an agrarian culture experienced that the very concept of a cosmos, and the symbols used to represent it, had to change in a fundamental way. The mobile hunter-gatherer lived out in the open amid the forest and plain, populated by free-roaming animals considered equals and cousins. The farmer accepted a tamed, sedentary life with the closed stability of a homestead roof replacing the infinite, dynamic arch of the night sky; for the farmer, beasts of burden were possessions and worked as slaves to the human master. Where the hunter-gatherer lived through time as an unbroken whole, the farmer lived within a time marked by the daily rounds of animal husbandry, home maintenance and village life. Thus time and the cosmos had to change because the ways in which people encountered the material world had changed. Looking at the change from Paleolithic to Neolithic societies, Karen Armstrong notes that myths that cease to be useful will have to be abandoned. Thus, with the development of farming, new cosmologies and new conceptions of cosmic time would have to be invented. Agriculture was the product of analytic thought, an early kind of science. But unlike our technological revolutions, the agriculture of the Neolithic farmers was never a purely secular enterprise.48 The mythic universe of the Neolithic was a mix of new activities and a changed understanding of the wider universe that surrounded them. Farming was as much a sacred act in the Neolithic as hunting had been in the Paleolithic. Crops, emerging from careful seeding and cultivation, were a new form of symbol and a new representation of time. Cultivated plants grew through material engagement with the Earth and its unfolding powers in time. Thus, crops were both food and divine power. Time acted as an intermediary between the concrete world of farming and the symbolic world of the gods. Unseen energies, manipulated through time, were the focus of new mythic narratives, as the tilled Earth became a fertile womb for the community. The rites, rituals and myths of the Neolithic peoples responded to the requirements of this new agricultural cosmos. The whole community came to the fields, standing together as farmers ritually discarded the first seeds of the years sowing as an offering to the divine powers that would animate the new crops growth. Cosmic time was manifested in the fields for these men and women months later when the first fruits were left to drop, recharging the hidden forces animating the agrarian cycle. Ritual sexual union sometimes preceded the planting in order to signify the sacred marriage of soil, seed and rain.49 In all these rituals people were tapping into vast cosmic creative powers that, like the seasons, were clearly periodic in time. The close observation of the world that made agriculture possible had its internal complement in the new sacred narratives of mythology. Awe and wonder before the sky had led humans to cosmic myths of sky gods in the previous Paleolithic era. In the Neolithic, the Earth became central in the form of a mother goddess. Myths throughout the Fertile Crescent tell stories of goddesses and their connection to farming. The heroic hunters journey, which is so widespread in the Paleolithic, gave way to the dangerous travel of the mother goddess descending into the underworld of death and returning to bring new life. These myths expressed both the recurring terrestrial bounty an agricultural people experienced and its devastating alternatives such as drought, famine and flood. Mythology was never a form of escape. It was an honest expression of peoples personal knowledge, and it forced them to face up to the reality of life in the midst of death and transition, a life given meaning in new contexts of agricultural time. Most important, the new myths were sensitive to the cycles of the agrarian year and its implications for conceptions of time. The yearly cycles of life and death appear, for example, in the myth of Demeter and Persephone, which dates back to the Neolithic era. Demeter controls the fertility of the Earth. When Hades, god of the underworld, abducts her daughter, Persephone, in her grief Demeter starves humankind by shutting down the growing season. Zeus is forced to rescue Persephone. But once the God-King learns that Persephone has tasted the fruit of the underworld, the girl cannot be allowed to return fully and must spend several months of each year with Hades. It is Demeters grieving during these months that is meant to explain the bareness of winter. Time, bound up in the seasons, is essential to this sacred narratives plot.50 The great scholar of religion Mircea Eliade articulated this development in his work The Myth of Eternal Return. As social arrangements were built around agriculture, time itself was regenerated with each round of the year. On the occasion of the division of time into independent units, years, we witness not only the effectual cessation of a certain temporal interval and the

beginning of another, but also the abolition of the past year and of past time.51 The extended festivals of new harvests and first plantings were more than just an enactment of creation; they were, literally, the recreation of time. Costumed actors would embody the myths as a kind of sacred theater in which the entire community participated. Every new year is a resumption of time from the beginning, said Eliade. Thus at every new year, the community repeated, in ritual form, the origins of the cosmos. In many agrarian cultures these rituals of time regeneration required active human participation via the death of the king. The rituals would require the king to be felled either symbolically or in actuality. Spilling the kings blood and returning his creative energies to the Earth enabled time and the cosmos to be born again. The revolution that put the earth to the plow reshaped human consciousness and pulled us out of a time defined by now, by whatever was happening in the present. Cyclical time and cyclical universes, reborn anew each year, met the needs of our new ways of life and held a powerful grip on the human imagination across these long millennia. Thus in the Neolithic we see, for the first time, the switching of one cosmology for another. With the advent of agriculture a different cosmological time emerged, one mediated by our new material engagement with the world. This story of cosmos and culture enigmatically entangled through material engagement will be repeated again and again to the current day. It is still at work now as we face the end of the Big Bang and our own cosmological revolution. 2011 Adam FrankRevue de presse'"Time' is the most used noun in the English language, yet we still don't really understand it. Adam Frank tells the fascinating story of how humans have struggled to make sense of time, especially in the context of the universe around us. From prehistory to the Enlightenment, through Einstein and on to the multiverse, this is a rich and inspiring tour through some of the biggest ideas that have ever been thought." (Sean Carroll, author of From Eternity to Here: The Quest for the Ultimate Theory of Time)An eloquent book. (Nature)A fascinating and comprehensive survey of how technology - from farming to railways to telegraphy to the internet - has changed our everyday concept of time. [Frank] is excellent at showing how our ideas of human and cosmic time have evolved hand-in-hand Frank's thesis that our notions of cosmic and human time are braided together is compelling. (New Scientist)"A phenomenal blend of science and cultural history. (Kirkus s, starred review)"Frank (astrophysics, Univ. of Rochester; The Constant Fire: Beyond the Science vs. Religion Debate), cofounder of NPRs 13.7: Cosmos Culture blog and frequent contributor to Discover and Astronomy magazines, here endeavors to reconstruct our understanding of timeboth what he calls human time and cosmological timewith the contention that we are poised for a new definition or experience of time. He begins by ushering readers from the prehistoric to the modern era, showing how the cycles of nature and the sky became integrated into human culture over time. Next, he discusses cosmological time and lays out his proposal for a new order of time. The narrative is punctuated with vignettes, some of them amusing, designed to highlight and enrich various points of the narrative. VERDICT This will fascinate anyone curious about the nexus of astronomy and history and, of course, time. Recommended." (Library Journal)"University of Rochester astrophysics professor Adam Frank explains how our experience of time has been repeatedly rejiggered throughout the millennia. Archaeological evidence of ancient lifestyles and routines indicates that Paleolithic hunter-gatherers lived through time as an unbroken whole, he writes. But once humans settled down to farm, that changed. The farmer lived within a time marked by daily rounds of animal husbandry, home maintenance, and village life. Then came the clock, then the industrial punch clock and then synchronized time, which further altered how human beings perceived, used and organized the moments of a day. All the while, these changing notions of time altered how people understood the cosmos. Theories about the beginning of time gradually shifted from a mythological Eden to the universe-generating big bang. Frank ponders fresh ideas in cosmology, such as string theory and the multi-verse, and how the human perception of time will change in the future." (Washington Post)This one is a must-read! ...Culture of Science regulars are going to love About Time. The book does a wonderful job weaving together the story of human history and time in the context of the universe. From the Big Bang to the Renaissance to cell phones to the multiverse, he takes extremely complex ideas and makes them easily digestible, endlessly fascinating, and fun. About Time will make you think. And be assured, youll find yourself revisiting chapters again with new questions as you continue. It may even change the way way you perceive your place in the world. (Culture of Science)