THE FIVE AGES OF THE UNIVERSE pdf

1: The Five Ages of the Universe - Wikipedia

The Five Ages of the Universe is a popular science book written by Professor Fred Adams and Professor Gregory P. Laughlin about the future of an expanding universe.

Search Introduction A guide to the big picture, fundamental physical law, windows of space and time, the great war, and extremely big numbers. January 1, 7,,, A. The New Year rings in little cause for celebration. Nobody is present even to mark its passing. The Sun has swelled to enormous size, so large that its seething red disk nearly fills the daytime sky. The planet Mercury and then Venus have already been obliterated, and now the tenuous outer reaches of the solar atmosphere are threatening to overtake the receding orbit of Earth. Only a barren rocky surface is left behind. One can still trace the faint remains of ancient shorelines, ocean basins, and the low eroded remnants of the continents. By noon, the temperature reaches nearly degrees Fahrenheit, and the rocky surface begins to melt. Already, the equator is partly ringed by a broad glowing patchwork of lava, which cools to form a thin gray crust as the distended Sun eases beneath the horizon each night. A patch of the surface which once cradled the forested moraines of southeastern Michigan has seen a great deal of change over the intervening billions of years. What was once the North American continent has long since been torn apart by the geologic rift which opened from Ontario to Louisiana and separated the old stable continental platform to produce a new expanse of sea floor. The sedimented, glaciated remains of Ann Arbor were covered by lava which arrived from nearby rift volcanos by coursing through old river channels. Later, the hardened lava and the underlying sedimentary rock were thrust up into a mountain chain as a raft of islands the size of New Zealand collided with the nearby shoreline. A slab of rock cleaves off, causing a landslide and exposing a perfectly preserved fossil of an oak leaf. This trace of a distant verdant world slowly melts away in the unyielding heat. Soon the entire Earth will be glowing a sullen, molten red. This scenario of destruction is not the lurid opening sequence from a grade B movie, but rather a more or less realistic description of the fate of our planet as the Sun ends its life as a conventional star and expands to become a red giant. Right now, the universe is still in its adolescence with an age of ten to fifteen billion years. As a result, not enough time has elapsed for many of the more interesting astronomical possibilities to have played themselves out. As the distant future unfolds, however, the universe will gradually change its character and will support an ever changing variety of astonishing astrophysical processes. This book tells the biography of the universe, from beginning to end. It is the story of the familiar stars of the night sky slowly giving way to bizarre frozen stars, evaporating black holes, and atoms the size of galaxies. It is a scientific glimpse at the face of eternity. Each of these scales provides a different type of window to view the properties and evolution of nature. On each of these size scales, astrophysical objects go through life cycles, beginning with a formation event analogous to birth and often ending with a specific and deathlike closure. The end can come swiftly and violently; for example, a massive star ends its life in a spectacular supernova explosion. Alternatively, death can come tortuously slowly, as with the dim red dwarf stars, which draw out their lives by slowly fading away as white dwarfs, the cooling embers of once robust and active stars. On the largest size scale, we can view the universe as a single evolving entity and study its life cycle. Within this province of cosmology, a great deal of scientific progress has been accomplished in the past few decades. The universe has been expanding since its conception during a violent explosion -- the big bang itself. The big bang theory describes the subsequent evolution of the universe over the last ten to fifteen billion years and has been stunningly successful in explaining the nature of our universe as it expands and cools. The key question is whether the universe will continue to expand forever or halt its expansion and recollapse at some future time. Current astronomical data strongly suggest that the fate of our universe lies in continued expansion, and most of our story follows this scenario. However, we also briefly lay out the consequences of the other possibility, the case of the universe recollapsing in a violent and fiery death. Beneath the grand sweep of cosmology, at a finer grain of detail, are the galaxies, such as our Milky Way. These galaxies are large and somewhat loosely knit collections of stars, gas, and other types of matter. Galaxies are not distributed randomly throughout the universe, but rather they are woven into a tapestry by gravity. Some aggregates of galaxies have enough mass to be bound together by gravitational forces, and these galaxy clusters can be considered as independent astrophysical objects in their own right. In addition to belonging to clusters, galaxies are loosely organized into even larger structures that resemble filaments, sheets, and walls. The patterns formed by galaxies on this size scale are collectively known as the large-scale structure of the universe. Galaxies contain a large fraction of the ordinary mass in the universe and are well separated from each other, even within their clusters. This separation is so large that galaxies were once known as "island universes. As the universe expands, the galaxies act as beacons in the void that allow us to observe the expansion. It is difficult to comprehend the vast emptiness of our universe. A typical galaxy fills only about one-millionth of the volume of space that contains the galaxy, and the galaxies themselves are extremely tenuous. If you were to fly a spaceship to a random point in the universe, the chances of landing within a galaxy are about one in a million at the present time. These odds are already not very good, and in the future they will only get worse, because the universe is expanding but the galaxies are not. Decoupled from the overall expansion of the universe, the galaxies exist in relative isolation. They are the homes of most stars in the universe, and hence most planets. As a result, many of the interesting physical processes in the universe, from stellar evolution to the evolution of life, take place within galaxies. Just as they do not thickly populate space, the galaxies themselves are mostly empty. Very little of the galactic volume is actually filled by the stars, although galaxies contain billions of them. If you were to drive a spaceship to a random point in our galaxy, the chances of landing within a star are extremely small, about one part in one billion trillion one part in This emptiness of galaxies tells us much about how they have evolved and how they will endure in the future. Direct collisions between the stars in a galaxy are exceedingly rare. Consequently, it takes a very long time, much longer than the current age of the universe, for stellar collisions and other encounters to affect the structure of a galaxy. As we shall see, these collisions become increasingly important as the universe grows older. The space between the stars is not entirely empty. Our Milky Way is permeated with gas of varying densities and temperatures. The average density is only about one particle one proton per cubic centimeter and the temperature ranges from a cool 10 degrees kelvin to a seething million degrees. At low temperatures, about 1 percent of the material lives in solid form, in tiny rocky dust particles. This gas and dust that fill in the space between stars are collectively known as the interstellar medium. The stars themselves give us the next smaller size scale of importance. Ordinary stars, objects like our Sun which support themselves through nuclear fusion in their interiors, are now the cornerstone of astrophysics. The stars make up the galaxies and generate most of the visible light seen in the universe. Moreover, stars have shaped the current inventory of the universe. Massive stars have forged almost all of the heavier elements that spice up the cosmos, including the carbon and oxygen required for life. Most of what makes up the ordinary matter of everyday experience -- books, cars, groceries -- originally came from the stars. But these nuclear power plants cannot last forever. The fusion reactions that generate energy in stellar interiors must eventually come to an end as the nuclear fuel is exhausted. Stars with masses much larger than our Sun burn themselves out within a relatively brief span of a few million years, a lifetime one thousand times shorter than the present age of the universe. At the other end of the range, stars with masses much less than that of our Sun can last for trillions of years, about one thousand times the current age of the universe. When stars end the nuclear burning portion of their lives, they do not disappear altogether. In their wake, stars leave behind exotic condensed objects collectively known as stellar remnants. This cast of degenerate characters includes brown dwarfs, white dwarfs, neutron stars, and black holes. As we shall see, these strange leftover remnants will exert an increasingly important and eventually dominant role as the universe ages and the ordinary stars depart from the scene. The planets provide our fourth and smallest size scale of interest. They come in at least two varieties: The last few years have seen an extraordinary revolution in our understanding of planets. For the first time in history, planets in orbit about other stars have been unambiguously detected. We now know with certainty that planets are relatively commonplace in the galaxy, and not just the outcome of some rare or special event which occurred in our solar system. Planets do not play a major role in the evolution and dynamics of the universe as a whole. They are important because they provide the most likely environments for life to evolve. The long-term fate of planets thus dictates the long-term fate of life -- at least the life-forms with which we are familiar. In addition to planets, solar systems contain many smaller objects, such as asteroids, comets, and a wide variety of moons. As in the case of planets, these bodies do not play a major role in shaping the evolution of the universe as a whole, but they do have an important impact on the evolution of life. The moons orbiting the planets provide another possible environment for life to thrive. Comets and asteroids are known to collide with planets on a regular basis. These impacts, which can drive global climatic changes and extinctions of living species, are believed to have played an important role in shaping the history of life here on Earth. All four of these forces play significant roles in the biography of the cosmos. They have helped shape our present-day universe and will continue to run the universe throughout its future history. The first of these forces, gravity, is the closest to our everyday experience and is actually the weakest of the four. Since it has a long range and is always attractive, however, gravity dominates the other forces on sufficiently large size scales. Gravity holds objects to Earth, and holds Earth in its orbit around the Sun. Gravity keeps the stars intact and drives their energy generation and evolution. Ultimately, it is the force responsible for forming most structures in the universe, including galaxies, stars, and planets. The second force is the electromagnetic force, which includes both electric and magnetic forces. At first glance, these two forces might seem different, but at the fundamental level they are revealed to be aspects of a single underlying force.

2: Summary/Reviews: The five ages of the universe :

But The Five Ages of the Universe is more than a handbook of the physical processes that guided our past and will shape our future; it is a truly epic story. Without leaving earth, here is a fantastic voyage to the physics of eternity.

While I find speculation into extremely remote future ages dubious, because of any number of possible variables discovery of a new cosmological force leading to a big crunch or oscillating universe, brane theory alternative to inflation , hyper-advanced trans-singularity intelligences practicing space-time engineering, etc etc , it makes for an interesting example of a logarithmic timescale. The names of the two "briefest" ages, the Primordial and the Stelliferous, have been adopted in the cosmological review in Palaeos. The book divides the timeline of the universe into five eras: In addition to explaining current cosmological theory, the authors speculate on what kinds of life might exist in future eras of the universe. The speculation is based on a scaling hypothesis, due to Freeman Dyson, the idea being that all other things being equal the rate of metabolism -- and therefore rate of consciousness -- of an organism should be in direct proportion to the temperature at which that organism thrives. The authors envision life forms completely different from the biochemical ones of Earth, for example based on networked black holes. In this era, the Big Bang, the subsequent inflation, and Big Bang nucleosynthesis are thought to have taken place. Toward the end of this age, the recombination of electrons with nuclei made the universe transparent for the first time. The authors discuss the horizon and flatness problems. This is the current era, in which matter is arranged in the form of stars, galaxies, and galaxy clusters, and most energy is produced in stars. Massive stars use up their fuel very rapidly, in as little as a few million years. Eventually, the only stars will be miserly red dwarf stars. By the end of this era, bright stars as we know them will be gone, their nuclear fuel exhausted, and only white dwarfs, brown dwarfs, and black holes will remain. This is the era of brown dwarfs, white dwarfs, and black holes. White dwarfs will assimilate dark matter and continue with a nominal energy output. As this era continues, the authors hypothesize that protons will begin to decay violating the conservation of baryon number given by the Standard Model. If proton decay takes place, the sole survivors will be black holes. In this era, according to the book, organized matter will remain only in the form of black holes. Black holes themselves slowly "evaporate" away the matter contained in them, by the quantum mechanical process of Hawking radiation. By the end of this era, only extremely low-energy photons, electrons, positrons, and neutrinos will remain. By this era, with only very diffuse matter remaining, activity in the universe will have tailed off dramatically, with very low energy levels and very large time scales. Electrons and positrons drifting through space will encounter one another and occasionally form positronium atoms. These structures are unstable, however, and their constituent particles must eventually annihilate. Other low-level annihilation events will also take place, albeit very slowly. It should be emphasised that the above represents one possible time line, and one possible perspective on things, and is not a dogmatic statement. There are also the linear, ascending alternative. However, this sort of ascending evolution is only possible in the Stelliferous Era, where the universe is differentiated and transparent to radiation, and there is an abundance of free energy. Evolution towards greater complexity is an obvious fact from both a cosmological and systems theory perspective; as pointed out by writers such as Erich Jantsch , Irwin Laszlo, and Eric Chaisson. But it is also very much a product of, or rather, as I prefer critical realism to the epistemological prison of neo-kantean agnosticism, an insight of, 19th and 20th century optimism. Ascent to greater complexity is also very much disliked by some evolutionary biologists S. Gould , also some cladists because they want to avoid mentioning any hint of progress in the evolution life. Personally I consider such a position extreme, although others may disagree with me.

3: The Five Ages of the Universe | Revolvy

The five ages of the universe lays out the different stages of development of the universe from the initial big bang, through the turning on of light, into the age of stars, and then what the authors propose will occur during the decline of the universe.

The five chapters treat different eras in the evolution of the universe: The chapter on the primordial era discusses the early universe; most of the energy in the universe derives from nuclear fusion in the stelliferous era. The degenerate era is characterized by stellar remnants; in the distant future, black holes and their evaporation dominate the universe. Finally, in the very distant future, we find ourselves in the dark era in which the remnants that constitute the universe are photons, neutrinos, electrons, and positrons. The audience for whom the book was prepared will not find it "user friendly. Further, some of the physics is puzzling, e. Perhaps a second edition will turn an adequate book into a really good one. A complete college library probably should have a copy. General readers; lower-division undergraduates. Review by Booklist Review The question in cosmology is whether the universe will stop expanding. Physicists Adams and Laughlin are not banking on it. The appearance of a universe forever expanding is literally not bright, but since eternity provides the time, theory allows strangely interesting occurrences until an unimaginably distant Dark Era is reached. Of the other eras by which the authors arrange this fantastic, fascinating book, we live in the Stelliferous Era, dominated by stars in galaxies. The past was the Primordial Era, whose central event was the big bang; future auguries point toward a Degenerate Era, in which burnt-out remnants of stars sputter to their ends through proton decay, leaving the black holes to soldier on into their eponymous era, about ten billion quadrillion years from now. A stellar piece of science popularization. They view time not in linear years but in logarithmic cosmological decades. We live early in the 10th cosmological decade, approximately 10 billion 10 to the 10th power years since the Big Bang. For the first six cosmological decades, the Primordial Era, the authors explain, an intensely hot universe expanded and cooled. Elementary particles formed, followed by atoms and molecules. The stage was set for the present Stelliferous Era of galaxies, stars and planets that will continue through the 14th cosmological decade. Our universe will then be 10, times its present age, and even its slowest-burning stars will have used up their nuclear fuel. Stellar remnants will dominate the next 25 cosmological decades, the Degenerate Era. Following that will be the Black Hole Era, more than 60 cosmological decades long. The final chapter will be the Dark Era, a steadily diminishing, infinitely long decline toward universal equilibrium. The authors speculate on the survival of intelligent life through the entire history. They also discuss the evolution of universes in Darwinian terms. All rights reserved Review by Library Journal Review In order to tell the story of the universe from its origin to its ultimate demise, the authors both well-known astrophysicists have divided all of time into five eras. The first, the Primordial Era, begins with the big bang and the eventual synthesis of hydrogen that makes stars. The Stelliferious Era meaning filled with stars began just a few billion years ago, and we are currently in the middle of this era of bright stars and galaxies. The third era sees the diminution of the bright stars and the ascendance of white and brown dwarfs, neutron stars, and black holes. Black holes in fact become the only objects in the next era, naturally titled the Black Hole Era. Eventually, even the black holes evaporate, and the final Dark Era arrives, a time in which there are no stellar objects of any kind. Good illustrations help explain complex concepts, and the glossary is useful. This unusual history of the universe is accessible to the educated general reader and recommended for academic and large public libraries. James Olson, Northeastern Illinois Univ.

4: Five Ages of the Universe: Inside the Physics of Eternity : Adams :

Each cosmological decade represents a fold increase in years. When the universe was 10 years old, it ended its first cosmological decade. At , the universe marked its second cosmological decade.

June 7, This information helps astronomers determine the age of the universe. ESA and the Planck Collaboration. According to research, the universe is approximately They can determine the age of the universe using two different methods: Age limits The universe cannot be younger than the objects contained inside of it. By determining the ages of the oldest stars, scientists are able to put a limit on the age. The life cycle of a star is based on its mass. More massive stars burn faster than their lower-mass siblings. The mass also affects the brightness, or luminosity, of a star; more massive stars are brighter. They contained only hydrogen and helium, but through fusion began to create the elements that would help to build the next generation of stars. Scientists have been hunting for traces of the first stars for decades. Sobral was part of a team that identified a bright galaxy with evidence of Population III stars. Dense collections of stars known as globular clusters have similar characteristics. The oldest known globular clusters have stars with ages that appear to be between 11 and 18 billion years old. The wide range comes from problems in pinpointing the distances to the clusters, which affects estimates of brightness and thus mass. If the cluster is farther away than scientists have measured, the stars would be brighter, thus more massive, thus younger than calculated. It can be older, but not younger. Expansion of the universe The universe we live in is not flat and unchanging, but constantly expanding. Thus, finding the expansion rate of the universe â€" a number known as the Hubble constant â€" is key. A number of factors determine the value of this constant. The first is the type of matter that dominates the universe. Scientists must determine the proportion of regular and dark matter to dark energy. Density also plays a role. A universe with a low density of matter is older than a matter-dominated one. By measuring the thermal radiation left over from the Big Bang, missions such as these are able to determine the density, composition and expansion rate of the universe. The leftover radiation is known as the cosmic microwave background, and both WMAP and Planck have mapped it. In , Planck measured the age of the universe at Both of these fall within the lower limit of 11 billion years independently derived from the globular clusters, and both have smaller uncertainties than that number. Combined with the WMAP measurements, scientists were able to make independent calculations of the pull of dark energy. Freedman lead the study that used Spitzer to refine the Hubble constant. It is quite extraordinary.

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5: The Five Ages Of The Universe | Download eBook PDF/EPUB

The Five Ages Of The Universe is a popular science book written by Professor Fred Adams and Gregory Laughlin first published in It discusses the history, present state, and probable future of the universe, according to cosmologists' current understanding.

Laughlin [1] about the future of an expanding universe first published in The book divides the timeline of the universe into five eras: In addition to explaining current cosmological theory, the authors speculate on what kinds of life might exist in future eras of the universe. The speculation is based on a scaling hypothesis, credited to Freeman Dyson , the idea being, that all other things being equal the rate of metabolismâ€”and therefore rate of consciousnessâ€”of an organism should be in direct proportion to the temperature at which that organism thrives. The authors envision life forms completely different from the biochemical ones of Earth, for example, based on net-worked black holes. Peter Humss 11 The time scales treated in the book are sufficiently vast, that, the authors find it convenient to use scientific notation. They refer to the "nth cosmological decade," meaning 10n years after the Big Bang. In what follows, n refers to the cosmological decade. Toward the end of this age, the recombination of electrons with nuclei made the universe transparent for the first time. The authors discuss the horizon and flatness problems. Stelliferous Era The Stelliferous Era, is defined as, "6 white dwarfs, brown dwarfs , neutron stars and black holes will remain. The Degenerate Era The Degenerate Era is defined as "15 dark matter and continue with a nominal energy output. As this era continues, the authors hypothesize that protons will begin to decay violating the conservation of baryon number given by the Standard Model. If proton decay takes place, the sole survivors will be black holes. By the end of this era, only extremely low-energy photons, electrons, positrons, and neutrinos will remain. By this era, with only very diffuse matter remaining, activity in the universe will have tailed off dramatically, with very low energy levels and very large time scales. Electrons and positrons drifting through space will encounter one another and occasionally form positronium atoms. These structures are unstable, however, and their constituent particles must eventually annihilate. Other low-level annihilation events will also take place, albeit very slowly. Future revision The book was published in Fred and I are currently working on an update of the material in The Five Ages.

6: The five ages of the universe - www.enganchecubano.com

This book divides the history of the universe in 5 ages: Primordial Era (from the Big Bang to the creation of the stars), Stelliferous Era (the era in which we live), and the Degenerate, Black.

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7: Palaeos : Time : Five ages of the Universe

The authors consider the evolution of planets, stars, stellar populations, galaxies, and the universe itself over time scales that greatly exceed the current age of the universe.

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8: The Five Ages of the Universe: Inside the Physics of Eternity by Fred Adams

The Five Ages of the Universe Inside the Physics of Eternity Published June 8, by Free Press.

Cosmic age problem and Cosmic microwave background In the 18th century, the concept that the age of the Earth was millions, if not billions, of years began to appear. However, most scientists throughout the 19th century and into the first decades of the 20th century presumed that the universe itself was Steady State and eternal, with maybe stars coming and going but no changes occurring at the largest scale known at the time. The first scientific theories indicating that the age of the universe might be finite were the studies of thermodynamics , formalized in the midth century. The concept of entropy dictates that if the universe or any other closed system were infinitely old, then everything inside would be at the same temperature, and thus there would be no stars and no life. No scientific explanation for this contradiction was put forth at the time. In Albert Einstein published the theory of general relativity [16] and in constructed the first cosmological model based on his theory. In order to remain consistent with a steady state universe, Einstein added what was later called a cosmological constant to his equations. In addition, these galaxies were very large and very far away. Spectra taken of these distant galaxies showed a red shift in their spectral lines presumably caused by the Doppler effect , thus indicating that these galaxies were moving away from the Earth. In addition, the farther away these galaxies seemed to be the dimmer they appeared to us the greater was their redshift, and thus the faster they seemed to be moving away. This was the first direct evidence that the universe is not static but expanding. The first estimate of the age of the universe came from the calculation of when all of the objects must have started speeding out from the same point. The first reasonably accurate measurement of the rate of expansion of the universe, a numerical value now known as the Hubble constant , was made in by astronomer Allan Sandage. However Sandage, like Einstein, did not believe his own results at the time of discovery. His value for the age of the universe[further explanation needed] was too short to reconcile with the billion-year age estimated at that time for the oldest known stars. Sandage and other astronomers repeated these measurements numerous times, attempting to reduce the Hubble constant and thus increase the resulting age for the universe. Sandage even proposed new theories of cosmogony to explain this discrepancy. This issue was finally resolved by improvements in the theoretical models used for estimating the ages of stars. It was a chance result from work by two teams less than 60 miles apart. In , Arno Penzias and Robert Wilson were trying to detect radio wave echoes with a supersensitive antenna. The antenna persistently detected a low, steady, mysterious noise in the microwave region that was evenly spread over the sky, and was present day and night. After testing, they became certain that the signal did not come from the Earth , the Sun , or our galaxy , but from outside our own galaxy, but could not explain it. At the same time another team, Robert H. Dicke , Jim Peebles , and David Wilkinson , were attempting to detect low level noise which might be left over from the Big Bang and could prove whether the Big Bang theory was correct. The two teams realized that the detected noise was in fact radiation left over from the Big Bang, and that this was strong evidence that the theory was correct. Since then, a great deal of other evidence has strengthened and confirmed this conclusion, and refined the estimated age of the universe to its current figure. The space probes WMAP, launched in , and Planck , launched in , produced data that determines the Hubble constant and the age of the universe independent of galaxy distances, removing the largest source of error.

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The five ages of the universe: inside the physics of eternity User Review - Not Available - Book Verdict. In order to tell the story of the universe from its origin to its ultimate demise, the authors (both well-known astrophysicists) have divided all of time into five eras.

THE FIVE AGES OF THE UNIVERSE pdf

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