Pale Blue Dot: A Vision of the Human Future in Space Study Guide

Pale Blue Dot: A Vision of the Human Future in Space by Carl Sagan

BOOKRAGS

Contents

Plot Summary

Pale Blue Dot may initially appear to concern space and space travel; it is, after all, written by the famous astronomer and popular science writer Carl Sagan. Indeed, many chapters of Pale Blue Dot focus on the geology of the planets in the Solar System, how to travel to Mars, the history of the Voyager probes, and so on. However, Sagan has a broader aim, for Pale Blue Dot is arguably a work of post-Christian Western theology. In fact, the book's subtitle is "A Vision of the Human Future in Space" and in fact, it is just that.

The first four chapters outline Saganic theology. First, Sagan points out that humans seem born with a certain self-importance. They see themselves as the center of the universe and think that their conflicts are all-important and worthy of their total devotion. He sees men, as do many in Western religions, as arrogant but foolish, and as beings who consider themselves strong and noble but are in reality weak and petty. Sagan's man is fallen, although the stars hold the promise of human unity and redemption.

When we view Earth from far away, we see a "Pale Blue Dot" and it is this vision, Sagan believes, that should impress upon us how meaningless we are, how little we matter and how pathetic our fights are. Sagan then gives a spiritual, stylized history of humanity, where science rather than God humbles man's self-importance. Man passes through a series of "Great Demotions" as science progresses.

Initially man is superstitious and places himself and the Earth at the center of the universe. But astronomy and biology are liberators because each successive stage in the progress of these sciences show that man's fantasy of himself as unique is mistaken. His religions, his Gods - all of these things are illusions, and in Chapter 4, "A Universe Not Made for Us" Sagan argues that our position in the universe appears without any providential element.

Pale Blue Dot has twenty-two chapters and chapters five through eighteen cover a variety of important material about science, the structure of the universe, the geology of the planets, space flight and so on. Sagan discusses how to explore other worlds and protect the present one and worries openly about how to avoid various threats of apocalypse. In the last four chapters, Sagan argues passionately that our future lies in space and that our space exploration can bring us together but helping us to see how important it is to get along in a universe that is indifferent to us.

In the end, Sagan advocates the development of a religion that places humanity at its center, but emphasizes his fallibility and interconnectedness. It will give humans hope but through science and the intellect rather than faith and mysticism. With this religion we will go, "To The Sky!" as Chapter 21 is titled. In Chapter 22, Sagan foreshadows the human future across the stars and speculates on how we can recover a sense of human purpose in a Godless Cosmos.

Introduction, Wanderers

Introduction, Wanderers Summary and Analysis

Carl Sagan opens Pale Blue Dot with the proclamation that human beings have been wanderers since they first evolved on earth. Cavemen wandered to find fruit and meant. When times went well, however, men would settle down as we have for the last 10,000 years. Yet men have not forgotten their desire to wander, as represented in our stories and symbols. As civilization developed, religion did as well and we imputed these same desires to them and saw ourselves as mixed with them. Even further in time, humanity spread across the world and began to explore it, eventually with ships.

Our distant ancestors noticed that five stars moved unlike the others, which were "fixed." They had a complex motion and today we call them planets. Today we know of many worlds beyond this one. In the last few decades, the United States and the former Soviet Union have examined these distant worlds, from Mercury to Saturn. There are wonders that were never dreamed of by our ancestors. The Viking robotic mission passed by Mars in July 1976; Sagan spent that month "living" on Mars.

Yet space is empty and we cannot travel to other planets, devoid of life, unlike Earth's colonists before. This book is about those other worlds and what awaits us on them. Sagan will ask not only how to go there but whether we should. Should we solve our problems at home first? Or are the planets themselves a reason for going? Sagan is optimistic about the "human prospect." Saga will examine the widespread claims in human history that our world and species are unique; Sagan will deny these claims, explain our true nature, our trek through the Solar System and then how he imagines humanity's future in space will unfold. He believes a key element of our future lies on distant worlds.

Chapter 1, You Are Here, Chapter 2, Aberrations of Light

Chapter 1, You Are Here, Chapter 2, Aberrations of Light Summary and Analysis

In February 1990, Voyager I was speeding away from the Sun at 40,000 miles per hour. It suddenly snapped sixty pictures. Voyager I and II have explored four planets and sixty moons but were not built to travel past Saturn. Still, they are triumphs of human engineering. Pictures have been taken of the earth from the moon, where there are no signs of humans or their machines. Humans are too small and inconsequential.

However, Sagan wanted to risk exposing Voyager to the Sun's rays, which would possibly burn out its vidicon system, in order to take a picture of the earth from much farther away. In 1990, the photos were taken, small squares full of stars and tiny dots of light, mostly lost to the glare of the sun. In the photo, the earth appears bathed in light by the sun, but this was merely coincidental to Voyager's positioning. Sagan points out, powerfully, that everyone and everything that has ever mattered to them exists on this "pale blue dot" that seems awfully meaningless from so far away.

The image mocks our "posturing" and "imagined self-importance"; it shatters the "delusion that we have some privileged position in the Universe." Sagan argues that there may be no more proof of "the folly of human conceits than this distant image of our tiny world." To Sagan, it teaches the need for humans to be kinder to each other and cherish and preserve the "pale blue dot."

Sagan opens Chapter 2 by asking the reading to look at the picture of the pale blue dot and try to imagine that everything in that world and all the vastness beyond it was made for a single species, gender, or "religious subdivision." If that doesn't seem unlikely, pick another dot. You wouldn't take seriously the claims of the same sort on another world, right? The idea of our importance is a myth, but if so, why is it so compelling? The problem is that we can only witness so much; most of what has happened has been beyond the perspective of anyone.

Prejudice almost never feels as such. It is simply fitting to us that due to the fact that we are who we are that we should have a central position in the universe. However, we also make such interferences about our importance because we are insecure and vulnerable. Often many scientists bring this attitude to the table when doing their work. It seems to be so random and improbable that everything would come together for us such that life would be for us as it is. It seems like the universe is made for us and so we must be important. Geocentrists made the world the center of the universe; but no matter how sophisticated the geocentric theory go, the earth kept revolving around the sun.

However, scientists did the best they could. Some dissented and saw ahead in time. Sometimes we saw through our arrogance, thinking that God or the gods would punish us for our attitudes; and so the orderly appearance of the universe might simply be our arrogance. With Copernicus, in the middle sixteenth century, the issue of our centrality came to the fore. Geocentrism was in danger. Vatican theologian Robert Cardinal Bellarmine saw it clearly; Galileo changes things even more when he saw that Jupiter had little moons circling it. He spent the rest of his life on practical house arrest as a result.

Isaac Newton only pushed things further. He came up with a simple system that predicted planetary motion. English amateur astronomer James Bradley stumbled on the "aberration of light" because he found that starts traced little ellipses against the sky, all of them. If the earth were at the center of the universe, you would not expect this. Science blasted forward, religion be damned. By the 19th century geocentrism was dead. We can now observe the truth directly and from many perspectives. The idea that we are not the center of the universe, however, has been resisted. We are anthropocentric and it is hard to believe otherwise.

Chapter 3, The Great Demotions, Chapter 4, A Universe Not Made For Us

Chapter 3, The Great Demotions, Chapter 4, A Universe Not Made For Us Summary and Analysis

Sagan calls the "Great Demotions" moments in scientific history that downgraded humanity's place in the universe. Galileo helped to show that the Earth was not the only "world" along with it not being the center of the universe, bringing about another great demotion. Other great demotions have occurred, however, such as our discovery that we do not live in the only galaxy, or that our galaxy is not at the center of the universe or that no other star has planets. Today we have even discovered planets orbiting other stars.

The fundamentalist monotheisms want the universe to be only 6,000 years old, but this raises the awkward question of why there are objects more than 6,000 light-years away. Saga realizes that God may have created all the photos of light in such as fashion as to mislead generations of astronomers, but this theology is "malevolent." Radioactive dating, impact craters, star evolution and so on suggest that the universe is billions of years old.

It turns out that humans are extreme latecomers to the universe; there is nothing special about our position or epoch in the universe. In fact, not even our frame of motion is sacrosanct, for Einstein showed the "absolute" physics was just another form of "Earth chauvinism."

However, perhaps humans are different from other animals. Darwin showed us that there is no problem here. Our reasoning—self-consciousness, tool-making, ethics, religion, language, etc.—does not distinguish us either. We're probably not even the only intelligent beings in the universe. We have only begun to look and we may even create intelligent beings smarter than ourselves.

Sagan then explains the Anthropic Principle, the Strong version of which holds that the laws of Nature and values of physical constants were established so that humans would come to be. Yet this is silly; it would be like achieving a rare hand in a bridge game and attributing its extreme improbability to the hand of God. We don't know how improbable life is anyway, how many different ways it could evolve, and so on.

What if the universe is infinitely old? Then there's no question of creation. If the laws hadn't been what they were, we wouldn't be here to ask the question; it's not arbitrary that the laws of nature are what they are. No, even those who take the particular laws of nature to be evidence of design are mistaken.

Sagan begins Chapter 4 with the story of Galileo's condemnation by the Roman Catholic Church in 1633 for saying that the Earth goes around the Sun. Galileo was forced to recant on June 22nd of that year and it wasn't until 1832 that the Catholic Church permitted Galileo's work to be read. In fact, the Catholic Church has expressly forbidden itself to reconcile with modern civilization in The Syllabus of Errors in 1864, although in 1992, John Paul II renounced the Church's denunciation of Galileo. The Pope of that time admitted that the Scriptures were not meant as guides to the heavens.

Still Sagan points out that if Christians admit that the Bible is not everywhere literally true, then the Bible cannot be an inerrant guide to ethics and morals. So it seems that science makes people nervous about the stability of the social order. Ultimately, religions make the world safe and familiar; but science threatens this sense of the world. Primates tend towards anthropocentrism. Science is dispassionate, cold and remote, failing to lift human spirits. What we should really want from philosophy and religion is the truth, not mere therapy or comfort. Religion is simply humanity expressing its infancy and waiting for a Parent to come.

However, science has brought more awe than religion has. Eventually a faith will emerge that accounts for this. Today, though, believing in a traditional faith involves a blatant disregard of the evidence. We have no idea why we are in the universe. Life seems meaningless and absurd. We must simply overcome our fear of being tiny; for we will find ourselves in front of a vast and fascinating universe. Science brings us real hope and humans have accomplished great things despite religion getting in the way. The evidence science has explained does not require a designer.

Chapter 5, Is There Intelligent Life on Earth?, Chapter 6, The Triumph of Voyager

Chapter 5, Is There Intelligent Life on Earth?, Chapter 6, The Triumph of Voyager Summary and Analysis

Sagan opens asking the reader to suppose that she is an alien happening upon the earth in a spaceship for the first time and to consider the observations of her sensors. He uses this supposition to illustrate various meteorological features of the Earth. The illustration is used to show that one could learn an enormous amount about the earth before realizing that there is an intelligent life there. Life would be obvious, but not intelligence.

Only if the alien examined radio waves in some detail would she notice or if she zoomed in on the earth to the 100-meter range. Even at this distance one would know very little about human life. Even at low resolutions, the meter range, intelligence would become apparent but it would not be clear how humans fit into the story or whether they were the intelligent species or part of it.

Sagan finds it "sobering" that from space is it so hard to see human intelligence but easy to detect other features of earth, say, bovine flatulence. He then notes that the aliens would notice not only us but how we are destroying our world, by increasing the carbon dioxide in the atmosphere and destroying the rain forests. Maybe humans aren't so smart after all!

In Chapter 6, Sagan notes that NASA has had many engineering failures. It is an aging bureaucracy, but NASA still has had many triumphs, such as the Voyager Satellites and the Hubble Space telescope. Many other good things have come from this research. Voyager 1 and 2 opened the Solar System to humanity starting in August and September 1977 respectively. In the next twelve years, they sent back important information about many new worlds and continue to do so.

The Voyager spacecraft use trajectory and planet gravity to fly further away from earth and send back new information. Both Voyagers were sent to look at planets but at different ones. Voyager 2 was set-up for a flyby of Jupiter, then Saturn, Uranus, Neptune and on to the stars. NASA's Jet Propulsion Laboratory (JPL) had few funds and could only build satellites to make it to Saturn, but good engineering and design helped them go farther.

Sagan then reprints many of the photos they took and he describes their trajectory in detail, along with their navigation mechanisms. He notes that the radio communication

time stretches out and that both satellites often malfunction but their functioning is still impressive. The Voyagers should continue returning data through 2015.

Sagan thinks that Voyager is an intelligence, part robot, part human, extending humanity to far off worlds.

Chapter 7, Among the Moons of Saturn, Chapter 8, The First New Planet

Chapter 7, Among the Moons of Saturn, Chapter 8, The First New Planet Summary and Analysis

Sagan begins Chapter 7 describing the forms of life on Earth, where organic molecules formed on asteroids crash into earth, giving rise to microbes which in turn evolve into all the life we know today. Much of the process remains mysterious. Certain atmospheric preconditions were required to get the life we know.

It turns out that there is one sphere in the Solar System capable of the same feat, Titan, the largest moon of Saturn. Titan is very cold; however, once molecules are synthesized on Titan, they stick around, so the cold is an advantage.

The telescope opened many doors toward the discovery of Titan. In 1610, Galileo first discover the moons of Jupiter with his telescope. He saw a miniature solar system. Sagan says he grew up with Titan, doing his dissertation at U Chicago with Gerard P. Kuiper, who discovered that Titan had an atmosphere and that it had methane, one of life's building blocks. Sagan then notes other discoveries about Titan made by Kuiper's other students and Sagan's own students.

Our understanding of Titan was dramatically expanded by the 1980 and 1981 arrivals of Voyager 1 and 2 in the Saturn System. Nitrogen was found in large quantities as, again, was methane. Voyager 1 discovered a large range of energy surrounding Saturn which could irradiate the right amount of energy to Titan to create life. Sagan then tells the story of being involved in this discovery. Sagan also comments that while conditions for the evolution of life on earth were different than those on Titan, the relevant similarities hold.

Sagan laments that we still know so little about Titan. He mentions, for instance, that we do not know whether Titan has hydrocarbon oceans. Sagan mentions that he and another scientist, Dermott, calculated that such oceans should be there. He then mentions that Cassini will be able to help verify his hypothesis around 2004.

In Chapter 8, Sagan discusses the power of the simple night sky and speculates on how it must have affected ancient men. He discusses the development of the days of the week and growing knowledge of the planets. Initially, many believed that there could be only seven planets because seven was a perfect number but Galileo showed that there were more. Over time, numerological blockages to science were undone, even as they continued beyond Galileo's day.

Many believed that there were no new planets beyond Saturn, but Uranus was discovered by a musician, William Herschel. We have learned more about Uranus over

time. It has no solid surface, but atmosphere and clouds. Its air is hydrogen and helium. Some hydrocarbons are present. It also seems to lack a source of internal heat, unlike Saturn and Jupiter, but more like earth. Uranus is laid on its side and has an anomalous orbit.

In 1977, scientists discovered that it has rings. We now know that it has five large moons: Miranda, Ariel, Umbriel, Titania, and Oberon. Herschel found two himself. In 1986, Voyager 2 returned 4,300 pictures of Uranus to Earth; it has an intense radiation field. Ten more moons were found during this time and new pictures of the first five moons were revealed.

Chapter 9, An American Ship at the Frontiers of the Solar System, Chapter 10, Sacred Black

Chapter 9, An American Ship at the Frontiers of the Solar System, Chapter 10, Sacred Black Summary and Analysis

Neptune was Voyager 2's final destination. It is the penultimate planet, second only to Pluto. Neptune is extremely cold but it has heat in its interior. It was discovered in 1846 and has still not managed to make a complete revolution around the sun. Neptune is four times larger than earth and its blueness is its atmosphere, mostly hydrogen and helium. It also has a Great Dark Spot and rings. Its largest moon is Triton. Sagan then describes Triton in some detail. It bears various similarities to Titan but it has more rock and less ice.

Some scientists speculate that many planets with the building blocks of life exist beyond Pluto and that early events in the formation of the Solar System brought them about. They are probably mostly gone, some fallen into the Sun the others thrown into space. Other larger worlds may be hiding far away. Comets are there too, but they are not planets.

There may be planets around other stars, but some are so young that they only have disks that have not yet accreted into planets. Sagan then discusses some cases. No planets have been decisively discovered but efforts are underway to find some. Sagan describes some candidate star systems.

The Voyagers found no signs of life, much less intelligence in the outer Solar System. It would not have detected us from far away anyway. Yet there were not even the faintest of indications. Sagan thinks we might be missing something. He suspects in the future that we will find earth-like planets and scrutinize them for life. The Voyager spacecraft are going to the stars. We may as well.

Sagan tells the reader that the Voyager spacecraft's radio transmitters will die but that both contain golden phonograph records with greetings for other life. Most likely no one will ever find them, given how empty space is; but there is time to find them. It's a question to Sagan whether aliens will be able to decipher the information but they will know that the Voyager spacecraft were intelligently designed.

In Chapter 10, Sagan notes that different planets have very different skies and can be identified by them. Some have flown into the atmosphere, however, and seen the sky turn to black. Sagan then discusses the causes of the colors of these atmospheres,

particularly earth's. He also explains why the sunset is red. He then covers the appearance of the moons and skies of other worlds.

Chapter 11, Evening and Morning Star, Chapter 12, The Ground Melts

Chapter 11, Evening and Morning Star, Chapter 12, The Ground Melts Summary and Analysis

Venus is both the evening and morning star, along with being the subject of Chapter 11. Venus was first explored in 1960 and 1961 by Mariners 1 and 2. Sagan reviews the structure of the Venusian atmosphere, thick with sulfuric acid. Galileo 1 traveled to Venus twenty years later. The Pioneer 12, Magellan and Soviet Venera 15 and 16 used radar telescopes on Venus years later.

Many conceived of Venus as a sister world, as it has similar gravitation, mass and size to earth. However, it is in fact much different and this became clear in the mid twentieth century. It was much hotter than imagines and this heat was difficult to explain. Sagan then reviews competing explanations and his role in the theoretical controversy. He covers the discoveries of the various satellites that surveyed Venus over the years.

Chapter 12 begins with a discussion of volcanoes on Earth which show that the Earth's center is extremely hot. Volcanic eruptions push enormous amounts of debris into space. They also helped to form the final stages of the Earth, along with the Moon, Mars and Venus. Sagan then covers various potential volcanoes on the moon and the genuine former volcanoes on Mars. The volcanoes differ substantially between worlds. Mars's volcanoes are dead and Venus's while active function differently in the thick atmosphere surrounding them. Venus's volcanoes have generated a surface no more than 500 million years old despite the planet being 4.5 billion years old.

Oddly, volcanoes were even found on Io, the innermost of Jupiter's four large moons. In fact, it is covered with enormous volcanoes and they are thought to be generated by upwelling sulfur dioxide and molten sulfur.

Volcanoes seem to represent wounds in a planet, exposing their insides. The volcanoes are yet stirring spectacles, enhancing our sense of wonder and helping us to understand the volcanoes of our own world.

Chapter 13, The Gift of Apollo, Chapter 14, Exploring Other Worlds and Protecting This One

Chapter 13, The Gift of Apollo, Chapter 14, Exploring Other Worlds and Protecting This One Summary and Analysis

The moon was once understood as a symbol of the unattainable but when men landed on it, that notion was shattered. For many millennia, the moon was not even conceived of as a place, but in the last few centuries this changed. However, since 1972, no one from any nation has gone back to the moon and no one has gone anywhere save low earth orbit.

The reason no one has gone back is that going to the moon was about politics, about proving the United States superior to the Soviet Union. It was also showing about showing that the United States had the capacity to place weapons in space. One benefit of this attitude is that in those days it was easy to get money for space. We now know much more about the composition, age and history of the Moon than before the Apollo missions. The Apollo missions inspired the world and got many excited about science and exploration; the moon missions showed us that we share the same vulnerable planet and tell us what is important and what isn't.

Chapter 14 begins with the argument that space travel helps mankind to understand how petty its nationalisms are and how discovering any extraterrestrial life will revolutionize our understanding of our common biological design plan. However, environmental catastrophes threaten and are tied to planetary exploration. First, CFCs, chlorofluorocarbons, threaten to destroy the ozone layer, but they were discovered by two ivory-tower university scientists. It became clear to these scientists and those that followed them that CFCs threatened earth's survival.

The second catastrophe could arise from increasing greenhouse gas effects generated by carbon dioxide from burning fossil fuels. Sagan then explains the mechanism of global warming. He notes for climate change skeptics that Venus suffers from a massive greenhouse gas effect. Finally, nuclear winter is the third major potential catastrophe, the darkening and cooling of the Earth from fine smoke particles sent into the atmosphere perhaps by global thermonuclear war.

Planetary science, Sagan argues, helps to generate a broad, interdisciplinary point of view and aids in discovering and defusing environmental catastrophes. For this reason, Sagan still thinks that investing in space exploration would pay big dividends.

Chapter 15, The Gates of the Wonder World Open, Chapter 16, Scaling Heaven

Chapter 15, The Gates of the Wonder World Open, Chapter 16, Scaling Heaven Summary and Analysis

Sagan predicts that in the future there will be a nation of group of nations that will colonize new worlds and the human race will be on its way. Perhaps this planet will be Mars, the nearest planet whose surface we can see with a telescope. Sagan then describes the Martian terrain and how it apparent once had running water. Some Martian meteorites have hit the earth, giving us information about its surface. One day we might even retrieve subsurface rock and see if it has life. There is some reason to expect to find them, as Martian soil seems to contain organic material, and its moons, Phobos and Deimos, have it in rich supply.

Sagan transitions to discussing the Mars missions and satellite failures. Missions to Mars continue to be on the cutting edge of technology, but mission failure occurs. To date, however, only one Mars Observer was flown. Some information has been collected from Mars allowing artificial environments to be constructed.

A manned mission seems far off in the future, particularly because the Reagan Administration was not interested in a joint mission with the Soviets. The Soviet Union no longer exists, but Sagan hopes that the complementary technologies of the Soviet Union and United States will help the two programs to work together.

Whether there are cost-effective and supportable reasons to go to Mars is a hard question and there is no consensus. Sagan wants a permanent human outpost there. It could inspire and promote education but losses of spacecraft scare many. Mars also has more to teach than the moon and might be worth learning from. Sagan speculates on transportation methods.

In Chapter 16, Sagan speculates on the costs and benefits of a Mars mission, particularly when the money could be used here. The space program of the 1960s and '70s was expensive and it would be again. There were benefits, but they were unexpected. The space program is no longer motivated by nationalism and bureaucracies are hard to manage. Sagan then discusses various relevant government programs and difficulties estimating costs.

It looks politically impossible to bring about such a trip despite its technological feasibility. There might be profit lures, but it is hard to see what these would be. Perhaps it would generate fiscal stimulus to the economy. There are some non-monetary benefits, however, such as exploration and education. Sagan then explores the political dimensions and the steps that would be required to get such a manned flight off the

ground. Sagan's audiences, however, are impatient with practical details because they see in such a flight something inspiring.

Chapter 17, Routine Interplanetary Violence, Chapter 18, The Marsh of Camarina

Chapter 17, Routine Interplanetary Violence, Chapter 18, The Marsh of Camarina Summary and Analysis

The rings of Saturn are a "vast horde of tiny ice worlds" and are bound to Saturn by its gravity. It is not clear why Saturn has rings. The ring systems, Jupiter, Saturn, Uranus, and Neptune, are mysteries. They also differ from one another. Some think the rings came from planetary tides and Sagan explains the potential mechanism. Some rings will form into planets but others will not due to a lack of mass. Sometimes planetary collisions may produce the relevant matter.

Whatever the story is, the Solar System seems to have been produced through extraordinary but regular interplanetary violence. Again, there is no hint of intelligence here, in Sagan's view. As time goes on, the number of asteroids shrinks through gravity and collision. We know some of this from asteroid and comet-hunting scientists. Sagan then discusses the famous disrupted comet that crashed into Jupiter between July 16th and 22nd, 1994.

Sagan then explores the nature of the collision and asteroid paths generally. There are two-hundred known asteroids whose paths bring them near the earth. Many are bound for earth and this will have consequences. These asteroids differ in composition and will have different impacts as a result but they will certainly be disastrous.

In Chapter 18, Sagan discusses the impact of collisions on the earth. The Cretaceous-Tertiary Collision shows that asteroid impacts are causes of great peril and mass extinction. These collisions dramatically changed evolutionary history. As time goes on, the probability of such a disastrous impact increases, but even small impacts can cause incredible damage. World governments have now established detection systems for asteroids on collision-courses with earth.

We may want to practice landing on these asteroids to prepare for the future. Sagan then covers various methods by which impacts might be avoided, say through exploding nuclear weapons nearby or using rocket engines to change its course. There are worries about both strategies, even if all earth-bound asteroids are inventoried. The technologies required for the strategies may themselves prove dangerous. Some think it might be wise to move asteroids into earth orbit not only to make them safe but to mine them for precious metals. Sagan still worries that totalitarian societies might take advantage of threat systems. Deflection technology must be powerful and will therefore be dangerous.

In the end, dispersing humanity across the stars may be the only way to avoid extinction.

Chapter 19, Remaking the Planets, Chapter 20, Darkness

Chapter 19, Remaking the Planets, Chapter 20, Darkness Summary and Analysis

Sagan speculates that men might be able to live inside of asteroids, particularly carbon ones; the materials in asteroids could be used to synthesize products. Organic solids could be burned as fuel as well. Anti-matter might do as well, and mass manufacture of anti-matter may be available by the 22nd century.

"Terraforming" or modifying a planet for life would be feasible on Mars, where there is plenty of sunlight, water and carbon dioxide. As time progressed permanent colonies could be staffed. A new age of colonization may arise. And perhaps the Martian environment could be engineered so that men could live without elaborate settlement superstructures.

Sagan then examines the terraforming idea in more detail. Terraforming Venus would require reducing its greenhouse effect and blowing away much of its atmosphere. Mars would need more of a greenhouse effect and difficulties would arrive forming an ozone layer. The moons of Jupiter and Saturn present their own difficulties, but the easier would be Titan. The timescale for terraformation is quite large, however, but the right cultures would undertake them, particularly the culture of the United States.

Ethical questions arise, for instance about our moral authority to alter other worlds while destroying our own. Sagan thinks that one day we will have to answer these questions because if humanity is to survive, it cannot stay on the earth forever. Humans will change on other worlds.

Sagan exclaims that it is our fate to live in the dark in Chapter 20. The universe is almost entirely space, but there may be other life forms there, probably far behind or far ahead of us. This leads to a discussion of the search for extraterrestrial intelligence or SETI. Sagan thinks that the benefits of SETI outstrip the costs. He describes the machinery used to listen for alien radio waves and how millions of channels are currently monitored.

Various radiological problems are described and engineering problems related. Sagan also describes his particular project, META or Megachannel ExtraTerrestrial Assay. The point of META is to discern repeated radio patterns by monitoring a huge range of channels and looking for repetition. The NASA program SETI was turned on October 12th, 1992, with a radio telescope in the Mojave Desert. No sign of extraterrestrial intelligence has been found in decades but Sagan argues against those who would shut the programs down. The benefits of knowledge are simply too great.

Discovering an alien species would be perhaps the last "Great Demotion," uniting the earth as one and transforming our quest to find our place in the universe.

Chapter 21, To The Sky!, Chapter 22, Tiptoeing Through the Milky Way

Chapter 21, To The Sky!, Chapter 22, Tiptoeing Through the Milky Way Summary and Analysis

The history of space exploration is short but during this time the threat of humans destroying themselves entirely has become a reality. Sagan then recounts the many ways, including asteroid collisions and nuclear war. It looks like we are at a special point in history; we can wipe ourselves out and travel to the stars. Again, we may be forced to colonize space just to survive ourselves. Some attempts have been made to estimate our precarious human existence is and Sagan reviews them. He ends Chapter 21 arguing that while humans have no special place in the universe, they certainly have the right to colonize lifeless worlds.

In Chapter 22, Sagan notes that many religions have discouraged men from thinking themselves capable of anything. Sagan advocates on behalf of religions that encourage men to see their goal as that of becoming gods rather than worshiping them. We need a "myth of encouragement." Such responsibility will be difficult, though. Too much confidence will lead to disaster. Environmental problems much be faced and weapons of mass destructed destroyed. Authoritarian theocracy is to be resisted. World culture is needed but human vice will need restraint.

Sagan believes that spreading humanity across the stars would safeguard it from extinction. We would avoid having all of our eggs "in one basket." Sagan hopes that the many human worlds will all have ethics of exploration.

Sagan sees good things in the human future but acknowledges the difficulties of forecasting. He predicts, however, that even spreading across the planets in the Solar System will not be sufficient to safeguard humanity against possible disasters. At some point, the Solar System will become too dangerous. Sagan worries that sentient civilizations might destroy themselves at some stage of advancement that we have yet to reach, which would explain the apparent absence of alien species.

Sagan suspects that one out of every millions stars contain a technological civilization and that they are strewn randomly throughout the Milky Way. In a few centuries, one of these civilizations should receive our first radio signals. Perhaps they will visit. Sagan also suspects that some groups of humans will become alien in themselves, separating themselves off from humanity to preserve human existence.

Space exploration will lead us to encounter phenomena beyond anything we have encountered. Only 550 Astronomical Units out the effects of the solar corona on energy reception will die out and incredibly clear views will be available. Signals broadcasted

there would be able to reach many potential civilizations. There may also be "brown dwarf" stars where humans could live, survive and explore.

Stephen Hawking has worried that there may be many, varied small black holes. It isn't clear whether they can be or will be found. Some black holes may be in reach. They will be able to unveil new features of the laws of physics and contain a new source of energy. But all of this is only the beginning of potential speculation. Transportation advances will hopefully make space travel a live possibility. However, star travel may be tens or hundreds of generations in our future. Sagan notes that these people will not be us, although like us and he suspects they will have more strengths and fewer weaknesses.

At immense timescales, the centers of galaxies explode. A halo of dark matter surrounds the Milky Way and may extend halfway to the next spiral galaxy. We know little about this matter, which makes up perhaps 90% of the universe. Humans must ask how far the desire for safety will drive people outward. At some point, we may wish to exist the cosmic stage. In millions of years, we will be something else.

On the last few pages, Sagan brings the reader back from wild speculation. He notes that the pace of evolution appears to be quickening. Our next stage will be to colonize near earth asteroids and Mars. Once children are born off of earth, we will only have a fraction of humanity off world. And it will remain this way for a long time.

Sagan notes as we have lost religion we have lost a sense of a sacred mission and are left only with our fallibility but Sagan thinks this is good to bear in mind. In any event, a sacred project lies before humanity, and our survival depends on it. We can be unified by our dream of colonizing the universe; it will liberate us and give us a new telos. Religion is supposed to give us a feeling of being at home in the Universe. It can be our home if we are honest with ourselves about what it is. No extant religion helps us to feel at home in the real universe yet. That religion is in our future, past the Great Demotions.

The Cosmos may extend forever. We may be about to resume our ancient nomadic form of life; our descendants, spread across the worlds, will have a common heritage. However, they will gaze up and have difficulty finding the blue dot in the sky. They will love it but will marvel about how fragile human life once was and how humble our beginnings were.

Characters

Carl Sagan

Carl Edward Sagan is the author of Pale Blue Dot. He lived from 1934 to 1996 and was an American astronomer and famous science popularize. He was among the major promoters of SETI or the Search for Extraterrestrial Intelligence. Sagan presented a 1980 television series known as Cosmos: A Personal Voyage, viewed by over 500 million people. He also published a book by the same name. He wrote the novel Contact, which was the basis of the 1997 film. Sagan wrote more than 600 articles, essays and papers, and edited, authored or co-authored over twenty books.

Pale Blue Dot is one of Sagan's last works and it strongly reflects his endorsement of the values of skeptical inquiry, secular humanism and the scientific method. The book records many of his scientific achievements along with the scientific achievements of others. Sagan finds nature beautiful and inspiring and sees the perspective the astronomers take on the universe as humbling and moral, in that it shows just how small and insignificant humanity is.

Sagan is particularly focused on arguing that the Cosmos has no intrinsic purpose. In other words, it was not made for anything or for anyone, particularly not humanity. Sagan clearly sees religious belief, theism especially, as an obstacle to science and a series of illusions that people use to make themselves feel important and secure in a dangerous universe. Sagan prefers to stare reality in the face and find hope and meaning in a godless world.

Scientists

The main heroes of Pale Blue Dot are scientists, particularly the great early modern astronomers like Galileo and Kepler. Scientists play a key theological role in the historical story Sagan wants to tell about humanity's understanding of itself.

At each stage in modern history, it is the scientist who pushes humanity forward and anti-scientific figures, like ideologues and persons of faith, who hold humanity back. Sagan sees scientists as uncovering uncomfortable truths but boldly speaking these truths to power and he also sees scientists as discovering more impressive awe than any religious faith.

Sagan's story begins in the Medieval period before the rise of modern science. Eventually the dominance of the Catholic Church broke down and the Reformation and Renaissance occurred. Science began during this time as a result of free inquiry and valuing discovery and progress. During the Medieval period, men saw themselves as the center of the universe and believed that the universe was made for them but early scientists challenged geocentrism and showed that the Earth revolved around the sun.

This was among the first "Great Demotions" where humanity's belief in its own importance was diminished.

As time progressed, scientists discovered that even the sun wasn't the center of the universe; they found out that men evolved and had no special property that distinguished them from animals. They even discovered that the Milky Way galaxy was not the center of the universe. For Sagan the scientist is the honest hero of human history who helps us to both stay in reality and have genuine, rational hope.

Theologians

For Sagan, theologians tend to block scientific and moral progress because faith allows them to find meaning and comfort in a universe without it.

God

In some ways, God is Sagan's bête noire. He emphasizes again and again that there is no evidence for design in the universe of any kind.

Galileo Galilei

Galileo was the famed 16th and 17th century astronomer who proved that the earth revolved around the sun. He also ranks among the greatest "science martyrs" who suffered for advocating scientific truth.

Kuiper

Sagan's graduate adviser and friend for whom the Kuiper belt is named.

Sagan's Students

Sagan had many graduate students some of which helped him study the stars and planets. Some of his students helped him study Titan, the largest moon of Saturn.

Astronauts

Astronauts are another class of Sagan's heroes who first set foot in the heavens. Sagan compares them to the great explorers of the early modern period.

NASA

The National Aeronautics and Space Administration is the United States' government agency that runs the nation's space program. Sagan worked with NASA on many projects; Sagan was also one of NASA most vocal defenders.

SETI/META

In 1980, Sagan and some of his friends formed the United States Planetary Society in order to search radio waves coming to earth for signs of intelligence. As time progressed, their efforts grew increasingly sophisticated, resulting in the generation of META or the Megachannel Extra-Terrestrial Assay. BETA, or "Billion-channel Extra-Terrestrial Assay" came next. SETI or the Search for Extra-Terrestrial Intelligence is comprised of radio telescopes of varying degrees of power. In 1994, the United States Congress detached government support from SETI but the search continues.

Future Humans

Sagan suspects that future humans will be very different from what they are like today, with more strengths and fewer weaknesses.

Ancient Humans

Ancient humans were nomadic wanderers. Sagan suspects that we will become nomadic again when we start to colonize the stars.

Objects/Places

Pale Blue Dot

The Pale Blue Dot is earth but it comes from a photo of earth taken from a great distance. Sagan thinks the image shows us how insignificant we are.

Universe

For Sagan, a universe is a set of galaxies; we live in The universe, the only one we are aware of.

Cosmos

Sagan uses the word "cosmos" to refer to everything that exists, including anything beyond the universe.

The Solar System

The star system where the earth is located, along with seven other planets and the sun.

Voyager 1 and 2

Two robotic spacecraft launched in 1977 and 1978 respectively; they were intended to take pictures of far away planets and have done so successfully.

Rings

Jupiter, Saturn, Uranus and Neptune all have rings, but it is not clear why.

Moons

The only planet with no moons is Mercury. The gas giants all have many moons and Sagan talks about many of them in the book. He is most focused on Titan, Saturn's largest moon. It has been one of his objects of study for some time.

Aliens

Sagan helped to found SETI and suspects that there are aliens throughout the universe, perhaps one species for every million stars.

Venus

The second planet from the sun.

Mars

The fourth planet from the sun.

Jupiter

The fifth planet from the sun.

Saturn

The sixth planet from the sun.

Uranus

The seventh planet from the sun.

Neptune

The eighth planet from the sun.

Catastrophe

Sagan suspects that there are three forms of catastrophe that could currently destroy human civilization on the earth.

Terraforming

Terraforming is the process of converting other planets into habitable form.

Colonization

Sagan believes that humanity's survival depends on colonizing space.

Themes

Great Demotions and Pale Blue Dots

The title of the book, "Pale Blue Dot" indicates the book's primary theme. Sagan is particularly impressed with how small the Earth is compared to the universe as a whole. He was one of those who had one of the Voyager satellites turn to face the earth from millions of miles away and take a picture of our "Pale Blue Dot," and he draws a moral and theological lesson from the photo. It is this: we are small, insignificant and incredibly petty. Humanity should be united in hope and joy in the face of colonizing the universe and its potential for cosmic discovery. Instead we let nationalism, ideology and religion get in our way.

Humanity seemed to come into being believing that it was the center of the universe, and this manifested itself in a belief that the Earth was the center of the universe. Religion served to help humankind find meaning and comfort in a world that would otherwise seem terrifying to ancient humans who had so little control over their surroundings. However, religion makes humans self-centered and self-important. It is the scientist that humbles humanity. Scientific history has consisted in a series of "Great Demotions," or discoveries that reduced humanity's sense of its own importance.

The Great Demotions began with the refutation of geocentrism. Instead, scientists showed the world that the Earth revolves around the Sun. Eventually, however, even the Sun was found not to be the center of the universe, nor were humans particularly important in themselves. Instead, humans are continuous with animals, as Darwin showed. The final Great Demotion will, in Sagan's opinion, be when we encounter our first alien species.

Scientific Discovery

Scientific discovery is a major theme of Pale Blue Dot but it is a theme in two ways. Scientific discovery for Sagan is both an intrinsic good and an instrumental good. First, scientific discovery is an intrinsic good because it is simply good to know what is true and what is false. Science is the only solid and valid method of uncovering what is true and false. It often yields shocking conclusions but a sober person, honest with themselves, prefers to believe the truth, however horrible, rather than a comforting lie.

Thus, Sagan fills the book with beautiful descriptions of the universe and stunning pictures of space, stars, planets and moons in order to impress upon us the glory of knowing reality as it genuinely is. Even the details of geophysics are of fascination to Sagan because they tell us how awe-inspiring the universe truly is.

Sagan employs the glory of scientific discovery to another purpose. He argues that scientific discovery should displace other forms of inquiry. For instance, the idea that theology and revelation can teach us true facts about the world seems ridiculous and

obscurantist to a scientist like Sagan. Instead, scientists are those who reveal the truth to the religious, ideological and petty, showing them that reality is indifferent to their ridiculous doctrines. Thus, science is seen as a liberator and a force for promoting the progress of human social life.

Religion and Meaning in a Godless Cosmos

It is clear that Pale Blue Dot is partly a philosophical and theological book. It aims to show that the universe was not made for humans or even made by an intelligence at all. Sagan is interested in dispelling religious belief because he thinks it impedes human scientific and social progress. Religion gives us a comforting lie that helps us maintain our self-importance and prevent us from facing the fact that the universe doesn't care about us. On Sagan's view, religion must be displaced for mankind to reach the next stage in its evolution.

However, religion gives meaning to human life. And if we abolish religion, it seems that human existence has no purpose but what we give to it. Sagan acknowledges that this is unsatisfying. He prefers to face facts and believe the truth in any event, and is willing to accept that there is no human "telos" because there is no supernatural creator. However, Sagan is not ready to give up on the idea of faith and hope. Instead, Sagan suggests that a new religion must be built.

Specifically, this new religion should not prevent human beings from believing in scientific truth and should instead elevate science in its value scheme far more than any religion ever has. Further, it must be a humanistic religion, promoting the idea that humans have equal worth and dignity and that their suffering is an evil. Finally, this religion should give us a sense of purpose in helping ourselves to survive and unite, to produce beautiful things and to extend ourselves into the universe, always wandering and exploring, learning new things.

Style

Perspective

The perspective of Pale Blue Dot is that of its author, Carl Sagan. Sagan came of age during the high tide of Western atheism and skepticism. Everyone intelligent wished to be seen as scientific because science was held in such high regard. As such, Sagan has almost the caricature of a scientist's perspective on history, value, religion and truth. He sees history as humanity struggling to evolve to higher forms, and sees science as the primary means through which higher forms of being are achieved.

Sagan's perspective on value is highly humanistic. He sees humanity as having great value but also emphasizes how cruel humans are to one another and how much better it would be if humanity could take a more impartial and global perspective which would show that them they can live in harmony and unity. Sagan also sees ideology, religion and nationalism as fracturing this humanistic and universalistic perspective.

Sagan is quite hostile to traditional religion, particularly belief in God. He sees it as intrinsically self-centered and designed to give humans a false sense of security and allow some to control others. Scientists heroically refute religion with the truth itself and today, it seems clear to Sagan that a scientifically well-informed person cannot believe in a designer, creator God. Finally, Sagan believes that truth is objective and achieved through the scientific method primarily. He seems to believe in true ethical norms, but regards mysticism and religious experience as muddle-headed confusion.

Tone

The tone of Pale Blue Dot reflects Carl Sagan's key values. He is an ardent and well-known secular humanist, believing that humanity has great value but that there is no God or gods for us to ask for help. Instead, we are alone. Sagan's secular humanism comes out explicitly in the early chapters, particularly in Chapter 4, where Sagan argues that there is no evidence that the universe is designed for humanity.

The theme of secular humanism comes out in Sagan's presentation of the universe as profoundly empty, meaningless, alien and impersonal. He is frightened by humanity's arrogance and the problems that humanity makes for itself, particularly with respect to weaponry and the environment. However, he believes that space travel can harmonize humanity's interests and help them take a human perspective.

Sagan also strongly promotes the value of scientific inquiry. He carefully illuminates astronomical and planetary science for the reader and presents science as a method of inquiry with a power and awe that far exceeds anything religion could provide. The tone of a high value of scientific inquiry is also connected to his skepticism of certain claims made by many sects of humanity. Science is the path to knowledge and understanding; much else of what goes on is primarily posturing.

Thus, the tone of Pale Blue Dot profoundly reflects the values of its author; it presents and powerful view of the universe skillfully presented in Sagan's prose, but it is also heavily philosophically and theologically loaded.

Structure

Pale Blue Dot has a straightforward structure. It begins with an introduction, "Wanderers" that explains Sagan's view of the human conditions. We were once ancient nomadic wanderers and now we have settled in place on the earth. Yet he believes that we should turn out attention to space because that is where our future lies, to return to a wandering state. Chapter 1, "You Are Here" describes our insignificant place in the universe and Chapter 2, "Aberrations of Light," expands on this theme.

In Chapter 3, "The Great Demotions," Sagan introduces a historical vision of humanity beginning its history with a self-centered understanding of its place in the universe. However, heroic scientists gradually moved men off of this conception. In Chapter 4, "A Universe Not Made for Us," Sagan boldly argues that we live in a godless universe. Chapter 5, "Is There Intelligent Life on Earth?" shows how difficult it is to detect human life from space, further showing how small we are.

Chapter 6, "The Triumph of Voyager," reviews the missions of the two satellite probes, Voyager 1 and Voyager 2 and discusses Jupiter. Chapter 7, "Among the Moons of Saturn," introduces the moons of Saturn and their various properties. Chapter 8, "The First New Planet," discusses Uranus and Chapter 9, "An American Ship at the Frontiers of the Solar System," explores what we know about Neptune. Chapters 10 through 13 discuss various other features of the Solar System and the geology of the planets.

Chapter 14, "Exploring Other Worlds and Protecting This One," explains the dangers humanity presents to the earth and the possibilities of exploration. These themes also reverberate from Chapters 15 through 19; Chapter 19 discusses terraforming planets. Chapters 20 through 22 become more reflective, as the first chapters were and discuss humanity's future.

Quotes

"We were wanderers from the beginning." (Introduction, Wanderers, xi)

"Pale Blue Dot is about a new recognition, still slowly overtaking us, of our coordinates, our place in the Universe—and how, even if the call of the open road is muted in our time, a central element of the human future lies far beyond the Earth." (Introduction, Wanderers, xviii)

"Look again at that dot. That's here. That's home. That's us. On it everyone you love, everyone you know, everyone you ever heard of, every human being who ever was, lived out their lives. The aggregate of our joy and suffering, thousands of confident religions, ideologies, and economic doctrines, every hunter and forager, every hero and coward, every creator and destroyer of civilization, every king and peasant, every young couple in love, every mother and father, hopeful child, inventor and explorer, every teacher of morals, every corrupt politician, every 'superstar', every 'supreme leader,' every saint and sinner in the history of our species lived there—on a mote of dust suspended in a sunbeam." (Chapter 1, You Are Here, 8)

"There is perhaps no better demonstration of the folly of human conceits than this distant image of our tiny world. To me, it underscores our responsibility to deal more kindly with one another, and to preserve and cherish the pale blue dot, the only home we've ever known." (Chapter 1, You Are Here, 9)

"The entire Universe, made for us! We must really be something." (Chapter 2, Aberrations of Light, 15)

"For any human being in existence to think that there is nothing in the whole world superior to himself would be an insane piece of arrogance." (Chapter 3, The Great Demotions, 33)

"If we crave some cosmic purpose, then let us find ourselves a worthy goal." (Chapter 4, A Universe Not Made For Us, 57)

"Perhaps, you think, it's time to reassess the conjecture that there's intelligent life on earth." (Chapter 5, Is There Intelligent Life on Earth?, 79)

"The invention of the telescope in the seventeenth century led to the discovery of many new worlds." (Chapter 7, Among the Moons of Saturn, 106)

"Deep sky is, of all visual impressions, the nearest akin to a feeling." (Chapter 10, Sacred Black, 156)

"The volcanoes of other worlds provide a stirring spectacle. They enhance our sense of wonder, our joy in the beauty and diversity of the Cosmos." (Chapter 12, The Ground Melts, 201)

"What began in deadly competition has helped us to see that global cooperation is the essential precondition for our survival." (Chapter 13, The Gift of Apollo, 215)

"The lesson to me seems clear: There may be no way to send humans to Mars in the comparatively near future—despite the fact that it is entirely within our technological capability." (Chapter 16, Scaling Heaven, 268)

"The more science in the media—the healthier, I believe, the society is. People everywhere hunger to understand." (Chapter 16, Scaling Heaven, 281)

"Their eventual choice, as ours, is spaceflight or extinction." (Chapter 18, The Marsh of Camarina, 327)

"Maybe it's a long shot, but the discovery of extraterrestrial intelligence might play a role in unifying our squabbling and divided planet. It would be the last of the Great Demotions, a rite of passage for our species and a transforming event in the ancient quest to discover our place in the Universe." (Chapter 20, Darkness, 365)

"Sailors on a becalmed sea, we sense the stirring of a breeze." (Chapter 21, To The Sky!, 377)

"They will gaze up and strain to find the blue dot in their skies. They will love it no less for its obscurity and fragility. They will marvel at how vulnerable the repository of all our potential once was, how perilous our infancy, how humble our beginnings, how many rivers we have to cross before we found our way." (Chapter 22, Tiptoeing Through the Milky Way, 405)

Topics for Discussion

What is a "Great Demotion?" What spiritual message is Sagan using the Great Demotions to illustrate?

What is the Pale Blue Dot? What is it supposed to teach us about humanity's purpose? About human connectedness?

What is Sagan's argument that the world is not made for us? Is it any good? What does the fact that the universe is very large and appears without purpose imply about religious belief?

Describe Sagan's case for space exploration and colonization. What are his arguments? Are they successful?

Describe three important astronomical discoveries during Carl Sagan's time that he was involved in. What did he draw from these discoveries?

Name three potential sources of catastrophe that Sagan discusses. How might we avoid them?

What is Sagan's problem with traditional religion? Are his arguments any good? What do you think of his history of religion and science?

Sagan believes that humanity may have lost a sense of its purpose when it abandoned religion. How does he think humanity can get it back? What does he think the new human purpose should be?