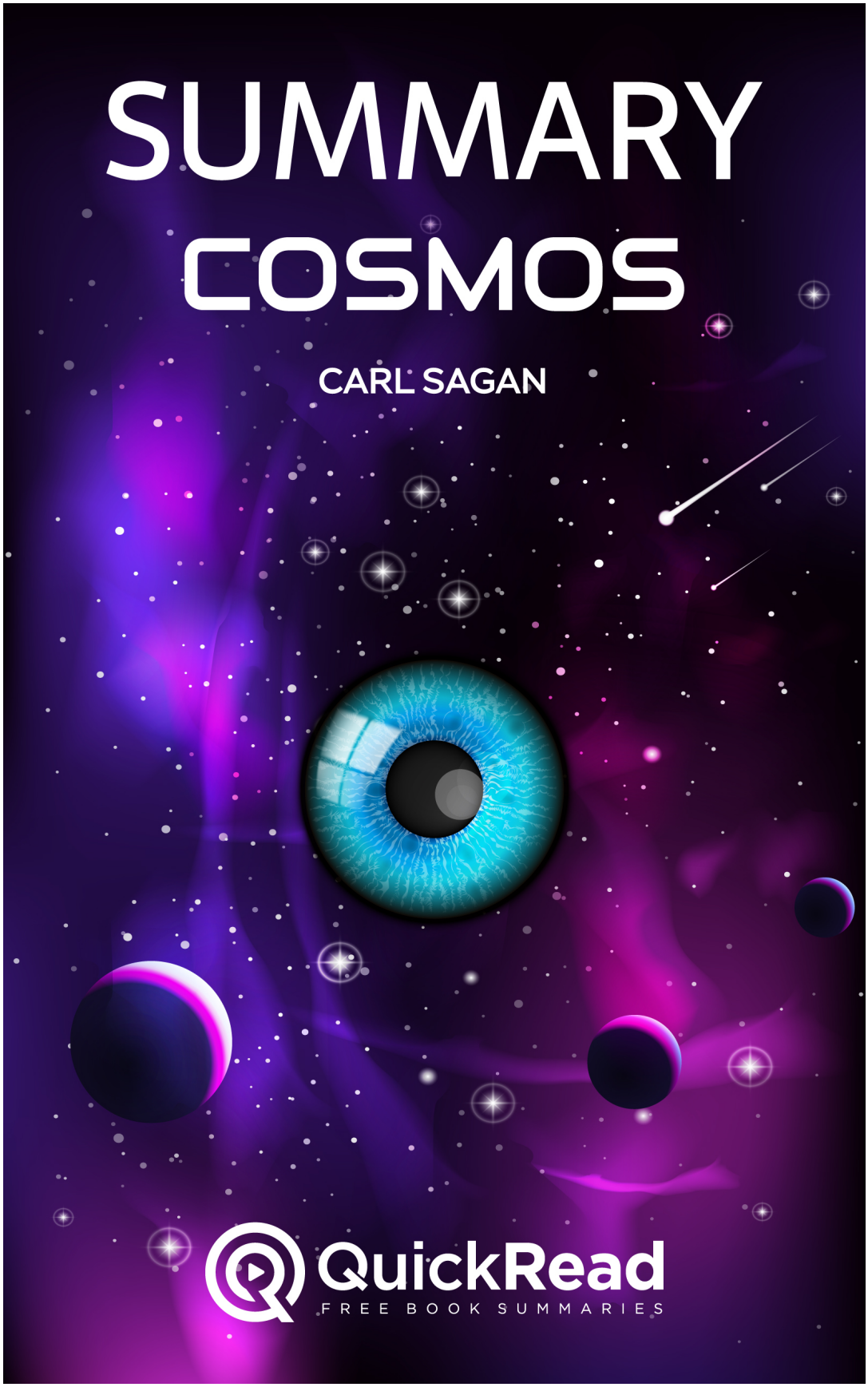
SUMMARY
COSMOS
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Summary of “Cosmos” by Carl Sagan

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Unlock the mysteries of the universe.

Introduction

Have you ever felt like you're the only person in the world? When we say it like that, it sounds incredibly selfish, but the truth is that it's all too easy to get swept up in that feeling! When our food is an hour late at the restaurant, for example, we get so caught up in our annoyance that-- for the moment-- it's all we can think about. When we're stuck in rush-hour traffic, we fret as though we're the only people in danger of missing appointments. Likewise, when we're standing in a long line or anxiously awaiting news, it's easy to feel as though we're the only people with annoyances today. But sometimes, when we take a step back and view our circumstances through the lens of mental clarity, we put our problems in perspective by saying things like, "But in the grand scheme of things, it's really not a big deal" or "Looking at the stars makes you realize just how small your problems are."

However, we rarely carry our introspection beyond that step. We don't often take extra time to consider how small we really are in relation to the vastness of the entire universe. And that's where Carl Sagan comes in. By putting the complexities of the universe into simplistic, user-friendly language, Sagan invites us to explore the universe through his research. Learning that the story of the cosmos is more than just math and physics can show us that the universe isn't accessible only for scientists and astronauts. Every one of us can connect with it and take a journey through time and space.

Earth is Actually A Speck of Dust

Okay, not really. It's still a planet. But Sagan uses this example to speak metaphorically. Because earth is everything to us-- it's quite literally our whole world!-- if we do think outside of ourselves and our own problems, we usually only contemplate earth. That's why Sagan points out that if we think about earth in relationship to the entire universe, it's actually no bigger than a speck of dust! And that's because of the magnitude of the universe itself. In fact, that sheer size is why scientists have developed a new form of measurement exclusive to the universe.

"Light-years" might sound cool when they say it in shows like Star Trek or Star Wars, but it's so much more than just something to say in a galaxy far, far away. As Sagan explains, scientists chose light-years as a unit of measurement because light is the fastest unit of measurement. In fact, it can travel 186,000 miles in only one second! That's seven times around the circumference of the earth in the time it takes you to blink! So, if that's how far light can travel in a second, how far can it actually travel in a year? The author tells us that one light-year equals 6 trillion miles, a number most of us can't even fathom! So, unsurprisingly, that's why we use light-years to measure the vastness of space and time.

But now that we know how we measure the Cosmos, let's think about what it contains. (And if you didn't feel like your problems were insignificant before, get ready!) Because the Cosmos contains a hundred billion galaxies. If you're like most people, your brain can't even stretch to imagine how much that really is. Most of us have never seen a billion of anything, let alone a billion galaxies, each with their own complex life cycles and solar systems. For most of us, "a hundred billion" just sounds like the kind of hyperbolic number we would have made up when we were kids! That's why we use mathematical formulas to simplify it a little bit by writing it out as 10^{11}. But if your mind isn't blown already, then let's consider that each separate galaxy contains 10^{11} planets and 10^{11} galaxies! And as the author explains, that makes our planet only one of 10^{22} planets in the Cosmos.

When you think about it that way, it kind of makes you wonder how we could ever think our problems matter at all!

The Stargazers

Did you ever lay in the grass in your backyard as a kid and stare up at the stars? Did you ever learn about the constellations and try to identify them for yourself? We've all probably interacted with the stars at some point in our lives, but stargazing is by no means a pastime of the modern age. In fact, the author points out that as long as there have been human beings, there have been people who gazed up into the night sky and wondered about the stars. And though today we might bask in the security of our modern advances, in the olden days, stargazing wasn't just for fun, it was also useful. That's because early scientists were learning about the galaxy as a way of making sense of the world.

For example, records found in cave paintings indicate that our ancestors used the positions of the stars as a means of telling time. They learned to identify seasons based on the movements of the heavens. They coordinated the times to plant and harvest their crops, to hunt, to connect with other tribes. They might not have known what to call the heavenly bodies they gazed at, but they knew they could trust them to order our lives. The author explains that that's because stars are predictable. If you watch the sky long enough, he acknowledges, you'll be able to observe that the planets move through the sky in a sort of circuitous loop.

This observation led early philosophers to theorize that the planets move on some sort of rotation (which they do) and to get it slightly wrong by suggesting that the earth is the center of the universe. Once again, through this logic, we see how human perception colors our understanding of the world; because the earth is the center of our universe, we assume it must be the same for the entire Cosmos. But of course, as Nicolaus Copernicus discovered in 1543, the planets (including earth) actually revolve around the sun. 60 years later, astronomer Johannes Kepler expounded on this theory by positing that the planets actually orbited around the sun in an elliptical fashion. This challenged the pre-existing widely accepted theory that the planets moved in a circular rotation and, after Kepler was able to

prove it, his theory of the laws of planetary motion replaced the prior assumption. And although he formulated his theory in 1605, a mere 60 years after Copernicus first discovered that the earth revolves around the sun, Kepler's principles form a major pillar of modern astrophysics today!

Life on Other Planets

The possibility of life on other planets is a question that has endlessly fascinated humanity. We ponder the possibility of alien invasions and little green men as much as we question our potential for intergalactic exploration. Could we form a colony on Mars? Could we exist somewhere else if our own planet was destroyed? The answer, according to Sagan, is both yes and no. Considering the other planets available for potential habitation, the author begins by acknowledging that human life could never exist on Venus. That's because Venus is 67 million miles closer to the sun than Earth. That means it gets significantly hotter than Earth, with average temperatures reaching 900 degrees Fahrenheit. So, if we wanted to try and explore Venus, we'd all be pretty crispy critters in a hurry!

But even if, by some miracle, we managed to avoid literally frying to death, there are other factors which render Venus inhospitable for human life. For example, its atmosphere is over 96% carbon dioxide! And the clouds on this planet are also comprised of pure sulfuric acid. So, there's no doubt about it: Venus is a toxic environment for any living thing. But the same isn't true of Mars, our red planet. For starters, it's closer to Earth than to the sun, and it's pretty similar to Earth in a few key ways as well. Its days are 24 hours long, for example, and some of its geological features-- polar ice caps and white clouds for example-- resemble features common to Earth.

So, even though we have no proof that aliens do or ever have existed on Mars, it's not a stretch to assume that humans could create a life on the red planet. Even though the temperatures on Mars are significantly colder-- ranging from an average of 32 degrees Fahrenheit to -112 degrees Fahrenheit-- this climate is actually quite similar to that of the Antarctic and we know humans can sustain life there! The biggest difference, however, would be in the supply of water available to us on Mars. Unlike Earth, Mars possesses no oceans and no other large bodies of water. In fact, there is no water in its entire atmosphere! This would pose a variety of new difficulties in constructing a colony on Mars, but the author theorizes that

we could perhaps melt Mars' polar ice caps and craft our own man-made water canals to replace natural bodies of water. So, if you're dreaming of life on another planet, don't give up hope!

But Are we Sure Aliens Don't Exist?

Having established the fact that there is no extraterrestrial life on Mars or Venus, the author now turns his attention to one of humanity's most pressing questions: the existence of aliens. Maybe it's because we're a little bit scared. Maybe it's because we're fascinated by the idea of little green men in spaceships. But no matter what our reason is, one thing is for certain: human beings are obsessed with the possibility of discovering extraterrestrial life. And that's why Sagan devotes this chapter to applying scientific reason to this question. So, if there is life on other planets, what would these other life forms look like? How would they reach us?

Although Sagan can't answer either of those things for sure, he posits that we can know one thing: "aliens" would definitely look very different from human beings. They might not be green and they probably wouldn't sprout antennae or tentacles like their most common depictions in the movies, but they would look different because their climate, evolution, and biology is not only not human, it would also be dictated by a different set of planetary laws. For example, Earth has generated such varied life forms as the centipede, the single-cell amoeba, and the basking shark. Each of these creatures are radically different from one another and they evolved in very different climates. The only thing they have in common is that planet Earth provided them all with the necessary evolutionary conditions to develop and grow.

Therefore, the same would be true of life forms on another planet, who would evolve according to the laws of their own unique environment. And even though they might be alive, the author speculates that these other life forms wouldn't necessarily be humanoid in nature. They might be more similar to plants or stars and thus unlikely to make contact with us through traditional human communication channels. But if humanoid lifeforms did exist and attempt to make contact, Sagan remarks that it probably wouldn't be through the dramatic spaceship crash-landing depicted in the movies. Instead, if we were going to communicate with extraterrestrial beings, it

would likely be through radio. That's because this form of communication would likely be accessible to any developed civilization and because radio waves can be used to communicate across very long distances, it's something we, as humans, would easily pick up on.

So, what would they say? Again, it's impossible to know for sure, but it's unlikely to be the type of direct or hostile threats we see in alien invasion films. The author posits that a message composed of prime numbers would be more likely because we could quickly and easily work out that this is a message rather than a blip of the radio waves. Does that mean aliens communicate through numbers? Does that mean we share a numerical system with other lifeforms? Sadly, these questions are also impossible to answer right now, but they're definitely intriguing to consider!

Final Summary

As human beings, it's easy to get lost in our own heads and overestimate our own importance. We often assume that our problems are of utmost significance or that we are the center of our own universe. But if we pause for only a moment to consider the magnitude of the Cosmos, any sense of our own importance fades away. As we grapple with the vastness of a seemingly endless entity and ponder the billions of galaxies it contains, our own problems pale in comparison and we are invited to explore the mysteries of the universe.

Carl Sagan writes to make these mysteries accessible by exploring such questions as the Earth's relationship to the Cosmos-- it is, in fact, only one of a billion galaxies-- and the possibility of extraterrestrial life. We can also use his study of the universe to chart a connection to our primitive ancestors by learning how early man used the stars to navigate life. And by comparing the early advancements in astronomy and physics, we realize that modern science isn't quite so modern after all. In fact, some of our foundational principles were developed in the early 1600s! This proves that time and space places no limits on the possibilities that can be achieved by an inquiring human mind.