https://www.youtube.com/watch?v=qS7tt_9P1k8

What Is The Universe Expanding Into?

Do čeho se vesmír rozšiřuje? Historie vesmíru

History of the Universe

991 tis. odběratelů

306 699 zhlédnutí 15. 2. 2025

Go to https://ground.news/hotu to stay fully informed on what's happening in and out of our solar system. Subscribe through my link to get 40% off unlimited access. ---------------------- Written by Colin Stuart Check out his fantastic astronomy newsletter here: https://colinstuart.substack.com

306 699 zhlédnutí 15. 2. 2025 Přejděte na https://ground.news/hotu a zůstaňte plně informováni o tom, co se děje v naší sluneční soustavě a mimo ni. Přihlaste se k odběru prostřednictvím mého odkazu a získejte 40% slevu na neomezený přístup.

0:00
(01)- "You must not attempt this approach to parallels. I have traversed this bottomless night, which extinguished all light and joy in my life. I entreat you, leave the science of parallels alone…" Two trains hurtle along tracks side by Two trains hurtle along tracks side by side, straining every rivet and bolt. It's neck and neck, one locomotive inching in front of the other, before conceding ground. Crowds line the sidings, waving flags and cheering for their favourite engine in this unusual race. Then the unthinkable happens. Gasps ring out as the trains smash into each other, metal folding like paper as they burst into flames. But how could this have happened? After all, the tracks the trains were racing along were parallel. The very definition of
1:01
parallel lines is that they will never meet, no matter how far you extend them. How could they have come together? Mathematicians have studied parallel lines for millennia. Among the earliest to juggle with these ideas was the Greek polymath, Euclid - often referred to as the Father of Geometry. Euclid penned one of the most influential books ever written, Elements - containing many of the rules that underpin mathematics to this day. And the fifth of these rules is called the parallel postulate. This effectively states that two trains travelling along parallel tracks should never, ever meet. The other four postulates were quickly proven, but the parallel postulate remained evasive, unproven for almost two thousand years. Until finally, in the 19th century, mathematicians dropped an existential bombshell. The postulate hadn't been proven because it couldn't be. Two parallel lines could meet after all.
2:06
Suddenly, Euclidean geometry was no longer the only game in town. It became possible to bend and contort space in ways that completely upend the usual rules. Indeed, among those who broke Euclid's parallel postulate was Hungarian mathematician night that extinguished all joy in his life. But what does this mean? And why does this matter outside of mathematics? The answer, as we will see, is truly bizarre. For today, non-Euclidean geometry

lies at the heart of one of the most fundamental questions in the universe. A cosmic question close to the top of the list of those asked to astronomers. Our journey towards answering this question will take us to bizarre, twisted universes where light loops round and we can see the same galaxies multiple times in the sky. It will guide us through universes folded back on themselves, universes where if you look hard enough you may see yourself staring back - and universes where parallel lines meet again and again and again.

3:04

It is a trip that will defy common sense, but is guaranteed to leave you with a much deeper understanding of the cosmos in which we live - and possibly even which cosmos in which we live. And the question we will be answering? If the universe is expanding, just what is it expanding into...? On the 27th of December 2024, a telescope in Chile discovered something that caused the UN to activate a planetary defence protocol for the very first time. The telescope had discovered 2024 YR4, an asteroid the size of a football field, that if it hits Earth in 2032 will unleash hundreds of times more energy than the Hiroshima bomb.

4:00

But the question is - will it? With breaking news like this, especially science breaking news, which is very susceptible to hyperbole, it is hugely important to know where your information is coming from, which is why I use Ground News as an indispensable resource when researching, and they've kindly helped make this video possible. Ground News gathers the world's news in one place so you can compare coverage and verify your information. For the 2032 asteroid, it lists 224 news sources all on one handy page, and rates each publication for bias and factuality, as well as providing information about the publication's ownership. For example, one source listed as 'mixed factuality' originally ran with the headline 'Graphic shows asteroid the size of a football pitch on course to hit Earth' whereas most of the sources listed as high or very high factuality were more up front that the chances of impact with earth are only between 1 and 2%. And so I encourage you to visit ground.news/HOTU or scan my QR code if you're looking for a quick

5:05

and easy way to stay fully informed, on any topic, Make sure you use my link to save 40% off unlimited access to their Vantage plan – the same one I use.

An Expanding Universe

In Medieval Naples, Pope Innocent IV lies on his sickbed. The Pontiff's advisors have just delivered the crushing news that his Papal forces have been overrun by Manfred, the King of Sicily. This devastating development is widely credited as the reason for his death just days later at the age of 59. And yet, in some circles at least, there are growing whispers that

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Suddenly, Euclidean geometry wasn't the only game in town. It was possible to bend and twist space in ways that completely defied the usual rules. Yes. Twisting, curving, packing space, space-time is the essence of matter production. This model is my HDV. I would never have guessed that such a breathtaking idea would not be read by anyone for 40 years, that no one would want to think about it. (and maybe another 20 years). Why? Indeed, among those who violated Euclid's parallel postulate was the Hungarian mathematical night that extinguished all joy in his life. But what does it mean? And why does it matter outside of mathematics? The answer, as we will see, is truly bizarre. For today, non-Euclidean geometry lies at the heart of one of the most fundamental questions in the universe. The cosmic question is near the top of the list of those that astronomers have been asked. Our journey to answer this question will take us into bizarre, twisted universes, where light goes around and around and we can see the same galaxies in the sky multiple times. ?? The warping, the twisting of dimensions belong to the microcosm of Planck scales. Conversely, in the vast expanses of the global universe, I would look for unfolded dimensions in which localities = galaxies float. It will take us through universes folded back on themselves, universes where, if you look closely enough, you will see yourself staring back - and universes where parallel lines meet again and again and again.

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It is a trip that will defy common sense, but it is guaranteed to leave you with a much deeper understanding of the universe we live in - and perhaps even which universe we live in. And the question we will answer? If the universe is expanding, what is it expanding into ...? On December 27, 2024, a telescope in Chile discovered something that caused the UN to activate the planetary defense protocol for the first time ever. A telescope has discovered 2024 YR4, an asteroid the size of a football field that, if it hits Earth in 2032, will release 100 times more energy than the Hiroshima bomb.

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and easy way to stay fully informed on any topic. Be sure to use my link to save 40% on unlimited access to their Vantage plan—the same one I use. **Expanding Universe**. In medieval Naples, Pope Innocent IV lies sick on his bed. The Pope's advisors have just delivered the devastating news that his papal forces were defeated by Manfred, King of Sicily. This devastating development is widely believed to have been the reason for his death a few days later at the age of 59. And yet, at least in some circles, it is increasingly whispered that

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(02)- the Pope's early demise came from an entirely different source. That he was, in fact, murdered. The proposed culprit? The ghost of a little known English bishop with whom he'd clashed time and time again. A clergyman by the name of Robert Grosseteste.

6:05

This supposed spiritual assassin was born in the 13th century and rose to become the bishop of the English cathedral city of Lincoln. Quarrelsome and restless, he sought reforms to the Catholic Church that would bring him into direct conflict with Pope Innocent IV as well as King Henry III. Yet it is Grossteste's contributions to the fledgling field of modern science that are far more noteworthy. For he was a particularly early advocate of the scientific method - and the crucial role of experiment in revealing the hidden laws that invisibly govern our world. To begin with, Grossteste was the first person in history to correctly explain rainbows as the result of the refraction of light. And light became somewhat of an obsession and played a central role in his version of something bishops and cosmologists both fixate on: the creation of the universe. According to Grossteste, the

7:06

universe began when light expanded outwards from a central point, before condensing into matter. This was a full seven centuries before modern astronomers would hit upon a similar notion. And so today, Grosseteste is known in some circles as the "Big Bang bishop". Grossteste died in 1253 and is buried in Lincoln cathedral. Miracles were reported at his shrine and he was widely considered a saint in England as a result. Although Grosseteste's sainthood was never ratified by the Vatican, in large part due to the rumour that his ghost murdered the Pope. But as we know Grosseteste´s idea for an expanding universe would not be developed in the following years - it would take more than half a millenia for it to raise its head again. And interestingly, it was another Catholic man of the cloth that would ultimately rekindle Grossteste's idea in the early 20th century: the Belgian priest Georges Lemaître.

8:04

Lemaître was lucky to even be alive at this point. As an artillery officer at Ypres during the First World War, he narrowly escaped the horrors of a cloud of chlorine gas when the wind changed direction and blew it away from him. Then, in the Second World War, the Americans accidentally bombed his home. In 1927, Lemaître published his solutions to the equations of Einstein's General Theory of Relativity, our best and most complete theory of gravity. He wasn´t the first to do this - people had been doing it for years - indeed Karl Schwarzschild had been one of the first more than a decade earlier, using his solution to propose the idea of a black hole. Lemaître's solutions however were different - they implied that the entire universe was expanding. But most ignored his findings. Einstein was among those who were brutally dismissive: "Your calculations are correct, but your physics is abominable," he said. Einstein famously would go on to tweak his

9:02

own equations to maintain a static universe. However, the seeds of the proof that Lemaître was right – and Einstein wrong - had already been sown - for in 1915, the American astronomer Vesto Slipher had announced his discovery that galaxies appear to be running away from us. And Slipher reached his landmark conclusion thanks to measurements of redshift, one of the most important weapons in an astronomer's armoury. First, take light from a galaxy and break it up into its constituent colours - much like Grosseteste correctly assumed raindrops do to create rainbows. Second, look for the dark bands hidden in this spectrum that represent missing colours swallowed by the various chemical elements that make up the galaxy. Finally, measure how far this pattern of lines has been shunted towards the red end of the spectrum. The more pronounced this "redshift", the faster the galaxy is receding from us. This was only one half of the puzzle, however.

10:05

The final, missing piece would be provided by Edwin Hubble in 1929. He measured the distances to galaxies, before comparing them to the speeds with which the galaxies are fleeing. In doing so he found a very strict pattern now known as Hubble's Law. The further a galaxy is from us, the faster it appears to be running away. How fast? According to modern measurements, about 23 kilometres per second for every million light years. And so Hubble immediately knew that Lemaître was right. The universe is expanding after all, just as the visionary Grossteste had suspected centuries before. Despite how often it is talked about, it's not always immediately obvious why the fact that more distant galaxies are fleeing from us

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the universe began when light expanded outward from a central point before condensing into matter. >It was a full seven centuries before modern astronomers came across a similar idea<. (…I have a lousy feeling about how my HDV will turn out? When will physicists notice it… .. er, …) And so Grosseteste is now known in some circles as the "bishop of the big bang." Grosseteste died in 1253 and is buried in Lincoln Cathedral. Miracles were reported at his shrine, and as a result he was widely regarded as a saint in England. Although Grosseteste's sainthood was never ratified by the Vatican, in large part because of a rumor that his ghost had murdered the Pope. But as we know, Grosseteste's idea of an expanding universe would not develop in the years that followed—it would be more than half a millennium before it reared its head again. And interestingly, it was another Catholic who finally revived Grosseteste's idea in the early 20th century: the Belgian priest **Georges Lemaître**.

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Lemaître was lucky to be alive at that moment. As an artillery officer in Ypres during World War I, he narrowly escaped the horrors of a cloud of chlorine gas when the wind changed direction and blew him away. One cloud is said to have killed a million people (?) Then, in World War II, the Americans accidentally bombed his house. In 1927, Lemaître published his solutions to the equations of Einstein's General Theory of Relativity, our best and most complete theory of gravity. He wasn't the first to do it - people had been doing it for years - indeed **Karl Schwarzschild** was one of the first to use his solution to propose the idea of a black hole, more than a decade ago. But Lemaître's solution was different - it suggested that the entire universe was expanding. But most physicists ignored his findings. Einstein was among those who were brutally dismissive: "Your calculations are correct, but your physics is atrocious", he said. Um, my HDV would say: "Your calculations are atrocious, but the idea is correct, tremendous". Einstein would famously go on to refine his

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https://www.hypothesis-of-universe.com/docs/c/c_455.jpg own equations to maintain a static universe. The seeds of proof that Lemaître was right – and Einstein was wrong – have already been sown – because in 1915 the American astronomer **Vesto Slipher** announced his discovery that galaxies seem to be running away from us. And when I announce that the universe is expanding, experts remain silent and many are offended. I even lecture that space-time from BB not only expands (in the flow of time) but =simultaneously= collapses (its dimensions) in locations into packages and these are then elementary particles of matter https://www.hypothesis-of-universe.com/index.php?nav=ea ; it expands into large-scale scales and collapses into matter into a mini-world. And even more: the universe is constantly, constantly being created all around us, in a boiling vacuum, on the Planck scale of about 10-40 m, that is how the infinite numbers of singularities are. That "first" singularity was the interface between two states: the pre-bang and the post-bang, when "instantly" the Universe changed the curvature **k = 0** to the curvature **k = infinity**. Inflation occurred UNPACKING dimensions to "acceptable" values, then plasma, etc…etc. And Slipher reached his breakthrough conclusion thanks to measurements of redshift, one of the most important weapons in the arsenal of astronomers. First, take the light from the galaxy and break it into the colors, which is again the famous warping of dimensions) of which it is composed – much like Grosseteste correctly assumed that raindrops form a rainbow. Second, look for dark bands hidden in this spectrum, which represent the missing **colors absorbed** by the various **chemical elements** that make up the galaxy. They were absorbed by the fact that the "packed curvature" drowned in those atoms….like some "packages" again https://www.hypothesis-of-universe.com/docs/c/c_275.gif ; Finally, measure how far this line pattern was shifted towards the red end of the spectrum. The more pronounced this "redshift" is, the faster it will move from

the galaxy is moving away from us. O.K. And they are moving away linearly only up to a certain distance towards the Big Bang. Then the curvature of the cp starts to grow and "Hubble's law" no longer applies. And that's why physicists make mistakes in estimating

distances and subsequently in estimating other parameters in the early universe. And they wonder what terrible things the Weber telescope is observing there But that was only half of the puzzle.
10:05 **The last missing piece should have been provided by Edwin Hubble in 1929**. He measured distances to galaxies before comparing them with velocities at which galaxies are fleeing. In doing so, he found a very strict (?!). formula now known as Hubble's law. However, "strict" only up to a distance of 400,000 years from the Big Bang. Then towards the Big Bang, the global large-scale space-time begins to noticeably /knowably warp…; https://www.hypothesis-of-universe.com/docs/c/c_239.jpg ; The further away a galaxy is from us, the faster it appears to be running away. How fast? By modern measurements, about 23 kilometers per second for every million light years. And so Hubble knew immediately that Lemaître was right. The universe is expanding after all, as the visionary Grossteste had suspected centuries ago. Despite how often it is talked about, it is not always immediately obvious, why more distant galaxies are running away from us. To me, it is obvious. The Big Bang was a "change of state" from **k = 0** to **k = infinity**, and…and then the cp started to unroll. From the perspective of the Big Bang, the expansion is getting slower and slower, or rather the curvature is changing slower and slower… fast in the early universe and now slow ◊ and that is exactly what Hubble observed: in the early universe, or closer and closer to the Big Bang, the expansion (unfolding) is getting "faster and faster".
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(03)- faster automatically means that the universe must be expanding. So let's nail the link with a more familiar example of something else that expands: bread. Bread with raisins in it - to be precise. Imagine mixing and kneading the dough, before placing it in the oven for an hour to bake. In that time it will double in size to give you a tasty treat. But now imagine placing yourself on one of the raisins and looking around you at the other raisins as the dough rises. A raisin that was initially one centimetre away from you will end up two centimetres away at the end of the baking time. It will have moved one centimetre in an hour. If a raisin was already two centimetres away from you to begin with then it will end up four centimetres away, moving at an apparent speed of two centimetres per hour. A third raisin initially three centimetres away would finish the bake six centimetres distant, apparently moving at three centimetres per hour.
12:03
In other words, the bigger the initial gap between you and raisin, the faster you'll see it move away from you. Why? Because the dough is expanding. It is not that the raisins are moving through the dough. Nor is more dough somehow being added. Instead the gap between the raisins is stretched by the existing dough's expansion. The more dough there was between you and a raisin to begin with, the more pronounced the effect of its expansion. Hubble's Law offers up an identical explanation for galaxies. As Slipher realised, most appear to be running away from us, but the galaxies themselves aren't fleeing through space. Instead, the space between the galaxies is expanding and carrying them ever further from us. The more space there was to begin with - in other words the further a galaxy is from us - the faster it will appear to move away. No new space is being added, merely existing space stretched. This is allowed by General Relativity - space and
13:06

time are malleable, inconstant things. And it is the expansion of the universe that is also responsible for the more pronounced redshift of more distant galaxies spotted by Slipher. As the light waves travelled towards Earth, they were stretched as the space they travelled through expanded. Of all the colours of the rainbow, red light has the longest waves. The more space the light had to travel through to get here, the closer to the red end of the spectrum the spectral lines will appear.This is a good illustration of another subtle point that often vexes people when it comes to fully understanding an expanding universe. People often ask about what happens to energy as the universe expands. Energy conservation is one of the most famous laws of physics, stating that energy can't be created or destroyed and that the total energy of a system must stay the same. However, energy is not conserved in an expanding universe.

14:07

The energy conservation rule holds for the kind of physics covered by Isaac Newton's three famous laws of motion where particles move through a benign background space that isn't changing. However, space is constantly changing in an expanding universe and so the total energy of the particles moving through it is not conserved in the same way. Redshifted light is a perfect example. As the expansion stretches out the light waves, they lose energy. The total energy of all the photons reaching Earth decreases, it is not conserved. And this expansion of the universe also leads to another curious effect. Light from the most ancient events takes longer to arrive as it has had to travel a long way through an expanding universe to get here. The result is that the oldest objects in the universe appear to evolve almost five times more slowly than the same events today.

15:12

The fact that the universe is expanding is clear, but when exactly did this expansion start? Well, if the universe is getting bigger day by day then it was smaller yesterday. It was smaller still a century ago and yet more minuscule nearly a millennium ago when Grossteste's ghost was supposedly seeing-off the Pope. And so how far back does this expansion go? It is Hubble's Law that tells us how much expansion there has been since the Big Bang. Rewinding the clock on this expansion tells us when the expansion started. At this earliest moment in the universe's history, every part of the modern cosmos was concentrated down into an infinitely small speck. This little piece of nothingness is what Lemaître called the "Primeval Atom" - today, astronomers call it the Big Bang. And rewinding Hubble's Law timestamps the beginning of this expansion at around 13.8 billion years ago. The very name of the event - The Big Bang - calls to mind some kind of explosion, one that continues to drive the ongoing

16:07

expansion of the universe even to this day. Understandably, people then ask astronomers for ……………………………………………………………………………………………..

(03)- faster automatically means that the universe must be expanding. Or it expands https://www.hypothesis-of-universe.com/docs/c/c_032.gif I repeat: "faster" at the beginning and with increasing billions of years it becomes slower and slower, because there is "nothing" to expand anymore, the curvature is getting smaller and smaller from about the first billion to 13.8 billion years… I think the idiots who insulted me for 20 years and still insult me and delete all my YouTube posts, that they understood, … they already understood. So let's nail the link with a more familiar example of something else that expands: bread. Bread with raisins - to be precise. Imagine mixing and kneading dough before putting it in the oven for an

hour to bake. During that time, it will double in size and provide you with a tasty treat. But now imagine that you lie down on one of the raisins and look around at the other raisins as the dough rises. A raisin that was originally one centimeter away from you ends up two centimeters away at the end of the baking time. It moves one centimeter in an hour. If the raisin was already two centimeters away from you at the beginning, it ends up four centimeters away and is moving at an apparent speed of two centimeters per hour. A third raisin, initially three centimeters away, would finish baking six centimeters away, apparently moving at a speed of three centimeters per hour.
12:03
In other words, the greater the initial gap between you and the raisin, the faster you will see it moving away from you. Why? Because the dough is stretching. At "our" age of the universe of 13.8 billion years, the curvature is global (almost) zero…only localities are unrolling (?) I don't know, (I'm not an omniscient being)… It's not like the raisins are moving through the dough. No more dough is added. Instead, the space between the raisins is stretched by the expansion of the existing dough. The more dough there was between you and the raisin at the beginning, the more pronounced the effect of its expansion. Hubble's Law offers the same explanation for galaxies. As Slipher realized, most of them seem to be running away from us, but the galaxies themselves are not running away through space. But they are still unrolling... Instead, the space between galaxies is expanding, carrying them further and further away from us. The more space there was to begin with - in other words, the further away the galaxy is from us and closer to the Big Bang - the faster it will appear to be moving away. No new space is being added, oh, who knows. Maybe the Universe is "growing", that "curvy locality" = Our Universe floating in an infinite flat space-time... it is just stretching the existing space. Stretching means "what"? This is made possible by the General Theory of Relativity - space and
13:06
time are malleable, unstable things. And it is the expansion of the universe that is responsible for the more pronounced >redshift< of more distant galaxies that Slipher spotted. I am convinced that the redshift is evidence of the "rotation of systems", the system of the observed object (e.g. a quasar) and the system of the Observer "passed" to rest. As the light waves traveled to Earth, they were stretched, as the space they traveled through increased. And maybe it was not (and is not) *stretching of wavelengths*, but it is the effect of the rotation of space-time, the curvature of dimensions... https://www.hypothesis-of-universe.com/docs/c/c_230.jpg ; https://www.hypothesis-of-universe.com/docs/c/c_231.jpg
Red light has the longest wavelengths of all the colors of the rainbow. The more space the light had to travel through to get here, the closer to the red end of the spectrum the spectral lines appear. This is a good illustration of another fine point that often worries people when it comes to fully understanding the expanding universe. People often ask what happens to energy as the universe expands. The conservation of energy is one of the best-known laws of physics, which states that energy can neither be created nor destroyed, and that the total energy of a system must stay the same. But energy is not conserved in an expanding universe.
14:07
The conservation of energy rule applies to the kind of physics covered by Isaac Newton's three famous laws of motion, where particles move through a harmless background space that doesn't change. But space is constantly changing in an expanding universe, so the total energy of the particles moving through it is not conserved in the same way. Redshifted light is a perfect example. As expansion stretches light waves, they lose energy. And if it's not

>stretching waves< but a system rotation or a wavelength fiction, https://www.hypothesis-of-universe.com/docs/c/c_231.jpg then even that energy isn't lost...** The total energy of all photons hitting Earth is decreasing, it's not being conserved. And this expansion of the universe also leads to another curious effect. Light from the oldest events takes longer to arrive because it had to travel a long way through the expanding universe to get here. **I don't know if time is being stretched, but I have "speculations" about it... The result is, that it seems that the oldest objects in the universe are evolving almost five times slower than the same events today. But this is denied by the Webb telescope (?!)

15:12

That the universe is expanding is clear, but when exactly did this expansion begin? Well, if the universe is getting bigger every day, then it was smaller yesterday. It was smaller a hundred years ago, and even smaller almost a millennium ago, when Grossteste's ghost supposedly saw off the Pope. And how far back does this expansion go? It's Hubble's law that tells us, wrong, how much expansion has occurred since the Big Bang. Winding the clock on this expansion tells us when the expansion began. Maybe the clock is winding down at a different rate "inside the galaxy" than "outside the galaxy (?) do we know for sure? Is the rate of time still the same? It's not. At this earliest moment in the history of the universe, every part of the modern cosmos was concentrated into an infinitesimal speck. This tiny piece of nothingness is what Lemaître called the "primordial atom"—nowadays astronomers call it the Big Bang. And the reversal of Hubble's law marks the beginning of this expansion about 13.8 billion years ago. The very name of the event—the Big Bang—suggests some kind of explosion that continues to drive the ongoing

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expansion of the universe to this day. Understandably, people then ask astronomers

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(04)- the location of the explosion. To point them to the place in the universe where the Big Bang banged. Where is the centre of the universe? After all, if a bomb exploded in a room then investigators sent in in the aftermath could piece together the necessary clues from the shrapnel and debris to work out where in the room the bomb went off. So why can't the same be done with the Big Bang? Well, the Big Bang created the universe. If a bomb exploded, and in doing so created a room, then it would make no sense to ask where in that room the bomb detonated. After all, the room didn't exist before the explosion. In an expanding universe everyone thinks that they are at the centre of the expansion, when in fact there is no centre at all. And so - It's clear that the universe isn't

17:12

expanding from anywhere, but then what is it expanding into? It is one of the other questions most frequently asked of astronomers, but also one that turns out to be trickier to answer than it first appears, with deep and profound consequences for the way we understand the universe…

The Shape Of The Universe

The view is magnificently monochrome as you hurtle high above the surface of the Moon. Prehistoric craters, smooth lava plains, soaring mountains and spindly volcanic rilles

18:00

jut and spread for as far as the eye can see. An ancient, empty wasteland touched only by twelve pairs of American boots in billions of years. Flying over the jagged lunar landscape is more than just breathtaking. It is also a journey through the history of science. You'll

find crater after crater named after the most towering figures ever to contemplate the cosmos. Indeed, this roll-call of celestial greatness includes Einstein, Hubble, Slipher and Lemaître. And it also includes two craters that sit on opposite sides of the Moon - one on the northern nearside and the other on the southern far side. Their geographical juxtaposition is apt because the two physicists they are named after - Wilhelm de Sitter and Hermann Minkowski - also lend their names to opposing possibilities for the shape of our universe. Which one turns out to be correct governs whether or not the cosmos will ever end - and has important consequences for our question of what exactly the universe is expanding into. Minkowski was once Einstein's professor. They didn't always see eye to eye, however. "He's a lazy dog who never bothered about mathematics at all," Minkowski once said of the most famous scientist who has ever lived. Indeed, Minkowski was far closer to the legendary German mathematician David Hilbert, who wrote a touching obituary of his friend. Referring to their shared scientific work, Hilbert said: "It seemed to us a garden full of flowers. In it, we enjoyed looking for hidden pathways and discovered many a new perspective that appealed to our sense of beauty, and when one of us showed it to the other and we marvelled over it together, our joy was complete." de Sitter, on the other hand, was born in 1872 to a judge, the latest in a long line of lawyers stretching back generations. However, Wilhelm would abandon enforcing the rule of law for a chance to understand the hidden rules of the universe.When he died of pneumonia in 1934, the New Times wrote of him: "He is not a cold, dispassionate juggler of Greek letters, a balancer of equations, but rather an artist... Only the musician can fully grasp what it must have meant to de Sitter to see the cosmos shaping itself in new ways in his formulas." And it is for their work on the overall shape of the universe that the two men are most remembered today. Minkowski space and de Sitter space are different ways to describe the way in which the fabric of the universe curves. Minkowski space is usually referred to as 'flat', which is not intuitively the clearest way to describe it - because to astronomers and mathematicians, 'flat' doesn't necessarily mean two dimensional like
21:00
a flat sheet. Instead it refers to space that has zero intrinsic curvature. Indeed, shortly we'll encounter multiple examples of 'flat' shapes that are very much three dimensional. Shapes drawn in Minkowski space follow the rules of Euclidean geometry, named after the Ancient Greek mathematician Euclid. Euclidean geometry may sound unfamiliar, but it is the bedrock of high school mathematics. Triangles drawn in Minkowski space, for example, have angles that add up to 180 degrees, just as our teachers repeatedly tried to drum into us. Parallel lines stay parallel - forever. What your teachers probably didn't tell you, though, is that this isn't true for all triangles. And to see why, let's return to the Moon… Imagine yourself atop the lunar North Pole. You travel down towards the lunar equator, crossing the de Sitter crater on
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(04)- the explosion site. Point them to the place in the universe where the Big Bang struck. Where is the center of the universe? After all, if a bomb exploded in a room, investigators sent as a result could piece together the necessary clues from the shrapnel and debris to find out where in the room the bomb exploded. So why can't the same be done with the Big Bang? (*) The Big Bang created the universe. My model is different. The Big Bang did not create the universe. The Big Bang was/was a "change of state" of the previous one, where there was only a flat 3+3D spacetime with **k = 0** , without matter (infinite, without the passage of time, without laws..). After the bang, there was a change of state of curvature of the flat dimensions to a state with **k = infinity**. Now the flow of time was "stopped", the unpacking of dimensions

was started, laws were recruited (laws were "born" and folded into a sequence, see explanation elsewhere). The curvatures of dimensions from **k= infinity** decreased exponentially to "acceptable" sizes, the state of the universe begins with plasma, i.e. foam of dimensions, boiling vacuum and elementary particles are born by "packing" dimensions into balls, 4 physical laws of the behavior of matter versus space-time are "set". BB was the first bang, **the fundamental change of state** and after it other changes of states develop, a bushy tree, into enormous bushiness of changes (up to the "big-cruich", when in that unreal "final" future there will be a slowdown of changes of states again, attenuation and…and according to Penrose to a cyclic new change from **k=0** to **k= inf**., i.e. Universe No. 2, and…and again in the next future Universe No. 3, Universe No. 4 etc. ; Universe No. "n". - - I repeat my opinion: BB did not create the >bigUniverse<. The Big Bang created "our universe" with matter that is born by "packing dimensions" ; https://www.hypothesis-of-universe.com/index.php?nav=e ; I worked on this vision for 10 years. If a bomb exploded and created a room, then it would make no sense to ask where in that room the bomb exploded. After all, the room before did not exist by explosion. The room did not, but the Universe did. It existed in the form of "all-round inert space-time". And where did it come from? Well, I don't know, only God knows. The space-time dimension can be imagined as three infinite straight lines of length and three infinite "threads" of time. Time does not tick, time runs only when the curvature of the time dimensions begins to unfold. Time ticks only when an object – a subject that cuts time intervals – starts to move along the time dimension. So Time as a quantity does not run, it does not tick…, time does not run for us, but we run for it, we after time…, an object after time, and that can also be a cursor< anything that cuts intervals. - - I have a lot of interpretations of visions "about time", "about the unfolding of dimensions", but it is pointless to keep repeating it over and over again (22 years), it is just stupid. || And so "what does the infinite line expand into? Well, it rotates until 90^0 you see only >point<, and then the second line "y" rotates until it becomes a point, and then the third line "z" rotates and becomes a point, **the point here is triune** (like God is triune). Now """God's Big Bang""" occurs, or a change of state to the state "NOTHING"....then another change of state and "SOMETHING" occurs, then...and it repeats cyclically, *nothing and something*, something is infinite and nothing is finite... or vice versa (!), that (?). So what is God? = Nothing and Something....nothing = something → here God is no longer triune, but dual. ☺ I have to finish the story so that Petrásek doesn't send psychiatrists after me. In an expanding universe, everyone thinks that the expansion is at the center, even though in reality there is no center. And so – it is clear that the universe is not 17:12
expanding from anywhere, but **to what does it expand**? It is one of the most frequently asked questions by astronomers, but also a question that turns out to be more difficult to answer than it seems at first glance, O.K., with deep and profound implications for the way we understand the universe… I have HDV… **The Shape of the Universe**. The view is beautifully monochrome as you hurtle high above the surface of the Moon. Prehistoric craters, smooth lava plains, towering mountains and thin volcanic cliffs
18:00
protrude and spread as far as the eye can see. An ancient, empty wasteland that has been touched by only twelve pairs of American shoes in billions of years. Flying over the jagged lunar landscape is more than just breathtaking. It's also a journey through the history of science. You'll find crater after crater named after the most sublime figures who have ever ||contemplated|| the universe. Me too… Indeed, this celestial-sized moniker includes Einstein,

Hubble, Slipher, and Lemaître. (!) And it also includes two craters that are located on opposite sides of the Moon—one on the north-facing side, the other on the south-facing side. Their geographical juxtaposition is apt, since the two physicists for whom they are named—**Wilhelm de Sitter** and **Hermann Minkowski**—also lend their names to opposing possibilities for the shape of our universe. Which one turns out to be correct determines whether or not the universe will ever end **Roger Penrose…** – and has important implications for our question of ||what exactly the universe is expanding into||.
To the point of being a double-digit number = God. Minkowski was once Einstein's professor. But they didn't always see eye to eye. “He's a lazy dog who never studied mathematics” Minkowski once said of the most famous scientist who ever lived. I also regret that I don't understand mathematics very well...I'd be done with that HDV by now. Minkowski was actually much closer to the legendary German mathematician **David Hilbert**, who wrote a moving obituary for his friend. Referring to their joint scientific work, Hilbert said: “It seemed to us like a garden full of flowers. We enjoyed looking for hidden paths in it and discovering many new perspectives that appealed to our sense of beauty, and when one of us showed it to the other and we marveled at it together, our joy was complete.” I'm single, and it makes me sad, terribly,...terrible that no one reads my model. (Ondřej Rotter is 80% to blame). It is an immense disgrace that suffocates me. On the other hand, de Sitter was born in 1872 to a judge, the last in a long line of lawyers stretching back generations. But Wilhelm would give up enforcing the rule of law for a chance to understand the hidden rules of the universe. When he died of pneumonia in 1934, Nový Čas wrote of him: “He is not a cold, dispassionate juggler with Greek letters, a balancer of equations, but rather an artist ... Only a musician can fully understand what de Sitter must have meant in his comosshares. And it is for their work on the overall shape of the universe that both men are best remembered today. Minkowski space and de Sitter space are **different ways** of describing the way the structure of the universe curves. Yes, different ways to describe… https://www.hypothesis-of-universe.com/docs/eng/eng_096.pdf (Eng) ; https://www.hypothesis-of-universe.com/docs/aa/aa_078.pdf (CZ) ; https://www.hypothesis-of-universe.com/docs/c/c_310.jpg Minkowski space is usually referred to as “flat”, which is not the most intuitive way to describe it – because to astronomers and mathematicians “flat” does not necessarily mean a two-dimensional
21:00
flat sheet. Instead, it refers to a space that has ||zero intrinsic curvature||. O.K. k=0. In fact, we will soon encounter many examples of “flat” shapes that are very three-dimensional. Shapes drawn in Minkowski space follow the rules of Euclidean geometry, named after the ancient Greek mathematician Euclid. Euclidean geometry may sound unfamiliar, but it's the foundation of high school math. For example, triangles drawn in Minkowski space have angles that add up to 180 degrees, just as our teachers repeatedly tried to drum into us. Parallel lines will stay parallel—forever. But your teachers probably didn't tell you that this isn't true for all triangles. And to see why, let's go back to the Moon... Imagine you're at the lunar north pole. You're traveling down toward the lunar equator, crossing the de Sitter crater.
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(05)- the way. Upon reaching the equator you take a 90 degree turn, travel along the equator for a while, then take another 90 degree turn that sets you back on a path back to your starting point on the North Pole. Your entire journey traces

22:07
out a triangle across the craggy lunar surface. However, the base of this triangle already has two angles each equal to 90 degrees. The other angle at the North Pole is not zero and so the angles in this triangle must add up to more than 180 degrees. In fact, it is possible for a triangle drawn on a sphere to contain up to 540 degrees. This is an example of non-Euclidean geometry. A similarly shaped universe is referred to as closed. Just like circumnavigating the Moon or the Earth, even if you travel in a straight line you'll still eventually loop back round and return to where you started. Space with positive curvature is also known as de Sitter space.

23:02
There is a third possibility, however: anti de Sitter space. In this version of non-Euclidean geometry, the angles in a triangle add up to fewer than 180 degrees. This is due to the negative curvature of the space, similar to the shape of a saddle or even a Pringles chip. A universe shaped like this is referred to as open. The negative curvature 'pinches' the angles of the triangle, causing them to sum to less than 180 degrees. So of this trio of options, which kind of universe do we live in? Open, closed, or flat? We can imagine a spaceship tracing a giant triangle in the sky in an attempt to answer this question. They could fly for millions of light years across the universe, before returning to the Earth - a mega version of the triangle we drew on the lunar surface. If, like on the Moon, they needed to turn through more than 180 degrees to complete the triangle, we'd conclude that the universe is positively curved. If they managed to pull it off by travelling through fewer than 180 degrees then that would indicate negative curvature. Only if their triangular path contained exactly180 degrees would the universe be flat. Unfortunately, no astronauts have yet ventured further than the Moon and even our most distant spacecraft won't reach the nearest stars for tens of thousands of years. Let alone leaving the galaxy and flying for millions of light years.Thankfully, there is something else that has already travelled across the universe for billions of light years: the light from the Cosmic Microwave Background, the leftover radiation from near the birth of the universe.

25:00
Look at a map of the Cosmic Microwave Background and it is speckled with tiny temperature variations. Small regions a little hotter or cooler than the average. They correspond to areas of the baby universe that were a little denser or sparser. These regions were the seeds from which structure in the adolescent universe emerged. Denser regions gradually pulled in more material to construct huge superclusters of galaxies. Empty regions became larger as a result, fashioning enormous supervoids. Knowing the expansion history of the universe from Hubble's Law, astronomers can work backwards from the megastructures in the modern universe to predict the size of the speckles in the CMB. The answer they get matches their observations perfectly. And this tells us that the light from the CMB has travelled through a flat universe to reach us, one governed by the rules of Minkowski space.

26:02
Next, astronomers have to try and work out what's called the topology of the universe. To understand what is meant by topology, imagine two shapes each made out of modelling clay. If you can remould one of the shapes into the other without tearing the clay then the two shapes share the same topology. A doughnut, for example, is a match for a teacup – the hole in the handle of the cup can be reworked into the hole in the centre of the doughnut without needing to make any tears. The universe could resemble a giant sheet of paper. If you curl

that sheet up you get a cylinder and if you join the ends of the cylinder together you get a donut – a shape mathematicians call a torus. All of these topologies are considered flat because the angles in any triangle drawn on them add up to 180 degrees. There are, however, a total of 18 different
27:06
3D topologies consistent with a flat universe that follow the rules of Euclidean geometry. Indeed, by far the simplest option is the first: that, like an endless stretched out piece of paper, the universe just continues on and on forever. An infinite universe. That's impossible for a closed universe. As we've seen, you'll always eventually end up back where you started and the journey of our intrepid explorers would be finite. If the universe is indeed
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26:02
Next, astronomers must try to figure out what is called the topology of the universe. To understand what topology means, imagine two shapes, each made of modeling clay. If you can mold one of the shapes into the other without tearing the clay, then both shapes share the same topology. For example, a donut fits a cup—the hole in the handle of the cup can be reworked into the hole in the center of the donut without having to tear it. The universe could resemble a giant sheet of paper. If you roll this sheet up, you get a cylinder, and if you connect the ends of the cylinder together, you get a doughnut—a shape that mathematicians call a torus. A nice example here https://www.hypothesis-of-universe.com/docs/c/c_423.gif ; All of these topologies are considered flat because the angles in any triangle drawn on them add up to 180 degrees. However, there are a total of 18 different
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3D topologies consistent with a flat universe that follow the rules of Euclidean geometry. By far the simplest possibility is indeed the first: that the universe, like an infinite stretched piece of paper, simply goes on and on forever. The universe doesn't, but spacetime does (!) An infinite universe. That's impossible for a closed universe. As we've seen, you always end up where you started, and the journey of our intrepid explorers would be finite. If the universe|| really is
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(06)- infinite then it isn't expanding into anything. It can't be getting bigger to occupy more space as the space that's there is already infinite. But is the universe really infinite? Not in some of the other topologies that fit with our observations of the Cosmic Microwave Background and the apparent flatness of the universe. Take one of them, a shape known as the 3-torus. Imagine taking an ordinary cube, then bending a pair of opposite sides around and gluing them together. Then do the same for the other two pairs of sides. The result is a 3-torus. If the universe is shaped like this then travelling away from the Earth in a straight line would eventually see you return to the Earth on a finite, closed loop. Other flat topologies also have these closed loops, including the so-called Hantzsche–Wendt manifold. It can be constructed by starting with two cubes stuck together and then bending the different faces around to join one another. If the universe really has such closed loops then we could be living in a cosmic hall of mirrors. Light following a closed loop could result in us seeing the same object in different parts of the sky as its light is bent back around. Astronomers have looked for repeating, connected patterns in the Cosmic Microwave Background, but are yet to see anything significant. So it remains hard to
29:01
say if the universe is infinite or not. The Hantzsche–Wendt manifold has received particular attention because its complex geometry would actually obscure the repeating patterns, which might be why astronomers haven't seen them. To make matters worse, astronomers aren't

even 100 per cent sure that the universe is actually flat in the first place. In cosmology this dilemma has become known as the “flatness problem”. Strictly speaking, astronomers have used the Cosmic Microwave Background to measure the flatness of the observable universe – the bit they are able to see. There is thought to be more universe beyond this imaginary boundary. This leaves astronomers with two competing options. The first is that the entire universe is flat – the bit they can see and the bit that they can't. However, when astronomers calculate the odds of this happening they are astronomically small. The alternative is that the Big Bang has expanded the universe to such a degree
30:00
that any curvature the observable universe initially had was ironed out. This is similar to how the Earth appears to be flat beneath your feet, despite the fact that the Earth's surface is curved. That curvature is only noticeable above a certain scale and in the cosmos that scale could well be beyond the edge of the observable universe. Except, Hubble's Law tells us how much expansion there has been since the Big Bang 13.8 billion years ago. And there simply hasn't been enough to completely smooth out the observable universe. The most commonly accepted fix to this problem is a theory known as cosmic inflation. It injects a period of super-rapid expansion in the universe's first fractions of a second over and above Hubble's Law. Inflation also explains those tiny speckles in the Cosmic Microwave Background, which shouldn't be there according to the original Big Bang theory. According to inflation, the speckles are the result of tiny quantum fluctuations frozen into the universe forever
31:01
when it suddenly ballooned in size. But as yet there's evidence that this short, sharp period of Hubble expansion on steroids really happened. Finding definitive evidence for inflation would put the possibility of a non-flat and therefore finite universe firmly back on the table. Yet with that the nagging question of what the universe is expanding into re-emerges. Although, as it turns out, we don't necessarily need for it to be expanding into anything at all… It is the late 1780s. The United States of

Embedding Space

America has yet to reach its teenage years. France is about to descend into a chaotic revolution that would eventually see King Louis XVI meet the business end of a guillotine. And meanwhile, in Germany, a young schoolboy by the name of Carl Friedrich Gauss is sitting in a classroom
32:03
listening attentively in a mathematics lesson. The teacher has just set the students a task. They must add up all the numbers from 1 to 100. Within seconds Gauss pipes up: “5050, sir”. The teacher’s jaw drops faster than a guillo tine blade. It is unclear whether this ever really happened. The story has joined the annals of other likely apocryphal tales in the history of science. Think Archimedes running naked down the street or the apple falling on Newton’s head. Indeed, the trick to arriving at 5050 within just a few heartbeats is to realise that you don’t actually have to tediously add up all the numbers. Instead, you pair the numbers off. 1 with 100. 2 with 99. 3 with 98 and so on. Each pair will always add together to make 101.
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(06)- infinite, then it doesn't expand into anything. Sure. But only spacetime is infinite, and the Universe (ours, aka. After the Big Bang, curved with matter) is finite, a location "nested" in infinite spacetime. It can't get bigger to take up more space, because the space there is already infinite. But is the universe truly infinite? Apparently not, spacetime is infinite... Not

in some other topologies that match our observations of the cosmic microwave background and the apparent flatness of the universe. Take one of these, a shape known as a 3-torus. Imagine taking an ordinary cube, then bending a pair of opposite sides and gluing them together. Then do the same for the other two pairs of sides. The result is a 3-torus. If the universe is shaped like this, then traveling away from Earth in a straight line would eventually return to Earth in a final closed loop. Other flat topologies also have these closed loops, including the so-called **Hantzsche–Wendt** manifold. It can be built by starting with two cubes glued together and then bending different faces around to connect to each other. If the universe really does have such closed loops, then we could be living in a cosmic hall of mirrors. ?? Light following a closed loop could lead to us seeing the same object in different parts of the sky as its light bends back. Astronomers have been looking for repeating, interconnected patterns in the cosmic microwave background, but so far they haven't seen anything significant. So it remains difficult
29:01
to say whether the universe is infinite or not. The universe doesn't, but the spacetime in which the universe "floats" does. The Hantzsche–Wendt manifold has received special attention because its complex geometry would actually obscure the repeating patterns, which may be why astronomers haven't seen them. To make matters worse, astronomers aren't even 100 percent sure that the universe is actually flat in the first place. The universe with matter isn't. In cosmology, this dilemma has become known as the "flatness problem." Strictly speaking, astronomers have used the cosmic microwave background to measure the flatness of the observable universe—the bit they can see. It is assumed that there is more of the universe beyond this imaginary boundary. That leaves astronomers with two competing possibilities. The first is that the entire universe is flat—the part they can see, and the part they can't. But when astronomers calculate the odds of that happening, they are astronomically small. The alternative is that the Big Bang expanded the universe The Big Bang didn't expand anything, the Big Bang is a "change of state"… to such an extent
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31:01
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States Space for insertion America has not yet reached adolescence. France is about to descend into a chaotic revolution that would eventually see King Louis XVI meet the business end of the guillotine. Meanwhile, in Germany, a young schoolboy named **Carl Friedrich Gauss** is sitting in a classroom
32:03
listening intently in math class. The teacher has just given the students an assignment. They have to add up all the numbers from 1 to 100. Within seconds, the Gauss tube: "5050, sir." The teacher's jaw drops faster than a guillotine blade. It's unclear whether this ever actually happened. The story has joined the annals of other probably apocryphal stories in the history of science. Imagine Archimedes running naked down the street or an apple falling on Newton's head. In fact, the trick to getting to 5050 in a few beats is to realize that you don't actually have to add up all the numbers at length. Instead, you pair the numbers. 1 with 100. 2 with 99. 3 with 98, and so on. Each pair always adds up to 101. **Well, I'm staring**
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(07)- With 50 such pairs, all the young Gauss had to do was multiply 101 by 50
33:05
and arrive at the correct answer of 5050. Whether it happened or not, the anecdote is designed to illustrate Gauss's precocious talent for mathematics, even from a tender age. He would go on to become one of the most influential - if not the most influential - mathematicians of all time. And Gauss's work would eventually become a cornerstone of the way we understand the universe, what it truly means to say that it is expanding and whether or not it needs to be expanding into anything. Earlier, we used the analogy of raisin bread to explain the expanding universe. An inflating balloon with coins stuck onto its surface to represent galaxies is another analogy that's often used. As you blow up the balloon, the galaxies move further apart as the rubber between them stretches. Likewise,
34:02
we do not expand with the expanding universe, so tight are the shackles of our atomic bonds. However, all of these everyday analogies for an expanding universe have their limitations. In both scenarios the object is still expanding into something – either the oven or the room. And so to understand how the universe itself can expand without needing to expand into anything at all, we need to enter a baffling branch of mathematics known as differential geometry... To begin with, imagine a two dimensional sheet that's then rolled up into a cylinder. To achieve this you have to curve the sheet through a third dimension that's beyond the sheet itself. Mathematicians call this external dimension the embedding space. Now let's imagine that our universe really is shaped like this cylinder and that intrepid astronauts are tracing a giant triangle across its surface.The angles in that triangle would add up
35:05
to 180 degrees, just as they would on the original flat sheet. From the astronauts' point of view, they'd be unable to tell the difference between the flat sheet and the cylinder. That is unless they could somehow leave the surface of the cylinder entirely and look back on it from the embedding space. Only then could they see it was curved. Shapes like this are said to have extrinsic curvature – the curvature is only apparent from beyond the surface of the shape. To say this another way, a cylinder has no intrinsic curvature. And in mathematics, intrinsic curvature is also known as Gaussian curvature, because Gauss would make a huge breakthrough in differential geometry in 1827. Shapes with no intrinsic curvature - including cylinders - are regarded as 'flat'. You can see why it's a bit confusing.

However some shapes do have intrinsic curvature. The most obvious example is the sphere. As with
36:05
travelling across the moon, you don’t have to leave the surface of a sphere in order to know that it is curved. The fact that the angles in a large triangle add up to more than 180 degrees tells you that you're on a curved surface without the need for an embedding space. When Gauss published the details of this idea in 1827 it became known as “Theorema Egregium” - Latin for “remarkable theory”. An interesting consequence of the fact that a sheet has zero Gaussian curvature, but a sphere doesn’t is that all maps of the world are off. A 2D map of a 3D sphere will always be distorted.The most common world maps use the Mercator projection, which is designed to preserve the angles between objects and make navigation easier. However, that means that areas are skewed. Greenland, for example, appears
37:01
14 times larger than it really is. There are ways to preserve areas and skew angles instead - such as the Lambert cylindrical equal-area projection - but Gauss’s Theorema Egregium tells us that something always has to give. But so far we have spoken about hypothetical cylinders and spheres and maps of the earth - what about the real universe in which we live? Fast-forward to 1857 and a 76-year-old Gauss is the audience for a lecture given by one of his former protégés: Bernhard Riemann. Born in Hanover the year before Gauss published his Theorema Egregium, Riemann initially set his sights on studying theology, but ended up studying mathematics instead under Gauss’s tutelage at the University of Göttingen. Gauss once remarked that Riemann had “a gloriously fertile originality”. In his 1857 lecture, Riemann set out how to extend Gauss’s work on differential geometry beyond three dimensions. Today this is known
38:03
as Riemannian geometry and, as we will see, it would prove a crucial breakthrough. One of the most important concepts in Riemannian geometry is the geodesic - a line that represents the shortest path between two points on a curved surface. This often leads to odd-looking outcomes when you step down a dimension. Take the more than 30 flights that
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(07)- With 50 such pairs, young Gauss had only to multiply 101 x 50
33:05
and arrive at the correct answer of 5050. Yeah, I'll never be a Gauss... Whether or not that happened, the anecdote is designed to illustrate Gauss's precocious talent for mathematics, and that from an early age. He would become one of the most influential—if not the most influential—mathematicians of all time. (!) And Gauss's work would eventually become a cornerstone of how we understand the universe, what it really means to say it's expanding, and whether or not it needs to expand into something. Previously, we used the analogy of raisin bread to explain the expanding universe. Another frequently used analogy is an inflatable balloon with coins stuck to its surface, representing galaxies. When you blow up a balloon, galaxies move apart because the rubber band between them is stretched. Also,
34:02
we don't expand with the expanding universe, so the bonds of our atomic bonds are so strong. All of these everyday analogies for an expanding universe have their limitations, though. And is unrolling an analogy or not?? In both scenarios, the object is still expanding into

something—either an oven or a room. To understand how the universe can expand itself without us having to expand into anything, we have to enter a confusing branch of mathematics known as differential geometry ... Is that Aristotle's turtle? To begin, imagine a two-dimensional sheet that is then rolled up into a cylinder. You need a third dimension to roll it up into a cylinder! To do this, you have to curve the sheet through the third dimension that is beyond the sheet itself. See, I'm getting ahead of myself... Mathematicians call this outer dimension the embedding space. Now imagine that our universe is actually shaped like this cylinder, and that intrepid astronauts are tracing a giant triangle across its surface. The angles in this triangle would add up to
35:05
180 degrees, just like on the original flat plate. From the astronaut's perspective, they wouldn't be able to tell the difference between a flat plate and a cylinder. That is, unless they could somehow leave the surface of the cylinder completely and look back at it from the embedding space. Only then would they see that it was curved. Shapes like this are said to have an extrinsic curvature - the curvature is only noticeable beyond the surface of the shape. In other words, a cylinder has no ||internal|| curvature. O.K. And in mathematics, intrinsic curvature is also known as Gaussian curvature, because Gauss would make a huge breakthrough in differential geometry in 1827. Shapes without internal curvature – including cylinders – **are considered** to be “flat”. Putin is not a murderer, but he is considered a murderer…aha,… You can see why this is a bit confusing. However, some shapes do have internal curvature. The most obvious example is a sphere. As with 36:05 when you travel across the moon, you don’t have to leave the surface of a sphere to know that it is curved. The fact that the sum of the angles in a large triangle is more than 180 degrees tells you that you are on a curved surface without needing any room for indentation. When Gauss published the details of this idea in 1827, it became known as the “Theorema Egregium” – Latin for “remarkable theory”. This means that I am indeed on the right track when I have been saying for 20 years that the first three space-time dimensions are PHYSICAL and the extra dimensions are just MATHEMATICAL dimensions, not physical. Yes? Both kinds of dimensions can be curved, twisted, yes? Then I don't have to be ashamed of >my math< when I write the CNO cycle like this https://www.hypothesis-of-universe.com/docs/eb/eb_002.pdf ; An interesting consequence of the fact that a leaf has zero Gaussian curvature, but a sphere does not, is that all world maps are off. A 2D map of a 3D sphere will always be distorted. The most common world maps use the Mercator projection, which is designed to preserve angles between objects and make navigation easier. However, this means that areas are distorted. For example, Greenland appears
37:01
14 times larger than it actually is. Sure. There are ways to preserve areas and skew angles instead—like Lambert's cylindrical planar projection—but Gauss's Egregium theorem tells us that something always has to give. But so far we've been talking about hypothetical cylinders and spheres and maps of the Earth—what about the real universe, !! in which we live? Yes, and what about my packets of elementary particles of n+m dimensions?? Fast forward to 1857, and the 76-year-old Gauss is in the audience for a lecture by one of his former protégés: **Bernhard Riemann**. Riemann was born in Hanover the year before Gauss published his Theorem Egregium, initially focused on studying theology, but eventually studied mathematics under Gauss at the University of Göttingen instead. Gauss once remarked that Riemann had "a wonderfully

fruitful originality". In his 1857 lecture, Riemann set out how to extend Gauss's work to differential geometry beyond three dimensions. I'm excited about what I'm going to read… Today it's known
38:03
as Riemannian geometry, I've been reading about it for 50 years but I still don't understand tensors, manifolds, etc. and Riemannian differential geometry. We didn't learn it in school. I just have a hole in my brain "there", and as we'll see, it turned out to be a major breakthrough. One of the most important concepts in Riemannian geometry is the geodesic – a line that represents the shortest path between two points on a curved surface. That's an exception, I understood that before I had my first beard… ☺ . This often leads to strange-looking results when you leave the dimension. Go for more than 30 years
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(08)- travel between London and New York every day. London sits closer to the North Pole than New York, so you'd think that a plane flying to the Big Apple would set off from the UK and head south. In fact, it heads **north**, flies in a straight line, and still ends up further south. This straight line across a 3D dimensional surface looks curved when drawn on a 2D map. Perhaps even more bizarrely, it is possible to travel in a completely straight line from Alaska to India without ever flying over land. When drawn on a 2D map this journey looks about
39:08
as far from straight as it is possible to get. However, look at that path from space and you'll clearly see how straight it is. And these ideas - geodesics and Riemannian geometry would go on to form the backbone of Albert Einstein's General Theory of Relativity, our best-tested explanation of gravity. General Relativity says that the three dimensions of space and the one dimension of time are irrevocably woven together into a four dimensional fabric called spacetime - indeed it was Einstein's grumpy professor Hermann Minkowski who actually coined the term. This means that Gaussian differential geometry, which can only describe curvature in a total of three dimensions, is not sufficient. Only Riemannian geometry, which generalises Gauss's work to any number of dimensions, works.
40:02
According to General Relativity, the presence of massive objects curves four dimensional spacetime and it is this curvature that's responsible for the apparent force of gravity. Earth, for example, doesn't orbit the Sun because there's an invisible force of attraction between them as Isaac Newton had suggested in the 17th century. Instead, the Sun distorts the fabric of spacetime around it and the Earth is caught rolling around in this distortion. However, thinking of gravity in this way leads to what appears, at first, to be a controversial statement: that the Earth orbits the Sun in a straight line. At least that's true in four dimensions. Just as the straight London to New York flight path across a 3D surface appears curved when drawn on a 2D map, the Earth's straight path through 4D spacetime only appears curved in three dimensions. This curvature is particularly apparent in an effect known as gravitational lensing.
41:03
When light from a distant source encounters a massive cluster of galaxies, the light's path appears to bend around it. Riemannian geometry allows astronomers to estimate the amount of spacetime curvature required to do this, in turn leading to an estimate for the total mass of

the cluster. Usually there appears to be considerably more mass than can be accounted for by adding up all the visible material in cluster, strongly hinting to astronomers that the difference is made up of invisible 'dark' matter. And so, this all means, that thanks to its use of Riemannian geometry, General Relativity can completely describe spacetime, our universe and its expansion in terms of intrinsic curvature alone. There is no need for an external embedding space and so no requirement for the universe to be expanding into anything. However, as you might have guessed,

42:09

that is not quite the end. For just because the universe doesn't need to be expanding into anything doesn't mean that it isn't… After seven long months travelling through the solar system, it is the next seven minutes that will decide the fate of NASA's Perseverance rover. Hurtling through the thin Martian atmosphere at almost 20,000 kilometres per hour, from the planet's surface it looks like a giant

The Great Beyond

shooting star lighting up the daytime sky. Suddenly, the parachute pops and flutters open. The rover rig emerges from its protective chrysalis, stabilised in mid air by a series of thrusters, finally dangling down from the sky crane on long, puppet-like wires. With

43:06

the rover safely deposited on the surface, the sky crane powers away so as not to contaminate the pristine environment around Jezero crater that the mission has travelled almost half a billion kilometres from Earth to explore. Landing a car-sized rover on a distant planet is no mean feat. Yet this mission has another, even more impressive achievement up its sleeve: a miniature helicopter. Known as Ingenuity, it would go on to make the first powered flight on another world. In fact, it would make a total of 72 flights, despite only being designed for five. Endeavours like this are a stark reminder of just how weak the force of gravity really is. Despite the heft of an entire planet, this tiny aircraft - with a fuselage the

44:00

size of a tissue box and weighing no more than a bag of potatoes - could climb over twenty metres above the dusty Martian surface. As well as this, of the four fundamental

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(08)- travel between London and New York every day. London is closer to the North Pole than New York, so you would think that a plane flying to the Big Apple would leave the UK and head south. In fact, it heads **north**, flying in a straight line, and always ending up further south. This straight line across a 3D dimensional surface looks curved when drawn on a 2D map. Perhaps even more bizarrely, it is possible to travel from Alaska to India in a completely straight line without ever flying over land. When drawn on a 2D map, this path looks

39:08

as far from straight as it is possible to get. But look at that path from space and you can clearly see how straight it is. And these ideas – geodesics and Riemannian geometry – would go on to form the backbone of Albert Einstein's general theory of relativity, our best-tested explanation of gravity. The general theory of relativity says that three dimensions of space and one dimension of time are irrevocably woven together into a four-dimensional fabric called spacetime – indeed, it was Einstein's grumpy professor Hermann Minkowski who actually coined the term. This means that Gaussian differential geometry, which can only describe curvature in three dimensions, is not enough. Only Riemannian geometry works, which generalizes Gauss's work to any number of dimensions. Hurray, great. I figured that out (to any number of dimensions) without knowing anything about Riemannian geometry in advance or that someone had said it before me. But why hasn't anyone told me in the 20 years I've been presenting this on the internet that matter is made up of n+m dimensions by warping, by packing those dimensions together.

40:02

According to the general theory of relativity, the presence of massive objects warps the four-dimensional 3+3D spacetime spacetime, and it is this warping that is responsible for the apparent force of gravity. For example, the Earth does not orbit the Sun because there is an invisible force of attraction between them, as Isaac Newton proposed in the 17th century. Instead, the Sun warps the fabric of spacetime around it, and the Earth is caught rolling around in this warp. !! However, thinking about gravity in this way leads to what at first seems like a controversial claim: that the Earth orbits the Sun in a straight line. At least in four dimensions. Just as a straight flight path from London to New York across a 3D surface appears curved when plotted on a 2D map, the Earth's straight path through 4D space-time appears curved only in three dimensions. This curvature is particularly noticeable in an effect known as gravitational lensing.

41:03

When light from a distant source encounters a massive cluster of galaxies, the light's path appears to bend around it. Riemannian geometry allows astronomers to estimate the amount of space-time curvature required to do this, which leads to an estimate of the total mass of the cluster. Typically, there appears to be significantly more mass than could be explained by adding up all the visible material in the cluster, which strongly suggests to astronomers that the difference is made up of invisible "dark" matter. **And I consider this to be a mistake. I explain it by the incorrect use of Newton by those astronomers (see Vera Rubin) where they substitute measured values and use the distance between two places (two stars) in a straight, straight line. But the curvature of space-time in a galaxy (observed not from close up, but from a great distance) is curved, see Fig. https://www.hypothesis-of-universe.com/docs/c/c_489.jpg ; https://www.hypothesis-of-universe.com/docs/eng/eng_130.pdf All this means that thanks to the use of Riemannian geometry, the General Theory of Relativity can completely describe space-time, our universe and its expansion only in terms of internal curvature. There is no need for an external storage space, and therefore no requirement for the universe to expand into anything. I'm beating myself up, racking my brain and I still don't really understand it, this description of external curvature using internal curvature...
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\\\ phew, I'm already lying on the keyboard, I'm going to sleep** However, as you might have guessed,

42:09
to není úplný konec. Protože to, že se vesmír nemusí do ničeho rozpínat, neznamená, že tomu tak není... Po sedmi dlouhých měsících cestování Sluneční soustavou je to následujících sedm minut, které rozhodnou o osudu vozítka Perseverance NASA. Z povrchu planety se řítí řídkou marťanskou atmosférou rychlostí téměř 20 000 kilometrů za hodinu jako obr. The Great Beyond padající hvězda osvětlující denní oblohu. Najednou padák praskne a s třepotáním se otevře. Roverová souprava se vynoří z ochranné kukly, stabilizovaná ve vzduchu řadou trysek a nakonec visí dolů z nebeského jeřábu na dlouhých drátech připomínajících loutku. S
43:06
rover bezpečně uložený na povrchu, jeřáb odpojí, aby nekontaminoval nedotčené prostředí kolem kráteru Jezero, za jehož průzkumem mise cestovala téměř půl miliardy kilometrů od Země. Přistát s roverem o velikosti auta na vzdálené planetě není nic hrozného. Přesto má tato mise v rukávu další, ještě působivější úspěch: miniaturní vrtulník. Známý jako Vynalézavost a uskutečnil by první motorový let na jiném světě. Ve skutečnosti by provedl celkem 72 letů, přestože byl navržen pouze pro pět. Snahy, jako je toto, jsou ostrou připomínkou toho, jak slabá je ve skutečnosti gravitační síla. Navzdory hmotnosti celé planety je toto malé letadlo - s trupem
44:00
velikosti krabice od kapesníčku a nevážící víc než pytel brambor - mohl vyšplhat přes dvacet metrů nad prašný marťanský povrch. Stejně jako toto, ze čtyř základních
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(09)- forces, gravity also has the dubious honour of being the least understood - even though its rules were discovered centuries before those of the other three. This is even more perplexing considering that gravity is the force that most obviously affects our day-to-day lives. To underscore the disparity between gravity and the forces, imagine two electrons. Their gravitational attraction is one hundred tredecillion times weaker than the repulsive electromagnetic force between them. That's a one followed by a staggering 43 zeroes. This gulf in their might is particularl troublesome because physicists assume that all four fundamental forces were once united into a single force immediately after the Big Bang, before peeling away from each other in the universe's first slivers of a second. Indeed, there is already concrete evidence that the electromagnetic and weak forces were once the
45:07
electroweak force. And the rules that describe the strong force are so similar to those belonging to the electroweak that they appear a perfect fit - we just haven't ramped up the energy of particle accelerators enough yet in order to find proof. Gravity however, remains firmly out in the cold. As we've seen, it is described by Einstein's General Theory of Relativity instead - a theory that doesn't play nicely with the quantum field theories we use to describe the other three forces. And so if all four forces were once equal in strength, what happened to relegate gravity to such a lowly footing? Well, the answer could lie in a sci-fi sounding branch of physics known as the Braneworld - a truly bizarre theoretical example of an embedding space.
46:02
According to these theories, our four dimensional spacetime is merely a surface - or brane - embedded in a higher dimensional hyperspace known as "The Bulk". The word brane is a shortened form of "membrane". Perhaps the easiest way to picture this is to drop down a

dimension. Imagine an ant crawling around the surface of a hollow sphere floating in mid-air. That ant would be confined to a 2D surface – a brane – embedded in a 3D Bulk. Likewise, we could live on a 4D surface embedded in a Bulk with at least five dimensions. The Braneworld has its roots in string theory, which is one attempt to unite gravity with its fellow forces. According to string theory, sub-atomic particles are made of tiny vibrating strings, and within this theory just as you can play stringed instruments in different ways to create different notes, so Nature plays these strings to create different particles.

47:02

A family of particles called bosons is particularly important because they are responsible for carrying forces. It is only by exchanging bosons that magnets can attract or repel each other, for example. Atomic nuclei are only held together by the strong force because bosons called gluons are being exchanged between their constituent parts. Physicists have already experimentally verified the bosons behind three of the four fundamental forces, but they have yet to discover one linked to gravity. If it does exist, this "graviton" is proving particularly hard to find. Despite its elusiveness, the graviton could be the key to unlocking the mystery of why gravity appears so much weaker than the other three fundamental forces, with implications for what the universe is expanding into. There are two types of string in string theory: open and closed. According to the Braneworld,

48:09

open strings must always remain tethered to a brane at one end. Closed strings, however, which form a loop and so are effectively tethered to themselves, are free to wander through the full extent of The Bulk. The graviton is thought to be made of just such a closed string. In other words, the strength of gravity is diluted across both our brane and The Bulk. The other three forces, with their open string bosons, are restricted to just the brane. And so if true, it's no wonder that we see gravity as considerably weaker than its fellow forces. It is leaking away into hyperspace. There are ways to test this idea with experiments, even without the direct discovery of the graviton itself. It is possible that our atom-smashing efforts at places such as the Large Hadron Collider could create gravitons through

49:00

the collision of ordinary particles. If some of these gravitons wander off into The Bulk, they would leave behind tell-tale gaps in the data. Equally, physicists could find evidence of gravity leaking into The Bulk in modern versions of a famous 18th century experiment by Henry Cavendish. It was designed to measure the gravitational attraction between two nearby metal spheres. Forces usually follow what physicists refer to as an inverse square law. If you double the distance between the two spheres, their gravitational attraction drops to a quarter.

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(09)- Of the forces, gravity also has the dubious honor of being the least understood—even though its rules were discovered centuries before the rules of the other three. This is even more puzzling when you consider that gravity is the force that most obviously affects our daily lives. To underscore the difference between gravity and forces, imagine two electrons. Their gravitational attraction is a hundred and three-decillion times weaker than the repulsive electromagnetic force between them. That's a one followed by a staggering 43 zeros. 10^{-42} This gap in their strength is especially troubling because physicists assume that all four fundamental forces were once unified into a single force immediately after the Big Bang, I can't imagine the "shape" of the curvature of the dimensions of such spacetime… before they

peeled away from each other in the first fractions of a second. In fact, there is already concrete evidence that the electromagnetic and weak forces were once
45:07
the electroweak force. Just mathematical evidence, right? (on paper). And the rules that describe the strong force are so similar to the rules that belong to the electroweak force that they seem to fit together perfectly—we just haven't increased the energy of particle accelerators enough yet to find the proof. Yeah… so… Gravity, however, remains firmly out in the cold. As we've seen, it's instead described by Einstein's General Theory of Relativity—a theory that doesn't play well with the quantum field theories we use to describe the other three forces. The curvatures of the dimensions of the three forces are like foam, in which time runs "back and forth" at short intervals… so the foam is linear. Gravity is nonlinear, it's a parabola…, right?? And so if all four forces were once equally strong, what is "strong"? The MANIFESTATION of curvature is "equally strong", right? what happened to push gravity down to such a low level? Three forces remained "captured" by the high curvatures of the cp dimensions and one – gravity unrolled, the dimensions unrolled, which "took" the shape of a parabolic curvature. Why? I don't know. The answer may lie in a sci-fi-sounding branch of physics known as Braneworld – a truly bizarre theoretical example of embedded space.
46:02
According to these theories, our four-dimensional space-time is merely a surface – or gate – embedded in a higher dimensional hyperspace known as "Bulk". The word brane is a shortened form of "membrane". Perhaps the easiest way to imagine this is to unroll a dimension. Imagine an ant crawling on the surface of a hollow sphere floating in mid-air. This ant would be confined to a 2D surface – a gate – embedded in a 3D Bulk. We could also live on a 4D surface embedded in a Bulk with at least five dimensions. Braneworld has its roots in string theory, which is one attempt to unify gravity with the other forces. According to string theory, subatomic particles are made up of tiny vibrating strings. Turn strings ***out of nothing*** into dimensions. (And vibrate them. Or in that vibrating space-time foam, make packages). Then that's almost my HDV. and within this theory, just as you can play stringed instruments in different ways to create different notes, so **nature plays these strings to create different particles**. It is hard to imagine an n-dimensional string vibrating down to the shape of sulfuric acid…
47:02
A family of particles called bosons is particularly important because they are responsible for transmitting forces. But forces do not exist according to Einstein and other theorists. Apparently, vibrations are transmitted from monoblocks to other monoblocks. Only by exchanging bosons can magnets, for example, attract or repel each other. Atomic nuclei are held together only by the strong force, because bosons called gluons are exchanged between their components. Physicists have already experimentally verified the bosons behind three of the four fundamental forces, but they have yet to discover one associated with gravity. If it exists, this "graviton" turns out to be particularly hard to find. Despite its elusiveness, the graviton could hold the key to unlocking the mystery of why gravity appears to be so much weaker than the other three fundamental forces, with implications for how the universe expands. In string theory, there are two types of strings: open and closed. According to Braneworld,
48:09
open strings must always remain tethered to a gate at one end. Closed strings, which form a loop and are thus effectively tethered to each other, are free to move throughout The Bulk.

The graviton is thought to be made of just such a closed string. In other words, the force of gravity is diluted across both our gate and The Bulk. The other three forces, with open string bosons, are confined to the gate. And if that's true, it's no wonder we see gravity as significantly weaker than its other forces. It escapes into hyperspace. There are ways to test this idea experimentally, even without directly discovering the graviton itself. It's possible that our efforts to smash atoms together at places like the Large Hadron Collider could create gravitons through

49:00

collision of ordinary particles. If some of these gravitons wandered into The Bulk, they would leave behind gaps in the data. Similarly, physicists could find evidence of gravity penetrating The Bulk in modern versions of Henry Cavendish's famous 18th-century experiment. It was designed to measure the gravitational attraction between two nearby metal spheres. The forces usually follow what physicists call the inverse square law. ? If you double the distance between two spheres, their gravitational attraction drops to a quarter.

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(10)- Treble the distance and it drops to a ninth. The same holds for the strength of the electromagnetic force between magnets. Now let's imagine that wandering gravitons are causing gravity to leak away into a single extra dimension. In other words, a 5 dimensional bulk. Gravity's potency should fall away more quickly and it will follow an inverse cube law instead. That means doubling the distance between two masses would see their attraction drop to an eighth instead of a quarter. In order to be consistent with

50:09

the apparent weakness of gravity that we observe, this divergence from the inverse square law would show up over distances roughly equal to the gap between the Sun and the planet Uranus. And so clearly astronomers would have noticed such a deviation by now. The orbits of the outer two planets would follow different gravitational rules to those of the inner planets. However, the more dimensions you add to The Bulk, the more avenues there are for gravity to leak. This would lead to a greater deviation from the inverse square law as the strength of gravity drops even faster. It would also reduce the distance over which this deviation becomes apparent. For just two extra dimensions, it drops dramatically from a literally astronomical distance to a mere 0.3 millimetres. That may still sound relatively large, certainly compared to the size of atoms, but measuring gravity on

51:03

this scale is currently beyond our capabilities. However in 2021, a ground-breaking modern version of the Cavendish experiment did measure the gravitational attraction between two 90 milligram gold spheres separated by 40 millimetres. There was no deviation from the inverse square law. Perhaps one day we'll get this down to under 0.3 millimetres and finally see the proof of gravity leaking away into The Bulk. Although, even if physicists did spot a deviation, it isn't smoking gun proof that our universe is a brane embedded in hyperspace. Instead the extra dimensions that gravity is leaking into could be part of the universe itself, curled up so small so as to remain out of sight. Proving the existence of The Bulk would finally us give a more concrete answer to the question of what the universe is expanding into. Our 4D

52:05

universe could be growing into a potentially infinite higher-dimensional hyperspace. But there is another potential way to use string theory in order to recreate rules similar to those of

quantum physics - a groundbreaking discovery that goes by the rather dull name of AdS/CfT correspondence. The AdS part is something we've encountered before: anti-de Sitter space. The CfT stands for conformal field theory. The quantum rules behind the Standard Model of Particle Physics, which exquisitely explain all of its sub-atomic particles and the forces that govern them, are close cousins of conformal field theories. To better understand how AdS/CfT correspondence works, let's take a 3 dimensional example. First, imagine a disc that resembles an elaborate floor mosaic. It is made up of triangles and squares that follow the usual rules of anti-de Sitter space. That
53:09
means the angles in the triangles add up to less than 180 degrees and squares have angles that are pinched at the corners. Next, stack multiple copies of this disc on top of one another to form a cylindrical universe. This is an example of three dimensional anti-de Sitter space. Measure the angles of a triangle anywhere within it and they will add up to less than 180 degrees. But this cylinder has an unusual and critically important property. Put yourself at any point on the boundary and the space immediately around you will follow the rules of Minkowski space instead. In other words, the boundary of this anti-de Sitter space is flat. Given that the universe around us also appears flat, could our cosmos be the boundary of a higher dimensional anti-de Sitter bulk? That's the working idea behind AdS/CfT correspondence.
54:06
In theory, the bulk can have any number of dimensions and the boundary will always have one fewer dimension. What's remarkable about AdS/CfT correspondence is that if you apply string theory to a 5D anti-de Sitter bulk, the resulting physics on the 4D boundary are exactly the same as the rules of quantum physics.That's the correspondence part – a twinning of the physics of the bulk and the boundary.The two things are exactly equivalent of one another. Except there are big caveats to consider. In AdS/CfT correspondence, the four dimensions on the boundary are all dimensions of space.We do seem to live in a four dimensional universe, but one of those dimensions is time – only three are spatial dimensions. Plus, the conformal field theory that
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appears on the boundary is a very close match to quantum physics, but not a perfect one. So ………………………………………………………………………………………………

(10)- Raise the distance and it drops to a ninth. The same goes for the strength of the electromagnetic force between magnets. Now imagine that the traveling gravitons cause gravity to leak into a single other dimension. What is that?, a leak "into a dimension"? Is that like hiding from the devil in that dimension? In other words, a 5-dimensional volume. The gravitational force should decrease faster and instead obey the inverse cube law. This means that doubling the distance between two masses would mean their attraction would decrease by an eighth instead of a quarter. To be consistent with the
50:09
The apparent weakness of gravity that we observe would this deviation from the law ? is that a law? of inverse quadrature appear at a distance roughly equal to the gap between the Sun and the planet Uranus. So it is clear that astronomers would have already noticed such deviations. The orbits of the outer two planets would follow different gravitational rules than the orbits of the inner planets. But the more dimensions you add to The Bulk, the more ways for gravity to escape. This would lead to a greater deviation from the inverse square law,

because the force of gravity decreases even more rapidly. ☺ It would also would shorten the distance over which this deviation appears. In just two extra dimensions it drops dramatically from a literally astronomical distance to a mere 0.3 millimeters.
millimeters. I don't envy those physicists this ordeal, I don't have it. I hold the view that there are 3+3 physical dimensions and then the extra ones are just mathematical dimensions "for" the construction of matter. (and for all the elementary particles that physics has presented, Nature will suffice with 6 extra dimensions of length and 7 extra dimensions of time. Done. https://www.hypothesis-of-universe.com/index.php?nav=ea For all baryonic matter, Nature will suffice with 3+3 physical dimensions. That may still sound relatively large, certainly compared to the size of atoms, but measuring gravity
51:03
on this scale is currently beyond our capabilities. In 2021, however, a groundbreaking modern version of the Cavendish experiment measured the gravitational attraction between two 90-milligram gold balls separated by 40 millimeters. There was no deviation from the inverse square law. Perhaps one day we will get it down below 0.3 millimeters and finally see evidence of gravity seeping into The Bulk. Although, even if physicists have noted a deviation, it is not proof that our universe is a gateway set in hyperspace. Instead, the other dimensions into which gravity penetrates, nothing can penetrate the dimension. The dimension is there to be used "for something", but it is not there for someone/something **to penetrate it**…, that is an absolute misunderstanding of dimensions, and thus space-time, and thus the entire universe… they could be part of the universe itself, curled up so small that they remained out of sight. Of course, those extra dimensions are curled up and apparently they are small, and maybe one day it will turn out that the elementary particles are built from them…, that is my hypothesis, my model. And proving the reality of that model is up to respected physicists who may someday (!) notice HDV. Proving the existence of The Bulk would finally give us a more concrete answer to the question, what the universe is expanding into. You have your worries, and there are enough of them, my HDV also has one. Our 4D
52:05
universe could grow into a potentially infinite hyperspace of higher dimensions. But there is another potential way to use string theory to recreate rules similar to those of quantum physics—a groundbreaking discovery called the somewhat boring AdS/CfT correspondence. The AdS part is something we've seen before: anti-de Sitter space. CfT stands for conformal field theory. And they correspond? Why? The quantum rules of the Standard Model of particle physics, which so beautifully explain all its subatomic particles and the forces that govern them, are close relatives of conformal field theories. ?? To better understand how the AdS/CfT correspondence works, let's look at a three-dimensional example. First, imagine a disk that resembles an elaborate mosaic floor. It consists of triangles and squares that follow the usual rules of anti-de Sitter space. That
53:09
means that the sum of the angles in a triangle is less than 180 degrees, and squares have angles that are congruent at the corners. Next, stack multiple copies of this disk on top of each other to create a cylindrical universe. This is an example of a three-dimensional anti-de Sitter space. Measure the angles of a triangle anywhere in it, and their sum will be less than 180 degrees. But this cylinder has an unusual and critically important property. Place yourself at any point on the boundary, and the space immediately around you will instead follow the rules of Minkowski space. In other words, the boundary of this anti-de Sitter space is flat.

Since the universe around us also appears flat, could our universe be the boundary of a higher-dimensional anti-de Sitter matter? That is the working idea of the AdS/CfT correspondence.
54:06
Theoretically, a volume can have any number of dimensions and the boundary will always have one dimension less. O.K. well, what does this statement >solve<????? The remarkable thing about the AdS/CfT correspondence is that if you apply string theory to a 5D anti-de Sitter volume, the resulting physics on the 4D boundary will be exactly the same as the rules of quantum physics. And what does this statement solve??? That is the part of the correspondence – the doubling of the physics of the volume and the boundary. This is the solution? Of what, for what, for what??? These **two things** volume and boundary are exactly equivalent to each other. Ah, so this could solve the "connection" of the linear equation with the nonlinear equation?!!, right? But the volume is three-dimensional, the boundary is two-dimensional… Except that there are some big caveats to consider. In the AdS/CfT correspondence, the four dimensions on the boundary are all the dimensions of space. I don't understand this… It seems like we live in a four-dimensional universe, but one of those dimensions is time – only three are spatial dimensions. And what if it's not. !! Plus, that conformal field theory
55:02
It seems like it's very close to quantum physics on the boundary, but it's not perfect. **?? I don't understand. So
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(11)- for now, AdS/CfT correspondence is not a complete description of our reality. But when AdS/CfT correspondence was first proposed in the late 1990s by the Argentine physicist Juan Maldacena, it was a shot in the arm for an older theory known as the holographic principle. The hologram on the back of a credit card may give the illusion of looking three dimensional, but in reality all the information is encoded on a 2D card. Likewise, with AdS/CfT correspondence, all the information about the 5D bulk is encoded on the 4D boundary. In fact, AdS/CfT is sometimes called Maldacena duality for this very reason. It is also possible to take the same idea and drop down a dimension or two. Our universe seems to have three spatial dimensions,
56:01
but could all the information about this universe actually be encoded on some distant 2D boundary? Could the whole cosmos be a hologram? It's certainly a tantalising prospect - one that helps physicists solve other thorny issues such as what happens to information falling into black hole. However, the holographic principle remains notoriously hard to test. Yet it is a great illustration of the mental gymnastics and flights of fancy that physicists are willing to endure in the search for answers to one of the universe's greatest of questions. We've known for nearly a century that the universe is expanding. The work of Gauss and Riemannian led us to Einstein, who told us that the universe doesn't need to be expanding into anything at all. And yet, the idea of higher dimensions just won't go away. Should we ever find them, "What
56:57
is the universe expanding into?" certainly won't be the only monumental question being answered.
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(11)- The AdS/CfT correspondence for now is not a complete description of our reality. However, when the AdS/CfT correspondence was first proposed in the late 1990s by Argentine physicist Juan Maldacena, it was a shot in the arm for an older theory known as the holographic principle. A hologram on the back of a credit card may give the illusion of a three-dimensional appearance, but in reality all the information is encoded on the 2D card. And what good is/was/will that do?? Similarly, with the AdS/CfT correspondence, all the information about the 5D bulk is encoded on the 4D boundary. And what good is/was/will it do?? In fact, AdS/CfT is sometimes called the Maldacena duality for this very reason. It is also possible to take the same idea and expand it one or two dimensions. Our universe appears to have three spatial dimensions,
56:01
but could all the information about that universe really be encoded on some distant 2D boundary? And what good is/was/will that do?? Could the entire universe be a hologram? And what good is/was/will it do?? It's certainly an exciting prospect—one that helps physicists solve other thorny problems, such as what happens to information falling into a black hole. What information does a neutrino, a lambda esonance, a graviton, an electron... However, the holographic principle remains notoriously difficult to test. Still, it's a great illustration of the mental gymnastics and flights of fancy, aha, now I know what good is/was/will it do?? that physicists are willing to undergo in their search for answers to one of the universe's biggest questions. We've known for almost a century that the universe is expanding. It expands in early history, then in the future it expands in a near-linear fashion… The work of Gauss and Riemann led us to Einstein, who told us that the universe doesn't have to expand into nothing at all. O.K. And yet **idea** of higher dimensions doesn't just disappear. Hurray, it didn't disappear. I applied it in HDV. If we ever find them, "What? You're not looking where you're supposed to be looking….Is the universe expanding?" certainly won't be the only monumental question to be answered. The dimensions expand and gradually they all expand (even the extra ones in matter) and this will be the Universe again at the beginning of a new Big-bang No. 2, then No. 3, etc… .
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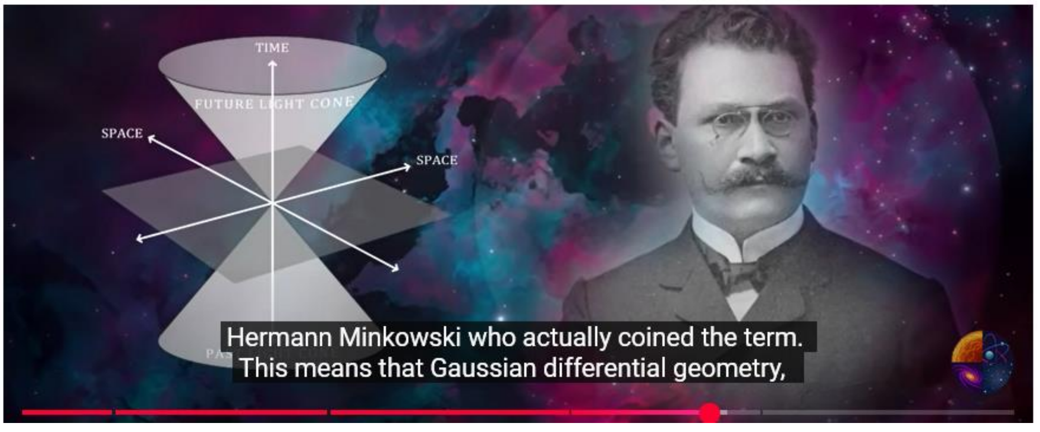
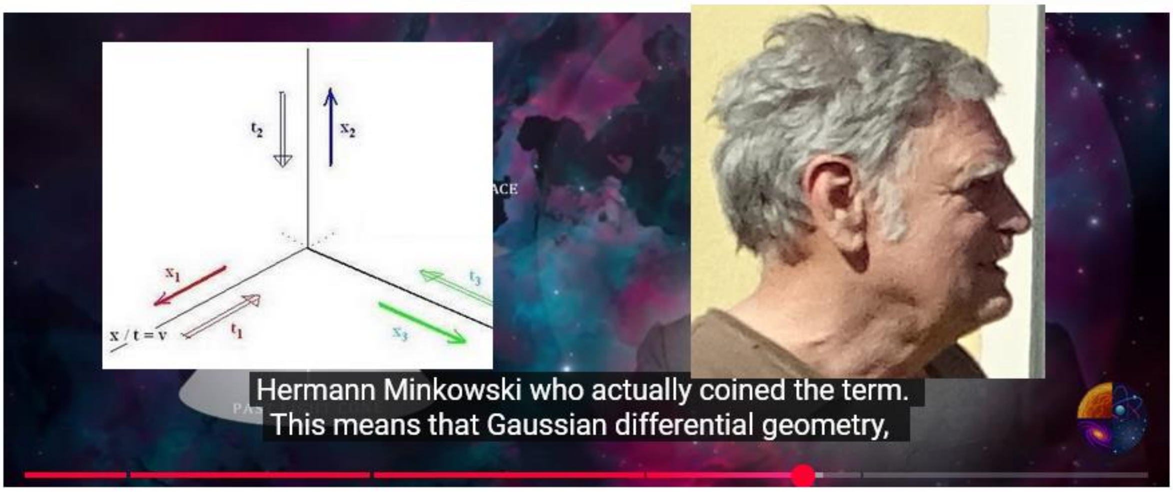
JN, 20.02.2025

Minkowski



Navrátil


t2
x2
x1
t3
x / t = v
t1
x3
Hermann Minkowski who actually coined the term.
This means that Gaussian differential geometry,