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Will the Big Bang repeat?

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(01)- This video was sponsored by Curiosity Stream.This video is about Roger Penrose's idea for the beginning of the universe and its end, conformal cyclic cosmology, CCC for short. It's a topic that a lot of you have asked for ever since Roger Penrose won the Nobel Prize in 2020.The reason I've put off talking about it is that I don't enjoy criticizing other people's ideas, especially if they're people I personally know.And also, who am I to criticize a Nobel Prize winner. on YouTube, out of all places.However, Penrose himself has been very outspoken about his misgivings of string theory and contemporary cosmology, in particular inflation, and so in the end I think it'll be okay if I tell you what I think about conformal cyclic cosmology.And that's what we'll talk about today.First thing first, what does conformal cyclic cosmology mean. I think we're all good with the word cosmology, it's a theory for the history of the entire universe, alright. That it's cyclic means it repeats in some sense. Penrose calls these cycles eons. Each starts with a big bang, but it doesn't end with a big crunch. A big crunch would happen when the expansion of the universe changes to a contraction and eventually all the matter is well, crunched together. A big crunch is like a big bang in reverse. This does not happen in Conformal Cyclic Cosmology. Rather, the history of the universe just kind of tapers out. Matter becomes more and more thinly diluted. And then there's the word conformal. We need that to get from the thinly diluted end of one eon to the beginning of the next. But what does conformal mean? A conformal rescaling is a stretching or shrinking that maintains all relative angles. Penrose uses that because you can use a conformal rescaling to make something that has infinite size into something that has finite size. Here is a simple example of a conformal rescaling. Suppose you have an infinite two-dimensional plane. And suppose you have half of a sphere. Now from every point on the infinite plane, you draw a line to the center of the sphere. At the point where it pierces the sphere, you project that down onto a disk.That way you map every point of the infinite plane into the disk underneath the sphere.A famous example of a conformal rescaling is this image from Escher. Imagine that those bats are all the same size and once filled in an infinite plane.In this image they are all squeezed into a finite area.Now in Penrose's case, the infinite thing that you rescale is not just space, but space-time. You rescale them both and then you glue the end of our universe to a new beginning. Mathematically you can totally do that. But why would you? And what's with the physics? Let's first talk about why you would want to do that. Penrose is trying to solve a big puzzle in our current theories for the universe. It's the second law of thermodynamics: entropy increases. We see it increase. But that entropy increases means it must have been smaller in the past.Indeed, the universe must have started out with very small entropy, otherwise we just can't explain what we see.That the early universe must have had small entropy is often called the Past Hypothesis, a term coined by the philosopher David Albert. Our current theories work perfectly fine with the past

hypothesis. But of course it would be better if one didn't need it. If one instead had a theory from which one can derive it. Penrose has attacked this problem by first finding a way to quantify the entropy in the gravitational field. He argued already in the 1970s, that it's encoded in the Weyl curvature tensor. That's loosely speaking part of the complete curvature tensor of space-time. This Weyl curvature tensor, according to Penrose, should be very small in the beginning of the universe. Then the entropy would be small and the past hypothesis would be explained. He calls this the Weyl Curvature Hypothesis. So, instead of the rather vague past hypothesis, we now have a mathematically precise Weyl Curvature Hypothesis. Like the entropy, the Weyl Curvature would start initially very small and then increase as the universe gets older. This goes along with the formation of bigger structures like stars and galaxies. Remains the question how do you get the Weyl Curvature to be small. Here's where the conformal rescaling kicks in.You take the end of a universe where the Weyl curvature is large, you rescale it which makes it very small, and then you postulate that this is the beginning of a new universe.Okay, so that explains why you may want to do that, but what's with the physics. The reason why this rescaling works mathematically is that in a conformally invariant universe there's no meaningful way to talk about time. It's like if I show you a piece of the Koch snowflake and ask if that's big or small.
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(01) - This video was sponsored by Curiosity Stream. This video is about Roger Penrose's idea of the beginning of the universe and its end, conformal cyclic cosmology, abbreviated CCC. It's a topic that many of you have been asking about since Roger Penrose won the Nobel Prize in 2020. The reason I postponed talking about it is because I don't like **criticizing other people's ideas**, especially if they are people. ((Ideas are common and desirable to criticize, but it's not polite to challenge the authors of those ideas ..)) I know personally. And also who I am to criticize Nobel Prize winners. ((Sure, and you're just saying you're small on criticizing **people**., Yes, but first you talked about the mistake of criticizing thoughts-ideas. Ideas yes, people don't)) On YouTube, among other things. However, Penrose himself expressed himself very openly about his doubts about string theory ((he criticized the idea, not the authors)) and current cosmology, especially inflation, ((I don't like inflation too much, I'm more in favor of a smooth "expansion"). smooth expansion of the Universe, space-time)) and so in the end I think it will be okay to tell you what conformal cyclic cosmology thinks about it. And that's what we're going to talk about today. First, what conformal cyclic cosmology means. I think we're all good with the word cosmology, it's a theory for the history of the whole universe, well. Being cyclical means that it repeats itself in a sense. ((I'm not against, nor for, rather for…)) Penrose calls these cycles **eons**. Each cycle starts with a big bang, but does not end with a big crunch. ((It ends with "dissolution", expanding the curvatures of space-time dimensions into Euclidean flatness, so that this 3 + 3D state / without matter, without fields, without flow of time, without expansion) is ready for the new Bang packed-packed, into an extreme foam of dimensions, in the form of a plasma, an extreme boiling space-time, which is "projected" / eg into the raster plane / or "cut" as "quantized" je, it is a view of "zeros and ones "," Points and gaps "," nothing "and" something ", extreme graininess, because the projection of packed-packed dimensions is a view of some quantum.)) A big squeak occurs when the expansion ((unpacking)) of the universe it turns into a contraction ((unpacking)) and in the end all the matter is fine, ((scattered and also "unpacked")) crunches together. A big crunch is like a big bang the other way around. ((?)) This does not happen in conformal cyclic cosmology. ((?)) Rather, the history of the universe is somehow narrowing. ((?)) Matter becomes more and more dilute ((Yes, O.K. and finally - big crash - the matter also "unpacks", because even elementary particles are packed dimensions into balls-cocoons-geons.)). And then the word conforms. We need to get from the thin end of one eon to the beginning of another. ((Conformal? Mě for me, big-bang is a change of state !!!, a change of extremely flat space-time 3 + 3 D to extremely curved space-time n + m)). But what does conformal mean? Conformal scaling ((O.K.. Dimension dimension changes to extra curvature-dimension collapse)). is stretching or shrinking that maintains all relative angles. Penrose uses this because you can use conformal scaling to create something that is infinite in size ((3 + 3D)) to something that has a finite ((n + m wrapped)) size ((in the form of super dense foam.)) Here is a simple example of conformal scaling. ((= bang = shrinking into foam.)) Suppose you have an infinite two-dimensional plane. And let's say you have half a ball. Now draw a line to the center of the sphere from each point in the infinite plane. ((In the video, Sabina demonstrates "unpacking" the ball into a plane)). At the point where it pierces the ball, you project it down onto the disk. In this way, you map each point of the infinite plane to a disk under the sphere. ((Abstractly, by **crumpling** the infinite plane, you get "singular foam" = our post-big-bang state of the Universe.)). This image from **Escher** is a famous example of conformal scaling. Imagine that all these bats are the same size and once they are filled in an infinite plane. ((Nobody opposes abstract visualizations…)). In this image, everyone is pressed into the final area. ((O.K. I use examples with extreme packing of dimensions "into each other" = into foam. http://www.hypothesis-of-universe.com/docs/c/c_168.gif)). Now, in the case of Penrose, the endless thing you change is not just space, but space-time. ((Correct!)) You scale both and then paste ((?)). the end of our universe to a new beginning. ((Well, he can also call it a "bang = change of state" 3 + 3D flat to 3 + 3D extremely collapsed, why not?)) Mathematically, you can do it completely. But why would you? And what about physics? First, let's talk about why you want to do it. ((O.K.))

Penrose tries to solve a big riddle ((me too)) in our current theories of the universe. ((HDV has not even been read ato let alone studied… and let alone discussed arguments, counter-arguments in 20 years)). It is the second law of thermodynamics: entropy increases. ((The theory of entropy is a beautiful thing - but there is also "something" that is the opposite of entropy!! And that is the "production of matter - elements and matter" of more and more complex entities when we end up in protein biology in DNA.)) increases. But the fact that entropy is increasing means that it must have been smaller in the past. ((And the smallest in the "chaotic foam of dimensions" in which the genesis of increasingly complex and complex matter begins to organize, .. and the genesis of physical fields, .. and the genesis of large-space galactic structures,… and the genesis of interactions in the microworld,… and parallel genesis of laws and rules and principles…)) The universe really had to start with very little entropy, otherwise we just can't explain what we see. ((O.K. "foam = plasma" = crumpled space-time and it begins to expand !! into networks - cobwebs on a macro scale http://www.hypothesis-of-universe.com/docs/c/c_362.jpg = http: // www.hypothesis-of-universe.com/docs/c/c_241.jpg ; http://www.hypothesis-of-universe.com/docs/c/c_344.jpg (13.8 billion years after the Bang) and in parallel with it also pack into those geons = elementary particles, http://www.hypothesis-of-universe.com/docs/c/c_283.jpg ; http://www.hypothesis-of-universe.com/docs/c /c_266.jpg then into atoms, molecules, compounds, it's all organized space-time http://www.hypothesis-of-universe.com/docs/eb/eb_002.pdf)) That the early universe must have had little entropy, is often called the past hypothesis, a term coined by the philosopher **David Albert**. Our current theories work perfectly with the past hypothesis. But of course it would be better if one didn't need it. If one had a theory from which to derive it instead. Penrose attacked this problem by first finding a way to quantify entropy in the gravitational field.

As early as the 1970s, he claimed to be encoded in Weyl's curvature tensor. ((The curvatures of what? The universe? Or space-time? ..?)) This is loosely part of the total tensor of the curvature of space-time. ??? According to Penrose, this Weyl curvature tensor should be very

small at the beginning of the universe. ((??? it's not clear to me and a layman's feeling tells me that there's something, some thought wrong)). Then the entropy would be small and the previous hypothesis would be explained. This is called the Weyl curvature hypothesis. So instead of the rather vague past hypothesis, we now have a mathematically accurate Weyl curvature hypothesis. ((What? http://www.hypothesis-of-universe.com/docs/c/c_239.jpg)). Like entropy, the Weyl curve would initially start very small and then increase as the universe ages. This goes hand in hand with the creation of larger structures such as stars and galaxies. ((Web - web - a view of the global "curvature" of the Universe, on the contrary, points to the "diversity" of curved gravitational fields between galaxies - - "network - web - web") in matter (stars, nebulae, etc.) ..)) The question remains how to make Weyl's curvature small. This is where the conformal scaling begins. You take the end of the universe where Weyl's curvature is large, change its scale, making it very small, and then assume that this is the beginning of a new universe. Well, that explains why you might want to do it, but what about physics. The reason this rescaling works mathematically is that there is no meaningful way to talk about time in a conformally invariant universe. It's like showing you a piece of Koch snowflake and asking if it's big or small
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(02)- These pieces repeat infinitely often so you can't tell. In CCC it's the same with time at the end of the universe.But the conformal rescaling and gluing only works if the universe approaches conformal invariance towards the end of its life. This may or may not be the case. The universe contains massive particles, and massive particles are not conformally invariant.That's because particles are also waves and massive particles are waves with a particular wavelength. That's the Compton wave-length, which is inversely proportional to the mass. This is a specific scale, so if you rescale the universe, it will not remain the same. However, the masses of the elementary particles all come from the Higgs field, so if you can somehow get rid of the Higgs at the end of the universe, then that would be conformally invariant and everything would work. Or maybe you can think of some other way to get rid of massive particles. And since no one really knows what may happen at the end of the universe anyway, ok, well, maybe it works somehow.But we can't test what will happen in a hundred billion years. So how could one test Penrose's cyclic cosmology? Interestingly, this conformal rescaling doesn't wash out all the details from the previous eon. Gravitational waves survive because they scale differently than the Weyl curvature. And those gravitational waves from the previous eon affect how matter moves after the big bang of our eon, which in turn leaves patterns in the cosmic microwave background. Indeed, rather specific patterns. Roger Penrose first said one should look for rings.These rights would come from the collisions of supermassive black holes in the eon before ours.This is pretty much the most violent event one can think of and so should produce a lot of gravitational waves.However, the search for those signals remained inconclusive.Penrose then found a better observational signature from the earlier eon which he called Hawking points. Supermassive black holes in the earlier eon evaporate and leave behind a cloud of Hawking radiation which spreads out over the whole universe. But at the end of the eon, you do the rescaling and you squeeze all that Hawking radiation together.That carries over into the next eon and makes a localized point with some rings around it in the CMB.
And these Hawking points are actually there. It's not only Penrose and his people who have found them in the CMB. The thing is though that some cosmologists have argued they should also be there in the most popular model for the early universe, which is inflation. So, this prediction may not be wrong, but it's maybe not a good way to tell Penrose's model from others. Penrose also says that this conformal rescaling requires that one introduces a new field which gives rise to a new particle. He has called this particle the "erebon", named after

erebos, the god of darkness. The erebons might make up dark matter. They are heavy particles with masses of about the Planck mass, so that's much heavier than the particles astrophysicists typically consider for dark matter. But it's not ruled out that dark matter particles might be so heavy and indeed other astrophysicists have considered similar particles as candidates for dark matter. Penrose's erebons are ultimately unstable. Remember you have to get rid of all the masses at the end of the eon to get to conformal invariance. So Penrose predicts that dark matter should slowly decay. That decay however is so slow that it is hard to test.He has also predicted that there should be rings around the Hawking points in the CMB B-modes which is the thing that the BICEP experiment was looking for. But those too haven't been seen – so far. Okay, so that's my brief summary of conformal cyclic cosmology, now what do I think about it. Mostly I have questions. The obvious thing to pick on is that actually the universe isn't conformally invariant and that postulating all Higgs bosons disappear or something like that is rather ad hoc. But this actually isn't my main problem. Maybe I've spent too much time among particle physicists, but I've seen far worse things. Unparticles, anybody? One thing that gives me headaches is that it's one thing to do a conformal rescaling mathematically.Understanding what this physically means is another thing entirely. You see, just because you can create an infinite sequence of eons doesn't mean the duration of any eon is now finite. You can totally glue together infinitely many infinitely large space-times if you really want to. Saying that time becomes meaningless doesn't really explain to me what this rescaling physically does. Okay, but maybe that's a rather philosophical misgiving. Here is a more concrete one.
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(02) - These pieces are repeated infinitely, so it is not recognizable. In CCC, it's the same with time at the end of the universe. But conformal scaling and gluing only work when the universe approaches conformal invarianty at the end of its life. It may or may not be so. The universe contains massive particles ((what are they?)) And massive particles are not conformally invariant. This is because particles are also waves ((and dualism is because and precisely because particles = a wave pack of dimensions "floats" in a less crooked 3 + 3D environment, and these balls "spill over" in the environment http; http://www.hypothesis-of-universe.com/docs/c/c_426.jpg Unfortunately, I don't know how to describe it verbally, but maybe there are those who think a lot and can imagine (!) in wavy space-time how to "roll in a rolling way "They have spilled curled-up balls of dimensions"; the picture has gathered here somewhere, but we need to make a far more complex and meaningful picture of a "wavy" environment in which packages of tangled dimensions "roll and intertwine" and change, transform into different curled balls. Here you need the high level of imagination (http://www.hypothesis-of-universe.com/docs/c/c_425.jpg)) and massive particles are waves with a certain wavelength. This is the Compton wavelength, which is inversely proportional to the mass. ((Of course, mass is a property of matter, and if the particle under consideration has a certain "twist" of the dimensions used, then after the collision of such two, another twisted wave will "emerge")). This is a specific scale, so if you change the scale of the universe, it will not stay the same. However, the masses of the elementary particles all come from the Higgs field, (((*) I have a different interpretation: http://www.hypothesis-of-universe.com/docs/aa/aa_188.pdf ; http://www.hypothesis-of-universe.com/docs/aa/aa_176.pdf ; http://www.hypothesis-of-universe.com/docs/aa/aa_175.pdf ; // Just a sentence, note: weight is a property of mass, ie after the package is packed using several selected dimensions and this package is "connected" with another wave package and then another interconnection and

another…, each configuration of used and packed dimensions then indicates the weight of the conglomerate of multi-packed dimensions (atoms, molecules, compounds) ..))
So if you can somehow get rid of Higgs at the end of the universe, then it would be conformally invariant and everything would work. Or maybe you can think of some other way to get rid of solid particles. ((Simply expand them…)). And because no one really knows what might happen at the end of the universe anyway, well, well, maybe it works somehow. But we can't test ((what we can't test is intrigue, says Kulhánek, and it doesn't belong in physics)) what will happen in a hundred billion years. So how can Penrose's cyclic cosmology be tested? ((Our Kulhánek will tell you that. (He already told me: gigantic phantasmagoria… and forbade me to join the discussion forum in 2005) ..)). Interestingly, this conformal rescaling does not wash out all the details from the previous eon. Gravitational waves survive because they change differently than Weyl's curvature. And these gravitational waves from the previous eon affect how matter moves after the big bang of our eon, ((gravitational waves are oscillations of time and space - that was a quote from professional physics. That is, the length and time dimensions wave. No theory, so far known , does not prohibit that the oscillations-waves of "something" (here dimensions) cannot be changed to "wrap-waves" of those surfr waves, ie to the wrapping of waves.)), which in turn leaves patterns in the cosmic microwave background. ((The wave leaves patterns ??? in the background? And what is the background?)). Indeed, rather specific patterns. Roger Penrose first said that we should look for rings. These rights come from collisions of supermassive black holes in the eon ahead of us. This is basically the most violent event one can imagine, and therefore it should produce a lot of gravitational waves. The search for these signals remained inconclusive. Penrose then found a better observation signature from an earlier eon, which he called Hawking points. The supermassive black holes in the former eon evaporate, leaving behind a cloud of Hawking radiation that spreads across the universe. But at the end of the eon, you change the scale and push all that Hawking radiation together. ((And there is no simpler HDV interpretation that at the end of the eon, which is the unfolding of all curvatures of space-time dimensions "outside" matter and "inside" matter), a totally Euclidean flat 3 + 3D space-time occurs I say in HDV there is a change from the pre-Bang state to the post-Bang state, ie the flatness with a jump (phase?) changes to the extreme curvature of all dimensions - boiling, chaotic, dense foam of dimensions = plasma. : packing into frozen geons-packets = elementary particles a… and unpacking those dimensions into the global environment of galaxy clusters.))
It transfers to the next eon ((?? Who will transfer it "there")) and creates a localized point with several rings around it in the CMB. And these Hawking points really are there. It's not just Penrose and his people found them at CMB. The point is that some cosmologists have argued that they should be there in the most popular model of the early universe, which is inflation. So this prediction may not be bad, but it may not be a good way to distinguish Penrose's model from others. Penrose also says that this conformal scaling requires the introduction of a new field that gives rise to a new particle. ((I repeat: do physicists **introduce** the universe? Or should the Universe introduce those physicists !! May I also "something" introduce the Universe?)) He called this particle "erebon," named after Erebon, the god of darkness. Ereboni can form dark matter. They are heavy particles weighing about Planck's mass, so they are much heavier than particles that astrophysicists usually consider dark matter. However, it is possible that dark matter particles may be so heavy, and indeed other astrophysicists have considered such particles to be candidates for dark matter. Penrose's erebons are

ultimately unstable. ((God said)). Remember that at the end of the eon you have to get rid of all the masses to get to conformal invariance.
((Physicists say that accelerated expansion "tears" matter, well, they don't say what's left of that matter torn (?)…)). So Penrose predicts that dark matter should decompose slowly. ((Ehm ... everyone calls it different. Nobel laureate, he "decomposes" matter. (Decomposes God knows what and how). I unpack matter, because it is constructed by packing dimensions, so at the end of the eon there will again be a clean flat 3 + 3D dimensional space-time. Will Penros be left with "what" of that matter?)). However, this decay is so slow that it's hard to test. ((Sure. Hell with devils is also hard to test)). He also predicted that there should be rings around Hawking points in CMB B modes, which is something the BICEP experiment was looking for. http://www.hypothesis-of-universe.com/docs/c/c_423.gif But even these have not been seen - yet. Well, that's my brief summary of conformal cyclic cosmology, what I think about it now. ((And Mrs. Sabino, what do you personally think? .. because what you say is Penrose et al.)). Mostly I have questions. Obviously, the universe isn't really conformally invariant , and that postulating all the Higgs bosons will disappear, or something like that is more ad hoc. ((Well, that's it - it's realistic in my HDV.)) But that's not really my main problem. I may have spent too much time among particle physicists, but I have seen much worse things. ☺ Unparticles, anyone? One thing that gives me a headache is that one thing is to make a conformal scaling mathematically. ((What do you mean? The mathematical scale is interesting…: in "almost-infinite" 3 + 3D space-time we will make "almost-zero" locality = singularity in the "near-infinite" 3 + 3D spacetime we will make a "near-zero" locality = singularity $\boxed{\infty \,.\, 0 = 1 \,.\, 1}$ by "packing" into the extreme curvature of the dimension and we will have extremely dense foam "floating" in infinite flat 3 + 3D space-time - what about you, Mrs. Sabino, I don't know math, so I help myself with logic → How does inequality $1 \neq 2$ go into equality $10^{5500} + 1 = 10^{5500} + 2$)) http://www.hypothesis-of-universe.com/docs/h/h_082.jpg ; http://www.hypothesis-of-universe.com/docs/eng/eng_008.jpg)) Understanding what this means physically is a completely different matter. You know, just because you can create an infinite sequence of eons doesn't mean that the duration of any eon is finite now. If you really want to, you can glue an infinite number of infinitely large timespaces together. The claim that time is meaningless does not really explain to me what this scaling is doing physically.
Okay, but maybe that's a rather philosophical misgiving. Here is a more concrete one.
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(03)- If the previous eon leaves information imprinted in the next one, then it isn't obvious that the cycles repeat in the same way. Instead, I would think, they will generally end up with larger and larger fluctuations that will pass on larger and larger fluctuations to the next eon because that's a positive feedback. If that was so, then Penrose would have to explain why we are in a universe that's special for not having these huge fluctuations. Another issue is that it's not obvious you can extend these cosmologies back in time indefinitely. This is a problem also for "eternal inflation." Eternal inflation is eternal really only into the future. It has a finite past.You can calculate this just from the geometry. In a recent paper Kinney and Stein showed that this is also the case for a model of cyclic cosmology put forward by Ijjas and Steinhard has the same problem. The cycle might go on infinitely, alright, but only into the future not into the past. It's not clear at the moment whether this is also the case for conformal cyclic cosmology. I don't think anyone has looked at it. Finally, I am not sure that CCC actually solves the problem it was supposed to solve. Remember we are trying to explain the past hypothesis. But a scientific explanation shouldn't be more difficult than the thing you're trying to explain. And CCC requires some assumptions, about the conformal invariance and the erebons, that at least to me don't seem any better than the past hypothesis.

Having said that, I think Penrose's point that the Weyl curvature in the early universe must have been small is really important and it hasn't been appreciated enough. Maybe CCC isn't exactly the right conclusion to draw from it, but it's a mathematical puzzle that in my opinion deserves a little more attention. This video was sponsored by Curiosity Stream. YouTube is a great place for some things. For example, from me you get the brief summaries on recent scientific topics. But sometimes brevity is not what you want. Sometimes you want a professionally made full length documentary, something that will entertain you as much as it will educate you. If you like that too, you should really check out Curiosity stream. Curiosity Stream has thousands of movies and shows about physics, space, medicine, technology, history, everything really.They're adding new ones every week. And you can watch them conveniently on your laptop or phone. On Curiosity Stream you can find for example a wonderful documentary about how the James Webb telescope was built. It has interviews with some of the key engineers and researchers and really shows the amazing complexity of this mission. They also have a lot of other documentaries on space, about gravitational waves and black holes and about "The Dark Secrets of the Universe". And of course I have a special offer so you can try it out yourself. You can get a subscription for Curiosity Stream for a whole year for just $14.99 if you use our link curiositystream dot come slash sabine or use the code sabine at checkout. Thanks for watching, see you next week.

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(03) - If the previous eon leaves the information printed in the next eon, then it is not clear that the cycles repeat in the same way. ((Sure, we're in the level of maximum speculation> for which Nobel-price is handed out <…> for HDV, insults and humiliation in phantasmagors are handed out <)). Instead, I think they will generally end up with bigger and bigger fluctuations, which will carry bigger and bigger fluctuations into the next age, because that's positive feedback. ((??? fantasy feeds another fantasy)) If it were so, then Penrose would have to explain why we are in a universe that is exceptional in that it does not have these huge fluctuations. Another problem is that it is not clear that you can extend these cosmologies back in time indefinitely. ((But: time does not run out for us, but we-material objects run "after it", after the time dimension, after the three time dimensions ...)). This is also a problem for "eternal inflation". ((Similar to the problem of finding God's horns on the head)). Eternal inflation is really eternal only into the future. He has a finite past. You can only calculate this from geometry. In a recent article, **Kinney** and **Stein** showed that this is also the case with the cyclic cosmology model presented by **Ijjas** and **Steinhard**, which has the same problem. The cycle can continue indefinitely, well, but only into the future, not into the past. ((The passage of time in one direction "applies" only to the macrocosm - as Kulhánek said -. And it also applies, as Kulhánek said - that the passage of time in the opposite direction is "normal" in the microcosm on the Planck scales, ie in *quantum theory*. In the boiling foam of dimensions, the arrows of the "cursor" move very quickly, which is reflected in the "directionless flow." And even Kulhánek said that at that level of such scales of the microworld "+ t" and "-t "It cancels out that the quantum doesn't need time. - The quantum may not, but the Universe needs the flow of time in the opposite direction just * inside those ball-mass packs of matter !!!)). It is not clear at this time whether this is also the case for conformal cyclic cosmology. I don't think anyone looked at it. ☺ In the end, I'm not sure if the CCC really solves the problem it was supposed to solve.
((Sabina, beware… Penrose received the Nobel Prize for that… and you said you would definitely not criticize people just their thoughts.)).Remember that we are trying to explain the past hypothesis. But scientific explanation should not be more difficult than what you are trying to explain. And the CCC requires certain assumptions about conformal invariants and

erebons, which at least don't seem any better to me than the previous hypothesis. ((O.K.)) Nevertheless, I think that Penrose's view that the curvature of Weyl ((what curvature?)) Must have been small in the early universe is really important and not sufficiently appreciated. Maybe the CCC isn't exactly the right conclusion to draw, but it's a math puzzle, ((um, like my http://www.hypothesis-of-universe.com/docs/g/g_073.pdf)) which in my opinion it deserves a little more attention. **!!** This video was sponsored by Curiosity Stream. YouTube is a great place for some things. For example, you will receive brief summaries of current scientific topics from me. But sometimes brevity is not what you want. Sometimes you want a professionally made feature documentary, something that will entertain you as well as educate you. If you also like it, you should really check out the **Curiosity stream**. Curiosity Stream has thousands of movies and shows about physics, space, medicine, technology, history, and about everything. They add new ones every week. ((The world does not have time to read new ideas and therefore "drowns" in ideas. In the "golden age of physics", 20 scientists were enough for all physicists and they knew each other and corresponded. https://upload.wikimedia.org/wikipedia/commons/thumb/6/6e/Solvay_conference_1927.jpg/1024px-Solvay_conference_1927.jpg Today?, 50 scientific articles a day.)) And you can comfortably watch them on your laptop or phone. For example, on Curiosity Stream you can find a wonderful documentary about how the James Webb telescope was built. He has interviews with some key engineers and researchers and really shows the amazing complexity of this mission. They also have a lot of other documents about the universe, about gravitational waves and black holes, and about the "Dark Secrets of the Universe." And of course I have a special offer so you can try it for yourself. You can get a full year Curiosity Stream subscription for just $ 14.99 if you use our curiositystream link slash sabina or use the sabine code at checkout. Thanks for watching, I'll see you next week.

I hope the google-translator has translated a complex interpretation well enough to understand. Thank you for your tolerance

JN, 04.03.2022