



Cycles of Time: An Extraordinary New View of the Universe

Roger Penrose

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One of our most distinguished scientists offers a radical new theory of the origin, and ultimate end, of the Universe.

Professor Sir Roger Penrose's groundbreaking and bestselling **The Road to Reality** provided a complete guide to the laws that govern our universe. **In Cycles of Time**, Penrose offers a completely new perspective on the often-asked question, 'what came before the Big Bang?' The answer that Penrose proposes involves a curious but fully rational way of looking at the expected ultimate fate of our accelerating expanded universe, and showing that its end can in fact be reinterpreted as the 'Big Bang' of a new universe.

Cycles of Time: An Extraordinary New View of the Universe Details

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From Reader Review Cycles of Time: An Extraordinary New View of the Universe for online ebook

Sarah says

Picked this off the 'in' shelf at the library. I can see from the date stamps that loads of people have been reading this.... Technically it lost me very soon. While I have previously encountered null cones and think I get the drift - I have also previously encountered strict conformal diagrams - and they are still complete mysteries. Maybe next time. Because that is what I love - I might not understand very much but each time I read a book like this I do understand a little more. And I just love to know that so many people are borrowing this book!

Hal Taylor says

The explanation of what happens before the big bang is laid out nicely in Roger Penrose's book "Cycles of Time". This book, like all Penrose, is not for wimps but at least this time he puts the Riemann geometry and manifold calculus in the appendix. According to Penrose the big bang is merely the remnants of the previous Universe which at the end of time has been cleansed of all its matter by black holes and Hawking radiation. As the boundaries of any Universe approach infinity space-time is re-scaled by a factor K as matter disappears ($S=KT$). When all the black holes have evaporated and there is nothing left but circulating electromagnetic radiation K approaches zero. The fascinating logic behind this is that time cannot exist without a means to measure it or be aware of it. And since photons do not experience time (they travel on the surface of the light cone after all) there's nothing left to experience time and space so it shrinks down to the point where all the energy of the Universe now in the form of photons and background radiation can no longer be confined and a big bang occurs.

A personal note to Roger Penrose:

Dear Sir:

You finally gave me an answer for what really happens at the end of time. The notion that all the space and mass in the universe can shrink down to a microscopic point to begin anew with another Big Bang was so counter-intuitive that I, like most laymen listening to TV cosmologists on public television, was not convinced that this could happen in real life. But then I read your book "Cycles of Time". At last someone has laid out a physical and mathematical rationale for what happens to all that space and mass. The idea of putting your friend Steven Hawking's discovery of black hole radiation to work was brilliant. As black holes vacuum up all the mass in the universe and the boundaries of the Universe approach infinity space-time gets re-scaled by the scaling factor K . $S = K T$. I was even able to conceptualize the Big Bang event in my own original way by observing that since time is defined as the interval between events then when time ceases to exist all events occur at once making all the left over energy in the Universe, now just in the form of circulating electromagnetic radiation, do an instantaneous flash-bang. In fact I would be flattered if you used that idea in your next book. Yep. I got it all figured out now, Dr. Penrose.

Thank you.

Hal Taylor

Bettie? says

Unabridged. Read by Bruce Mann. 7hrs 22 min

Big Bang or Steady State? Big Bang! however an *organised* Big Bang.

The second law of thermodynamics states that the entropy of an isolated system never decreases, because isolated systems spontaneously evolve towards thermodynamic equilibrium—the state of maximum entropy. Equivalently, perpetual motion machines of the second kind are impossible.

From Wiki: *Sir Roger Penrose OM FRS (born 8 August 1931), is an English mathematical physicist, recreational mathematician and philosopher. He is the Emeritus Rouse Ball Professor of Mathematics at the Mathematical Institute of the University of Oxford, as well as an Emeritus Fellow of Wadham College.*

Penrose is internationally renowned for his scientific work in mathematical physics, in particular for his contributions to general relativity and cosmology. He has received a number of prizes and awards, including the 1988 Wolf Prize for physics, which he shared with Stephen Hawking for their contribution to our understanding of the universe.

"impossibility in its purest form"

The Penrose Triangle

Thrown in the towel - too much for my poor noddle and I'd be better off sticking to the popular science publications.

Luca Campobasso says

I think is a book fulfilled of innovative ideas and surrounded by a fresh phylosophy, it's what I wanted from such a book. I will re-read it soon because of some parts I didn't understand very well. Probably I would like to see more concepts explained in the appendices, that's it.

Matt McClure says

Cycles of Time is Roger Penrose's attempt at (mostly) fleshing out his hypothesis of conformal cyclic cosmology (CCC), which is along the lines of previous cyclical cosmology proposals, suggesting that the current universe is merely a conformally ("smooth") geometric extension of universes past.

Penrose's prologue and epilogue in *Cycles of Time* are silly, but it is to my understanding that they're to presuppose the narrative structure of the book. Penrose begins with the problems of the second law of thermodynamics in modern physics, specifically the role of entropy, which he accurately relates (though not obviously) to microscopic degrees of freedom.

This raises the question of how highly dense, highly heated, low-entropy pre-big bang conditions can result in a universe that is getting hotter and whose entropy is increasing, irreversibly. Penrose does not explain (or, at least, I did not catch it in the text) how his CCC model shows the transition (or "crossover") from the

previous universe ("aeon") to the present universe in terms of the dynamics that take place during this transition. Specifically, I did not see Penrose explaining how, nearing the end of the universe (some 10^{100} years), a low-density, low-heat, radiation-riddled universe with decreased phase space (and thus decreased degrees of freedom) gives rise to a new big bang. (The radiation, Penrose assumes, arises from massive particles eventually becoming massless and turning into electromagnetic radiation, or photons).

CCC views the state of the universe in classical terms. Penrose dismisses modern cosmological models distinguished from CCC, such as string theory and loop quantum cosmology. CCC dismisses the necessity of discovering the nitty-gritty physics of space-time singularities in classical general relativity. In Penrose's view, non-classical (quantum) physics must be introduced at the Planck scale, which is the scale at which singularities must be dealt in order to avoid the problem, among many others, of infinite curvature. But Penrose dismisses the notion of infinity and the necessity of discovering new physics to explain space-time singularities. Rather than working to explain them, we should merely walk around them.

Penrose's CCC relies heavily on local conformity within Riemannian differential geometry. The mathematics he presents is not difficult to follow; he barely does any math, save for his work in the appendices. It is important to keep up with his definitions and to keep a reference of his notes, because they help to clarify or expound on certain points he is making. Penrose goes from a dab of statistical physics to general relativity. His arguments for CCC against other cosmological models with the aid of general relativity are easier to follow than is his reasoning for the dynamics that actually occur during crossover from one aeon to the next. Many of his explanations in these manners seem to be rather hand-wavy.

Cycles of Time is worth picking up, and although a narrative is present, I don't think it brings together every idea under CCC as cogently as possible. Chapter 1 poses great questions, and Penrose's attention to detail with how entropy operates in our universe is very refreshing. In addition, Chapter 2 is wonderful crash-course in special and general relativity. Chapter 3, however, leaves much to be desired. Overall, I would have preferred a more textbook-style exposition, so as to cover as many loose ends as possible. Penrose should have added another chapter devoted to explaining how CCC, in conjunction with other cherry-picked GR cosmological models, might work during crossover, and not just how it works or looks geometrically.

Cybermilitia says

Entropi, Hawking isimasi, isik konisinin kullanimlari konularinda geleneksellesmis bilgilerin uzerine bambaska bir bakis acisi getiriyor. Bu anlamda, bazen Feynman Lecture's okurken hissedilen "Bize niye boyle ogretmediler yahu?" duygusu hissedilebilir. Karadeliklerin faz uzayinin boyutunu kuculterek entropiyi baslangictaki durumuna dusurmesi fikri gercekten cok ilginç. Bu konu uzerinde cok daha fazla okuma yapmak gerek.

Kitabin ana iddiası CCC dusuncesi henüz eksik. Kutlecekim dalgalarının etkilerinin bir eon'dan bir sonraki eon'a gecme oykusu fazla desteksiz. En azından I, B gibi yuzeylerini bu kadar incelemisken, boyle hikaye anlatir gibi gecemsi hic ikna edici olmamis. Gerek kosullardan biri -entropinin sonunda dusmus olmasi gerekliligi- CCC yaklasimi icin yeterli degil. Bir de sonucta ana problem kalıyor: Neden? Ne oldu da eon basladi? Evren ne oldu da ortaya cikiverdi? Her ne kadar enflasyonu gecen eonun icine yerlestirme girisiminde bulunsa da bu da yetersiz kalmis. Neden yani? Ama zaten Penrose'da "Aha budur!" demiyor. Hawking'in "Karadeliklerde bilgi yuzeyde tutuluyor!" muphem icadindan sonra alti doldurulmamis fikirlerle ilerlemenin problemleri gorulmustur sanirim. :)

Daha sonra okuyup, ozellikle eklerindeki formul-keywordleri arastiracagim icin 4 yildiz. Ama fikirlerine oyle hemen ikna olmadim. 5 yildiz vermeyecegim.

David Nash says

I found this completely unintelligible.

Reading this book was like being kidnapped. I had a bag over my head and kept asking where we were going. Mostly I was ignored but occasionally I was told "we're turning left" or an explanation of how the steering mechanism worked.

I have a hard time imagining who the intended audience is. It's definitely not the general population.

You need some serious background in physics and mathematics to even start to understand what he's on about. So much so that you probably don't need to read the book, you could just read a summary of the argument and understand it.

I usually don't mind skim-reading the deeply technical parts and I can still appreciate a book where the author tells you what it all means in plain english. But that just never happens.

There wasn't even a conclusion that I could discern. The title on the cover says "Cycles of Time" but it's hard for me to relate that to anything in the at all book, really.

Cassandra Kay Silva says

I read this book cover to cover, and then the appendix and then tried again. I took a tea break walked in a circle, picked back up the book and continued to stare at it trying to glean somehow the information that I obviously was not meant to be clever enough to follow. I felt like Zoolander beating up the computer to get the information out of it. I can honestly admit that I could not understand nor have any basis for figuring out the vast majority of this book. I tried. I am not stupid. I know basic physics. This is not basic. The math is way in another universe from my limited calculus background. I really tried, and I kept trying because I think the idea is flawless. I love a cyclic universe. I want a cyclic universe and frankly I don't want just anyone, I want this one. It is beautiful and well conceived. I just can't honestly say I understood the building up of it from the mathematical viewpoint. I got lost three equations in. The IDEAS that are here I love. I just can't make any comment on the checking out of these ideas at this time in my life. Luckily I bought the book, and I plan on living a while longer, maybe I will eventually get enough background to re tackle this one.

Bradley says

I like to refresh myself on my intuitive understanding of physics every once in a while since I won't ever admit to understanding more than 30%-40% of the math.

Even so, what I do understand is still more than enough to endlessly fascinate and make me sit around fantasizing and ruminating and dreaming up new ways to describe what I know and how to apply it in interesting ways.

It's the curse of reading a ton of SF, too, and I'm pretty sure I'm not alone in this weird little habit of mind

games and flights of attempted non-entropic fancy.

That being said, I did understand everything in this book, at least in the broad strokes, because Mr. Penrose almost never deviated from common ground.

You know, background radiation proving the Big Bang, gravitational lensing effects to prove or disprove dark matter and/or dark energy, and a few other common steps along the way to build a standard case for our current understanding of the cosmology.

No problem. He's a good writer and his analogies are interesting even if they're ones I've heard a hundred times. You know, like the one about Einstein on a Train. Raindrops on a tarmac for mass distributions of black holes and the eventual release of their captured radiation over a grand long time until entropy has its final way.

Where the good stuff is, (in my opinion,) lies in the idea of time and its reversibility in the grand 10 to the 124 schema, or if we eventually throw this whole universe down a gravitational funnel, the 10 to the 125 manifold. Is this the reversal, the homogenous transformation of matter back into straight energy that preceded the original big bang? Is this an ongoing cycle that repeats?

Well, that was what *I* wanted to know, anyway. Let me let you in on a big spoiler: (view spoiler)

Honestly, this is good, even with all the talk about the lambda, Einstein's cosmological constant, and how it still maintains a strong presence in the grand discussion, but really? I truly have a much better time trying to wrap my puny little brain around the string theories more. Holographic universes also float my boat. Still, for all that this text tried to convince me of an old theory that may or may not be quite up to date, it's still a fun read.

Maybe one of these days I'll do more than just nod my head at some of the more complex equations. :) Truly, enough exposure to these, book after book, IS doing me a lot of good. Maybe if I collect enough great analogies and get a spinal shunt with a couple hundred external parallel processors to hang my brain on, I'll be just about ready to transform a few tensors. :)

Gendou says

This is a fun and (from the midpoint) challenging book.
The prefacing fiction story is a major groan, you can skip through it.
Penrose relies a lot on figures throughout the book.
This poses some difficulty for those listening to the audio version...

The problem CCC (Conformal Cyclic Cosmology) attempts to solve is:
Why does the universe have a low-entropy beginning?
(Specifically, why is this low entropy only in the gravitational degrees of freedom?)
As a computer programmer, I have no problem whatsoever accepting this boundary condition.
For some reason, certain physicists seem to think it a problem.
The journey to understand CCC feels like swimming out into the ocean.
The only dry land in sight is to go back to solid ground and accept the boundary conditions of the early universe without too much concern.
I mean, seriously, dissipating rest-mass, universal re-scaling, proton decay, etc.
It takes some serious suspension of disbelief... not that that's a bad thing.

Then again, if we ever do see evidence of a previous epoch in the CMBR...

Fredrik says

I klassisk Penrose-stil starter boken som utrolig lesbar og interessant og lærerik. Elsker hvordan man kan resonnerer om kosmologi. Etterhvert blir den vanskeligere og vanskeligere, og jeg må innrømme jeg falt av de to siste kapitlene (som ble skimlet).

Men hovedinntrykket var veldig bra.

Ami Iida says

The book themes are
How wide is our universe?
When does the universe start?
When does the universe finish?
How long the universe 's age?
What is the quantum gravity theory?. etc.....

Dan Cohen says

Crikey, this was hard work! Whilst I have the deepest respect for Professor Penrose (whom I saw lecture more than 30 years ago) I've got to say that this book doesn't work for this particular lay reader and I suspect it won't work for many others. The topological concepts are really difficult and much of the discussion of entropy rather baffling. I'm not sure I could summarise what I think the Prof is asserting, let alone have any understanding of it. I have only the faintest glimmer of what he's getting at.

Of course, all this could just be me being too stupid! Good luck if you attempt this one.

Manny says

This book introduces Conformal Cyclic Cosmology: an amazingly beautiful idea, which I would love to be true. Unfortunately, the evidence to date is far from compelling. But, even if it isn't correct, Penrose is asking such interesting questions that the book is absolutely worth reading.

So here's my understanding of what it's about. Penrose starts by explaining the basic puzzle, which was a key theme in *The Road to Reality* and has been tantalizing cosmologists in general for a good while. As everyone knows who was paying attention during high school physics, the Second Law of Thermodynamics says that entropy increases with time; the universe gets progressively more and more disordered. If you drop an egg off a table, it breaks. But the time-reverse of this process is so vanishingly improbable that you don't ever expect to see it happen. A mess of egg-white, yolk and shell will not magically reassemble itself into an

intact egg and then bound off the floor onto a table.

The rest of this review is available elsewhere (the location cannot be given for Goodreads policy reasons)

Bill Bowyer says

"The entire fabric of life on earth requires the maintaining of a profound and subtle organization, which undoubtedly involves entropy being kept at a low level." ... "The structure of life on this planet would run rapidly down were it not for a powerful low-entropy source, upon which almost all life depends, namely the Sun."

Remember reading Penrose in college and being blown away. Favorite living theorist, turns complex ideas into digestible knowledge with simple charts and a straightforward writing style. When you pick apart the details and rearrange them in a way that makes sense, they can be rather inspirational. Big takeaway: the universe is a force of living energy balanced by entropy. Eternal harmony through a little give and take.

Pay attention to 2.2 "The ubiquitous microwave background."
