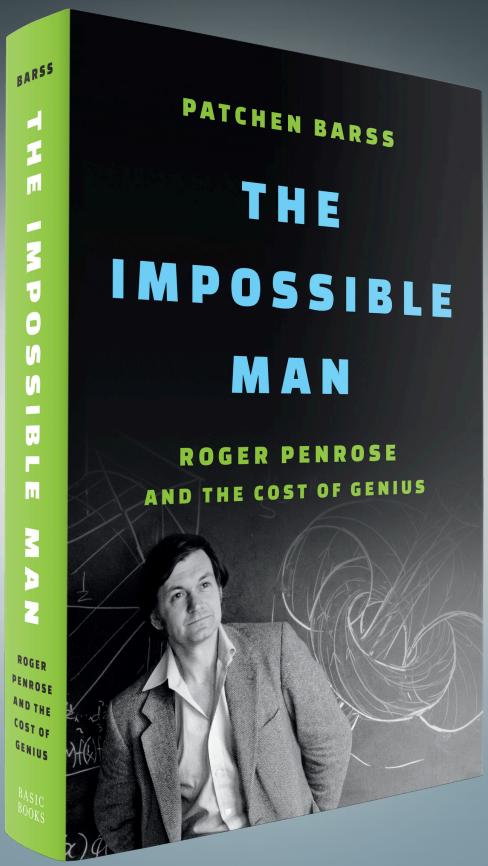
Patchen Barss

Roger Penrose's Unfinished Business



BONUS CONTENT

ROGER PENROSE'S UNFINISHED BUSINESS

Roger treated every challenge—personal and professional—as a problem waiting to be solved. This drive connected him to ideas so vast and beautiful they swept him away. It also shut out friends and family, leaving them heartbroken over his indifference to their love.

Since childhood, he had harboured more questions than he could answer in a single lifetime. His every breakthrough led to new, more intriguing questions. Every particle in his body was still single- mindedly devoted to answering them, racing against the moment when those particles were no longer bound together into the conscious entity known as Roger Penrose.

There were too many pieces, too many fragments of thought that still needed to be placed in the proper context. In a finite lifetime—as in a finite book—there isn't room to put every last piece in place. The puzzle is never finished.

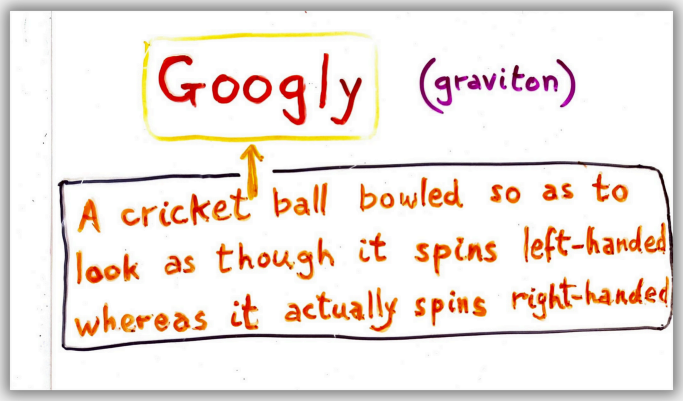
—Conclusion of *The Impossible Man*

I submitted my final manuscript to Basic Books in April 2024. In the intervening months while the book was being designed and printed, Roger continued to think, write, lecture, debate, and research. He maintained his daily walks and other routines. He traveled to London for an Order of Merit event with King Charles. In August, he celebrated his 93rd birthday, receiving greetings from friends and colleagues all over the world. His primary concern, though, remained his unfinished research, and the unresolved puzzles that still required his attention.

"Work is the important thing at the moment," he said on an autumn Zoom. "Life is all tied up with work."

Some of the puzzle pieces he toyed with were familiar and well-worn — concepts he'd developed or learned decades earlier that he still hoped would yield fresh clues. Others were so new he was still feeling out their shapes, trying to determine where they might fit into a model of the universe. He hoped at least some of them might hold the key to sliding everything into place.

The following is a rundown of his major current fascinations:



Penrose has been working on "the googly problem" for several decades. This image is a section of an undated overhead transparency he used in presentations to introduce the concept. [1]

TWISTORS REVISITED

When we spoke, Roger was preparing an in-person talk for a conference at Cambridge University called "Twistors in Geometry and Physics." His talk, "From the Origins of Twistor Theory to Bi-Twistors and Curved Space-Times" was half his classic hits and half new material. It included recaps of twistor theory's "first fundamental confusion" — the challenge Roger had addressed in the 1960s of how to use twistors to separate negative and positive frequencies and the helicities of massless particles. He also planned to speak about his decades-long effort to solve "the googly problem." Roger borrowed this term from cricket, where "a googly" describes a ball whose unusual spin causes it to unexpectedly deviate from its anticipated path. Roger applied it to the models for differing spins of "gravitons," theorized particles of gravitational energy that might help resolve the incompatibilities between quantum mechanics and general relativity.

"That's the lead-up," he said — the warm-up for his latest ideas. "I want to talk about bi-twistors and split octonians and their relationship to the curvature of spacetime." Bi-twistors are special combinations of twistors with complex algebraic relationships, which Roger hopes will help twistor theory overcome some of its limitations in creating a "model of four dimensional spacetime, and many other things." Split octonians are an extra-esoteric subfield of an esoteric branch of "hypercomplex" algebra, with applications for quantum theory and relativity.

Roger has long positioned his theory of cyclical cosmology as having the potential to revolutionize mainstream physics.

CONFORMAL CYCLIC COSMOLOGY

Roger and Polish researcher Krzysztof Meissner continue a longstanding collaboration on a paper aimed at resolving some of the issues around Conformal Cyclical Cosmology, Roger's theory of an infinitely old, endlessly expanding universe that periodically "resets" itself from one "aeon" to another by rescaling from a huge, dark, and empty death, to a hot, tiny, and dense rebirth. Roger believed bi-twistors might resolve some problems here as well.

"We got stuck on a problem of how you convert a universe that is expanding and increasingly rarified and cold and empty, and then is suddenly this very dense, hot thing, which is equivalent once you've lost the scale. How do you go smoothly from one side to the other?

You want a way of looking at physics that says, 'That's a triviality,'" he said with a snap of his fingers.

"I said to Krzysztof, the way to do this is using bi-twistors. And then I thought, no it's too complicated. I can't really make up my mind."

They were looking at "Hawking Spots," circular regions of low-energy-variance in the cosmic microwave background, which they theorize result from the evaporation of hyper-massive black holes in the dying stages of the universe's previous aeon.

Alan Guth, an American physicist who pioneered the theory of “cosmological inflation” (which Roger and Krzysztof’s theory would do away with, if it were successful), had examined their calculations, and determined they didn’t match up with what was found in the CMB.

“He told us the Hawking Spots we saw were too big by a factor of two,” Roger said.

He and Krzysztof have been talking in person and through emails and phone calls for months, trying to reconcile their predictions and observations with what they now call “the Guth anomaly.” Every time they seem to find a solution, it leads to new mathematical challenges.

They’re now working with a new idea that the earliest stage of our current aeon may have involved a crucial phase that came before the standard cosmological story begins.

“People say the first stage of the universe was a photon-dominated phase. We’re saying there was a gravitational wave stage before everything that gives you another phase of expansion. We think it gets rid of the Guth anomaly, but we haven’t made it work yet,” Roger said.

Penrose has not relented on his criticisms of major trends in theoretical physics since he created this title presentation slide around the time his book was originally published.

FASHION FAITH AND FANTASY

This October, Princeton University Press is reissuing Roger's 2016 book *Fashion, Faith, and Fantasy in the New Physics of the Universe*. The book, based on Roger's 2003 lectures, which were in turn based on a decade of increasing concern about the directions theoretical physics was going, feels as current to him as ever.

"The fashion was string theory. The faith was quantum mechanics at all levels and unitarity in particular. The fantasy was inflationary cosmology," he said. "This has been bugging me for 30 years. It hasn't changed that much."

He wrote an updated introduction for the new addition, reasserting his original objections, and also musing about some new ideas, including a concept of “retroactive causality” as a resolution for how to model the collapse of a quantum system. He suggested that whatever relativistic state the quantum system ends up then retroactively has existed since before the system collapsed. Measuring a quantum system in the present affects its classical properties in the past (an idea so far from intuitive, it seems to cry out for a new verb tense just to describe what will have already happened.)

“It doesn’t go back to the beginning of time. It may be a very short time, but it could be longer,” Roger said.

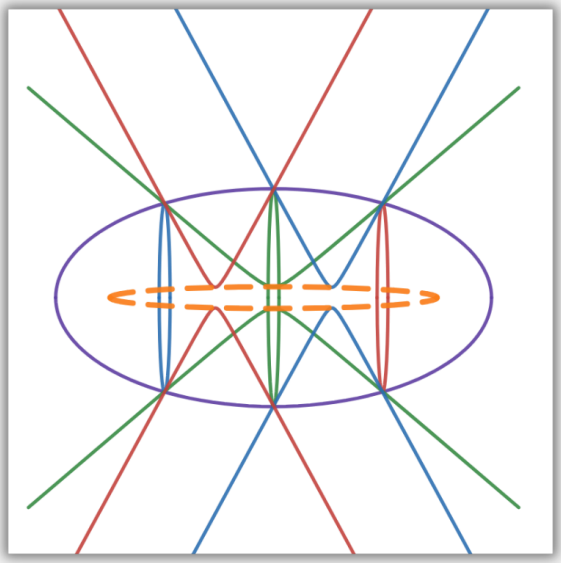
This image is not directly related to Roger’s current book project, but it exemplifies his longstanding fascination with Dutch lithographer M. C. Escher. Roger created a very limited number of these “Escherized” versions of Penrose Tiles. Today, these tiles are part of a private collection, and sadly not available for purchase.

ESCHERMATICS

Roger has been collaborating with a Boston-based physicist on a book titled *Eschermatics*. They hope to use the work of M. C. Escher as an educational tool, to provide lessons about many complicated areas of mathematics.

"We keep finding things in his work that we've never seen before," Roger said. "You can talk about conformal geometry and infinities and Cantor Sets in Escher. What about mathematical notions like group theory? You take this Escher picture and ignore the colours and it exhibits a certain type of symmetry. Then you add the colours back in and you can explain subgroups, factor groups, and other mathematical concepts."

They've been running into trouble meeting deadlines, which has been frustrating. "This has been going slowly and something has to perk up about this," he said.



This computer-generated diagram captures and idealized Roger's sketches and diagrams outlining relationships between double-contacting conic sections. [2]

THE PROJECTIVE GEOMETRY CLUB

One of the reasons many projects have been moving so slowly is because Roger has been helpless to resist another.

“It takes up time, but it’s great fun,” he said.

When he was an undergrad at University College London, he developed a theory he was quite excited about dealing with the relationships between conic sections on the projective geometry plane. Many existing theorems — some centuries old — could be derived from Roger’s idea. He had found the fountainhead out from which many other ideas in projective geometry flowed. He presented his “8 Conic Theorem” as part of his application to graduate studies, but his advisors firmly pointed him in other directions. The theorem languished for more than 60 years, and it bothered him greatly never to have published it.

In the 2020s, a new generation of mathematicians picked up on the theorem and began meeting regularly, dubbing themselves the “Projective Geometry Club.” They meet weekly to rediscover, test, and expand Roger’s original theorem. Roger has joined their calls, and the group is now working on paper that would finally make Penrose’s last theorem a peer-reviewed reality. The conic theorem won’t reconcile quantum mechanics with general relativity, but it brings other kinds of satisfaction.

“I know that I shouldn’t be spending my time on these things, as you with your computer apps can do much more exciting things than I can,” he recently wrote to the other club members, “But these things are so addictive.”

NO SIGN OF STOPPING

Oh yes, retirement! I had forgotten all about retirement!" he said, laughing. "The work is never finished. I have to go on forever."

Of course he knows that, while the universe has infinite time, he does not. He plans to keep working, though, right up until it's no longer possible.

"I remember going for a walk with my stepfather, [mathematician and codebreaker] Max Newman. He had a certain awareness he wasn't remembering things as well. Then things went down and down and down and he lost it altogether. That happens to people. But it doesn't happen to all people. Some people keep on going."

MEET THE AUTHOR

Patchen Barss is a Toronto-based science journalist who has contributed to the BBC, ***Nautilus*** magazine, ***Scientific American***, and the Discovery Channel (Canada), as well as to many science and natural history museums. His previous books include ***The Erotic Engine: How Pornography Has Powered Mass Communication, from Gutenberg to Google***, and ***Flow Spin Grow: Looking for Patterns in Nature.***

PHOTO CREDIT

[1] Unless otherwise indicated, all images captured by Patchen Barss, with permission from Roger Penrose.

[2] Image created by Anna Tsatsos, Boston University