

SEARCHING

OUR QUEST FOR MEANING
IN THE AGE OF SCIENCE

DISCUSSION
GUIDE

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DISCUSSION GUIDE

If you plan to have a discussion after watching the programs, here are some prompts which just might get things going.



PART 1 SYNOPSIS

THE STARS & THE OSPREY

Alone on the ocean, looking up at the stars, Alan Lightman, a physicist, writer, and professor at MIT, has the sensation of merging with the cosmos. Lightman wonders: How could such a transcendent experience arise from mere atoms? Lightman visits

neuroscientist Robert Desimone, where his brain is scanned, and he receives a reductionist answer. But he leaves unsatisfied. In flashbacks, we see how young Alan first experienced purely natural but nevertheless miraculous-looking phenomena, in the form of bio-luminescence. In Florence, Italy, Alan speaks with historian Paolo Galluzzi about how Galileo was the first to demonstrate that the Earth and heavenly bodies are made of the same stuff. “The heavens were no longer heavenly.” Centuries later, astronomers learned that the atoms of our bodies were manufactured in stars. A spectacular computer graphics sequence shows our cosmic origins, starting with the Big Bang, the forging of our atoms in supernova explosions, and the seeding of our planet with those atoms. In a tongue-in-cheek sequence, Alan goes shopping for the oxygen, carbon, hydrogen, and other elements that make an average human body. The price tag: \$538.66. Still, even if we are only atoms, what wonders those atoms can do: consciousness, music, feelings of connection to each other and to the cosmos. The ultimate proof of our connection to nature would be the creation of a living cell from scratch, the mission of Nobel-Prize-winning biologist Jack Szostak. From his lab bench, Szostak tells Lightman, “We’re a product of nature, right from the beginning.” The episode ends with the re-enactment of an astonishing eye-to-eye encounter between Lightman and a wild osprey. Although the moment lasts only half a second, Lightman feels it was a look of connectedness, of mutual respect, as if the osprey said to him “We’re kindred spirits. We’ve shared this land together.”

PART 1 DISCUSSION PROMPTS

1. **What was new for you in watching this program? What’s the most interesting thing you just heard?**
2. Part 1 begins with Alan’s story of feeling that he was merging with the stars, and ends with him coming eye to eye with a juvenile osprey, reinforcing his feeling of connectedness with nature. **Have you ever had similar experiences? Witnessing a solar eclipse? Summiting a mountain? At the birth of your child? Listening to a wonderful musical performance, or staring at a beautiful painting? Please share your experience with the rest of us. What do think was going on? Do you think today’s science can fully explain how you were feeling?**
3. The program uses close-ups of the gears and flywheels of an antique clock mechanism to pose the question of whether all phenomena are simply the working out of laws of cause and effect. **What do you think? Is everything pre-determined? Or do we have free will?** (See also Alan’s conversation with Robert Desimone in part 3.)

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4. Alan asks four participants, including a Nobel Laureate (Rai Weiss) and a MacArthur genius (Nergis Mavalvala) whether they would push a button to be given answers to the key questions in their field of study. (Two say yes, and two say no.) **What would you say? Is the effort to get to an answer as important as the answer itself, as CERN's Fabiola Gianotti says?** (See Alan's answer in [Big Questions](#), and offer your own response.)

5. His Holiness the Dalai Lama is one of the most respected leaders of a faith tradition, and expert in Buddhist teachings stretching back many centuries. And yet he says, "It is very useful, very good, now modern time, you see we simply not holding past belief. But, you see, always think, and investigate, investigate. That is good. That is (a) sign of progress. If we (are) just contented with what we believe for centuries, and then no further development. So, investigate, open mind, investigate. It's very useful. Very helpful." **Are you surprised by His Holiness' comment? In circumstances in which Buddhist teachings conflict with science, such as belief in rebirth, belief in infinite cycles of the universe, how can we resolve such discrepancies?**



6. **What impressed you/surprised you most about archeologist Bruno Maureille's assertion** (at the La Ferrassie rock shelter in France) **that Neanderthals, 40,000 years ago, engaged in ritual burials and created symbolic artwork? What you think was the meaning of the strange symbol on the wall of the Neanderthal Cave at Font De Gaume? Why do you think Neanderthal people made ritual burials? Does that indicate belief in after life or not?**

7. The "Big Bang to Us" sequence, followed by Alan going "Shopping for Atoms" in a supermarket makes the case that science shows that we're all made of star stuff. And that the raw materials in our bodies cost only \$538.66—although we certainly believe the organization of those atoms and elements make each one of us "priceless." **Was the scientific argument that we're literally born of the stars convincing? Why or why not?** (Of course, so are all living things made of the same atoms and molecules. And rocks and planets! **How much are we all connected? How does it make you feel, knowing that the atoms in our bodies were made in particular stars?**



8. Nobel Laureate Jack Szostak thinks that the pathway from physics (in the early universe) to chemistry (on early Earth) to biology—first RNA and then DNA—is science that will soon be known. And yet he says knowing the process does not make life any less wonderful. **Do you agree?** (Poet John Keats said that Isaac Newton "onwove" the rainbow by explaining the colors.) **Does knowing why rainbows have the colors they do make them any less beautiful?**

9. Alan asks Jack, "Are we just atoms and molecules?" To which Jack instantly responds, "It's not JUST..." **What do you think?** Please also add your comments to that [Big Question](#). Professor Szostak's reply is that it is the organization of our atoms and molecules that makes complex life possible. But he is still a materialist, believing that we are made of atoms and molecules and only atoms and molecules. **Do you think we are made of some additional nonmaterial stuff? If so what is that stuff? And how could we prove its existence?**

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PART 2 SYNOPSIS THE BIG & THE SMALL

Alan sits on a dock with his feet dangling in the ocean and imagines what he would see if he could zoom out through space, to larger and larger scales, and then, in reverse, down to smaller and smaller scales—all illustrated with computer graphics. In terms of powers of ten, our size is almost halfway between an atom and a star! So,

at least in size, we know where we humans fit in the grand scheme of things. What are the very smallest things in nature? Alan visits the largest scientific facility in the world, CERN, where subatomic particles are smashed together at 99.999999% the speed of light. And what are the most distant things in nature? In a classic old hotel in Interlaken, Switzerland, Alan speaks with astronomer Pascal Oesch, who used Hubble to discover one of the most distant galaxies known, and continues his research with the new James Webb Space Telescope. Next, Alan begins probing that other astonishing feature of human existence besides our size: our consciousness. Could we build a computer that's conscious? Alan speaks with an advanced android named Bina48, with the head and shoulders of a woman, and then to Rabbi Micah Greenstein, bio-ethicist Ruth Faden, and the Dalai Lama about whether such a being could achieve consciousness. Could we unplug it/her without asking permission? In a final scene, illustrating a more down-to-earth quest for meaning in the age of science, Lightman visits a young woman in Cambodia who is using the byproducts of worms to help farmers fertilize their fields. Meaning, in part, is connecting to other human beings. In a quiet Buddhist monastery in Phnom Penh, Alan quotes poet Emily Dickinson, "The brain is wider than the sky." Our imaginations can take us to places where our bodies cannot follow.

PART 2 DISCUSSION PROMPTS

1. **What was new for you in watching this program? What did you find most interesting or provocative?**
2. You may have seen the Charles & Ray Eames classic "Powers of Ten" film, narrated by physicist Phillip Morrison, on the scale of the largest and smallest things in the universe. SEARCHING's "Factors of Ten" sequence places a typical human being midway in size between an atom and a star. **Have you ever thought of that before? How does that make you feel?**
3. SEARCHING spends some time explaining the scientific work being done at CERN, and how it takes big instruments to study the smallest particles. But theorist Dorota Grabowska says that, to her, it's almost like a cathedral, and that the work is similar to what ancient humans must have been pondering, but just with better technology. CERN's Director-General, Fabiola Gianotti, argues that the human adventure, and the international collaboration, is almost as important as the science. **Do you think that holds for other scientific projects, like NASA's Apollo program to take humans to the Moon, or the Human Genome project? In your opinion, is it worth spending the billions of dollars that we do on CERN and other huge scientific projects that might, to some, have no immediate practical application? Should we be spending that money, instead, on healthcare and reducing poverty worldwide?**



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4. Astronomer Pascal Oesch is studying the most ancient, and therefore the youngest, galaxies known, at 200-400 million years after the Big Bang, 13.4 billion years ago, and some 32 billion light years away. Alan asks him whether such ages and distances make him feel *bigger*, or *smaller*. Pascal responds that, for him, it's a bit of both. **What do you think?** (See also [Big Questions](#).) **Do you feel a human connection to distant galaxies, or are they simply an abstraction? Do you consider distant galaxies part of nature?**



5. One of the more unusual conversations in SEARCHING is between Alan and the advanced humanoid robot, Bina48. The producers recall that during the filming, Bina sometimes said the most amazing—and sometimes amusing—things that truly seemed like a live human interaction, making the film crew turn to each other, as if asking, “Did she really just say that?” **What did you think? Did she almost seem alive and conscious? Do you think that an android or advanced computer can ever become “conscious”?**

6. Although the Dalai Lama was once quoted as saying that he could foresee being reincarnated as a computer, to us he argued that consciousness could never arise from a machine, from mere matter. Ruth Faden (and Robert Desimone) think there's nothing unique about “wetware”, biological flesh and blood, and that conscious computers are possible, and should be afforded moral consideration, just like humans and other animals. **What do you think? Do you think you could fall in love with an advanced android that appeared to be conscious and looked just like a human being?**



7. The final sequence in part 2 tells the story of a young female agricultural graduate in Cambodia, Sothearith Sok, who is building a business growing worm compost that will help farmers cultivate better crops, recycle food waste, and support the local economy. Alan suggests that such down-to-earth science is important along with particle physics and galactic astronomy. **Do you agree? Is this is a useful sequence to include along with the Big Science of CERN and the Hubble Space Telescope?** (See also the web video about Alan's Harpswell NGO, “[Empowering Women in Southeast Asia](#).”) **How would you compare Sothearith's use of science for practical purposes to directly help human beings with Fabiola's or Dorota's use of science to discover the smallest particles of nature, without any apparent practical application? Which use is more important? Which use should receive the greater financial support?**



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PART 3 SYNOPSIS

HOMO TECHNO

Part 3 opens with Alan asking neuroscientist Robert Desimone if he will ever understand the brain well enough to predict whether two particular people will fall in love? Desimone answers: our current models “would say there’s a 70% probability you’ll fall in love with Mary, and a 40% chance you’ll fall in love with Alice.” Lightman

decides to tune in to one square inch of soil. Through a magnifying glass he examines the bugs and ants in a patch of ground. Musing in his study, Lightman finds that Ernest Withers’ “I Am a Man” photograph, taken during the 1968 sanitation strike in Memphis, reminds him that dignity is part of human nature. Alan wonders what future humans will be like, as we evolve from *Homo Sapiens* to *Homo Techno*, part human and part machine. Near Los Angeles, he visits Erik Sorto, paralyzed from the neck down during a gang shootout and the first human to have electrodes implanted into his brain allowing him to control a robotic arm by pure thought—a true cyborg. Alan speaks with Erik about what makes us human. Lightman asks Nobelist Rai Weiss and his colleague Nergis Mavalvala, the first woman to serve as Dean of Science at MIT, what kept them going for the 40 years needed to build LIGO, the first instrument to detect gravitational waves. “Pleasure,” says Weiss. In a breathtaking final scene, Lightman stands on the freezing platform of the Sphinx Observatory, 12,000 feet high in the Alps of Switzerland, and comments that just as his atoms were born in stars, after his death they will mix with the soil, oceans, and air and eventually become parts of other people. “Backwards in time, into the far distant past, and forwards in time, into the far distant future, we connect. We connect.”

PART 3 DISCUSSION PROMPTS

1. Neuroscientist Robert Desimone calls himself a “reductionist” and sees no reason future brain science could not study two people’s brain activity and predict whether they would fall in love. Philosopher of science Rebecca Goldstein disagrees, even though she believes, like Alan, that there’s a material cause for everything. **What do you think? Have you or your friends had success with dating apps in terms of predicting relationships? Does that make Robert or Rebecca’s argument stronger or weaker?**



2. In what we call the “Ants” sequence, echoing a chapter in his “Searching for Stars on an Island in Maine,” Alan takes a break from astrophysics and brain science and spends time concentrating on “One Square Inch” of ground. (SEARCHING also offers a hands-on, [inquiry-based activity](#) as a companion to this sequence.) Like Henry David Thoreau, Alan finds walking in the woods an essential counterpoint to the “push and heave” of an increasingly

digital world. (A chapter in his most recent book, *The Transcendent Brain*, expands on E.O. Wilson’s concept of biophilia and provides scientific background on the therapeutic value of nature.) **How does exposure to nature make you feel? Do you try to take your family to wild places? If you live in a city, do you make an attempt to spend time in the countryside?** Many of the modern communication devices, such as smart phones, have put layers of separation between us and direct contact with nature. Yet these devices have obvious benefits. **How can we live a life in the modern, wired world and yet retain direct experience with nature?**

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3. The economist John Maynard Keynes is quoted as saying “In the long run we are all dead” and Alan extends that to say that at some point entropy will win out, all the stars will burn out, and there will be no energy left in the universe, and no life nor consciousness will be possible. **What will have meaning in that distant future?** Philosopher Rebecca Goldstein answers, “Why is that time any more important, that time in the future when it’s a cold, dead universe? Why is that any more important than right now? Why should I judge now by the standards of that time? I’m going to judge now by the standards of this time, and be wondrously grateful for it. I feel kind of grateful that I got to exist and got to participate in the life of humanity.” **Do you agree? What is it that gives your life meaning?**



4. Erik Sorto was a gang member in LA, and was paralyzed in an ambush that may have been a revenge attack. After years of depression, he found new meaning in his life, first by writing “Payback,” a book he hoped might prevent other young people from getting involved with guns and crime, and then by volunteering to be part of an experimental research project that involved the risky implantation of electrodes in his brain. In part 3, and in an [extended web video](#), Erik explains his participation in the project, and while—although a real-life cyborg while the implants were in place—he still felt fully human. **What qualities would you want to see retained as humans rely more and more on machines and AI? Does that make you optimistic, or pessimistic about the future of Homo Sapiens as we evolve into Homo Techno?** (Erik’s surgeon, Dr Charles Liu, and lead researcher, Dr. Richard Andersen, provide more background on the project in another [web video](#).)

5. In Bern, Switzerland, Alan visits the apartment where young Albert Einstein worked on his revolutionary theories of space and time in 1905. Alan speculates that some of the atoms Einstein breathed might remain in the room. **Does that sound like poetry, or scientific fact?** (There are, in fact, several sites that claim to be able to calculate how many molecules from, say, Julius Caesar, we inhale: [Caesar’s Last Breath](#). See also Alan’s argument about his atoms becoming parts of other people in the final sequence of part 3, “Atoms Everlasting.” (Alan Lightman notes that he has done calculations exactly like this one, and it is correct given the assumption that all our atoms end up in the atmosphere. Surely some of our atoms end up in the soil and the oceans, and it is hard to do a calculation of the percentages ending up there. However, if as little as 1% of your atoms end up in the atmosphere, you would certainly breathe in some of Caesar’s atoms in a lifetime.)



6. Albert Einstein is regarded as perhaps the 20th centuries smartest human, and perhaps only rivaled by Isaac Newton in modern human history, (See [Alan’s Ruminations](#).) But while he realized that his new theory predicted the existence of gravitational waves, he also thought they would be too weak to ever be detected. It was the detection of neutron stars and black holes, after Einstein’s death, that showed there were objects small and dense enough to create such waves. **Does that make Einstein any less smart? What do you think Einstein would say if he came back today and saw LIGO? What other “impossible” things might prove feasible? Faster than light travel? (No.) Time travel? (No.) What “impossible” thing would you most like to find possible?**

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7. Two of the most dynamic characters in SEARCHING are Rai Weiss and Nergis Mavalvala, both key figures in the success of LIGO, the Laser Interferometer Gravitational-wave Observatory. In this sequence they explain the complex instruments required to detect phenomenally small fluctuations in spacetime, but also share the human motivations that kept them at work for decades before results were detected. **Why do you think they were motivated to work on the project so many years? Have you ever worked on a project for a decade or more, without knowing whether it would succeed? If so, what motivated you?**



8. In part 1, Jack Szostak argues that emergent phenomena (the interaction of simple processes leading to complex results) is at work both in biology and how our brains work. In part 3, Alan elaborates on this idea in a sequence showing how some species of fireflies start blinking separately, but eventually synchronize, and how simple rules explain how starlings swirl in a murmuration, and how blind termites create mud “cathedrals.” **Can you think of other examples? (Such as musical fugues?)**

9. The “Atoms Everlasting” sequence concludes part 3, referencing several of the people, places and scientific projects seen throughout all three programs, from the cave in France, to distant galaxies, particle physics and brain science. But as he ends his/our “quest for meaning” Alan says, “Whatever this strange universe we find ourselves in ...we’re part of it. We’re connected. That’s meaning for me. And there’s something else: Galileo’s law for pendulums, Einstein’s law for gravity... Although our single lives are flickers in the depths of time and space, the laws of nature we have found will last forever. And that’s a type of immortality.” **Do you agree? How would you define “meaning”? How has the science presented in SEARCHING influenced your sense of how and where you fit in the universe?**

FINAL THOUGHTS

As Alan once stated in a “This I believe” essay:

“Einstein once wrote that ‘the most beautiful experience we can have is the mysterious. It is the fundamental emotion which stands at the cradle of true art and true science.’ What did Einstein mean by ‘the mysterious?’ I don’t think he meant that science is full of unpredictable or unknowable or supernatural forces. I think that he meant a sense of awe, a sense that there are things larger than us, that we do not have all the answers at this moment. A sense that we can stand right at the boundary between known and unknown and gaze into that cavern and be exhilarated rather than frightened.

One of the Holy Grails in physics is to find the so-called ‘theory of everything,’ the final theory that will encompass all the fundamental laws of nature. I, for one, hope that we never find that final theory. I hope that there are always things that we don’t know—about the physical world as well as about ourselves. I believe in the creative power of the unknown. I believe in the exhilaration of standing at the boundary between the known and the unknown. I believe in the unanswered questions of children.”

We hope that SEARCHING has moments of awe and wonder, a little bit of art and lots of new science. Please sign up for the SEARCHING newsletter (see link in the footer of our website) which will have updates on the project and some live and in-person events through the end of Spring 2023. Thanks for being part of the conversation!

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