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NOW Podcast

EPISODE 12 TRANSCRIPT

"We're In It Together": Why partnership is the key to understanding the universe and protecting our shared future

Host: Ken Stuzin, CFA

Guest: Jason Kalirai, Ph.D.

00:00:01 **Ken Stuzin:** Hello. This is Ken Stuzin. I'm a partner at Brown Advisory. Welcome to our NOW 2020 podcast. NOW stands for Navigating Our World. We are simply trying to understand the world better, to navigate some of the most pressing questions that are shaping our lives, our culture and our investment challenges. We are committed to sharing the views of CEOs and other leaders so that we can all learn from their perspectives on how to navigate the future. We would like to hear from you as well. We invite you to leave a review or take a moment to complete the short questionnaire on the NOW website so that we can learn from your thoughts, questions and feedback. As we look to the future, whether we agree or disagree with each other, the one thing we know for sure is that none of us can figure this out on our own. At Brown Advisory, we are focused on raising the future, and we hope these NOW conversations will help us do just that.

Back in April, we launched this podcast with a conversation with Jon Meacham, the Pulitzer Prize-winning historian. Speaking with Mike Hankin, our CEO, Jon described our current moment as a crucible, one that required citizens to sublimate their personal desires for the common good. He was referring to the pandemic and its economic fallout. This was a month before the additional turbulence from the killing of George Floyd and our national reckoning with racial violence and social injustice.

Mike and Jon talked about whether and how we could come together to address our challenges in the midst of what often feels like paralyzing polarization. And yet, in the realm of science and, specifically, in the arena of space science and space exploration, the focus is entirely on working together for the common good as space sciences tackle big questions. What does it mean to be human? What is our place in the universe? Are we alone? They collaborate across institutions and across countries, sometimes with countries which, from a geopolitical standpoint, may be perceived as adversaries.

I'm Ken Stuzin. You've heard my voice in the introduction to our podcast. But this week, I have the great pleasure of talking with Jason Kalirai, an astrophysicist and the mission area executive for civil space at the Johns Hopkins Applied Physics Lab. Talking with Jason about the immense scale of the universe and the challenge of exploring its mysteries was frankly inspiring. It was a powerful reminder about how shared inspiration and common purpose can bring us closer together.

00:03:05 **JFK Audio Clip:** We choose to go to the moon in this decade and do the other things not because they are easy, but because they are hard, because that goal will serve to organize and measure the best of our energies and skills, because that challenge is...

00:03:27 **Ken Stuzin:** Jason, it's really terrific to have you with us today. I suspect that I'm going to speak for a lot of our audience when I suggest that my education and vocational background are quite different than yours. So this should be a really great learning experience for many of us.

00:03:44 **Jason Kalirai, Ph.D.:** Yeah. So space exploration is a very exciting topic today within our nation's space program and also the global space program that we have. So I work at the Johns Hopkins University Applied Physics Laboratory, and I'm in charge of the Civil Space Program there, where we do a lot of work with

NASA to explore the universe and explore our understanding of the universe and better understand what our place in that universe is. So it's a very exciting time to be a space scientist. And we have a lot of projects underway, a lot of great engineering, great technologies, great scientific research, a lot of great international partnerships as well to expand our knowledge about the universe.

00:04:22 **Ken Stuzin:** Let me ask you to do this. Could we jump into one of the projects that perhaps we should all be aware of? In a sense, be more specific about the kinds of things you guys are working on or thinking about now.

00:04:37 **Jason Kalirai, Ph.D.:** So let's see. So one of the big discoveries in all of space science in the last couple of decades has been the discovery of ocean worlds, right? So when you look at our planet, when you look at Earth, one of its most distinctive characteristics is its ocean. And for a long time, we thought that ocean was unique to Earth, and other worlds didn't have an ocean. But we've now discovered that many of the moons in the outer solar system do have oceans. It's just that they're subsurface oceans. They're not surface oceans. And we've also seen evidence of those oceans venting into space. So there are probably layers of ice and fissures in that ice, and you could see that water spewing into space through different spacecraft and telescopes that we've built.

So there's a big goal right now on understanding these ocean worlds and trying to determine whether or not they could be habitable, whether or not there could be life in these oceans. If you look at our own ocean on Earth, even if you go down to the bottom of the ocean floor where there's intense pressure, there's heat sources from hydrothermal vents that are pumping heat into the ocean, there's no light -- we see life thriving. And so could there be life elsewhere in our solar system within these subsurface oceans?

So there's a project that we're building called Europa Clipper. It's a project that's being built jointly by the Jet Propulsion Lab and the Applied Physics Lab, a big NASA mission to explore habitability on one of Jupiter's moons, Europa. And there's another mission that we're building called Dragonfly, which is going to fly to one of Saturn's moons called Titan, which is a unique moon. It has a thick atmosphere. It has a low surface gravity. So we're actually going to fly in the air on Titan and land and study the prebiotic chemistry of Titan and explore its habitability. And then we're building this nuclear-powered octocopter that's about the size of your car that's going to land. It's full of science experiments. It has seismometers. It has cameras. It has a drill. It can sample into the Titan dirt and study it.

And then when we're done with a given landing site, we can fly. So it's like a drone, a big drone, a complex drone. We can fly it to another destination and repeat some of its science experiments. So those are two of the projects underway right now related to better understanding habitability in our solar system.

00:07:06 **Ken Stuzin:** Talk a little bit about the prioritization process. How do you determine which areas of exploration warrant the capital and effort to pursue?

00:07:16 **Jason Kalirai, Ph.D.:** So the way that space science is done not only in the U.S. but also in other countries -- for example, in the European Space Agency and the European Nations -- is that there are these processes called decadal surveys, where the National Academy of Sciences and Engineering gets the scientific community together once every 10 years, and the community outlines what they see as the biggest challenges in space exploration for the next 10 years. And so they write a major report, and then that report ends up becoming an input to, for example in the U.S., to NASA's space science program. It also guides some of the things that we do in the National Science Foundation and other science agencies.

And so within that decadal survey is kind of a census and an evaluation of the sense of the field. So for example, in NASA's space science program, we do one of these decadal surveys that's focused on Earth science, the study of our planet; one that's focused on planetary science, which is the study of planets and asteroids and comets and moons in our solar system other than Earth. One is the study of heliophysics, which is the study of our sun and how our sun impacts our planet and other worlds in our solar system. And one is astrophysics, which is the study of everything beyond our solar system. So it's really those community-driven studies that outline what the priorities are. And then once you have those priorities, then NASA implements missions to achieve those priorities. But scattered within that is a cadence of competitive opportunities where NASA will open it up and allow anybody in the science community to propose a bold challenge, a bold science experiment.

And so with planetary science, it's often building a spacecraft and flying that spacecraft to a destination to take measurements. Within astrophysics, it's often building a telescope, launching that telescope to orbit Earth and observing the universe from that vantage point.

00:09:11 **Ken Stuzin:** Let me ask you just a follow-up question on that. Given the vastness of the cosmos and given just basic probability, do you believe there are other forms of life? And I'm not suggesting little green men, but whether it be lichen or something that looks like a tadpole.

00:09:29 **Jason Kalirai, Ph.D.:** So before I answer your question, you know, Ken, I would say that the history of space science is essentially one that teaches us that nothing is special, right, that we're not special, right? And it's relatively recent, right? So if you just look in the last few hundred years, you know, we thought for a long time that we were very special, that we were the center of the universe and everything was moving around us, everything was orbiting around us. And it took science, right? It took a scientist looking through a telescope -- that was Galileo -- to change that model, because he observed other things in the universe -- the moons of Jupiter that were going around Jupiter -- and therefore everything wasn't moving around Earth.

And if you look -- if you fast-forward a little bit, look about 100 years ago, we thought that everything that we see in the night sky was a part of our galaxy. And, again, it took a scientist, Edwin Hubble, using a giant telescope that was built by engineers to change that model and overthrow that model.

00:10:24 **News audio clip:** The scope is Edwin Hubble, an American astronomer who in the 1920s proved the universe always expanding. Dr. Hubble died in 1953, but 50…

00:10:24 **Jason Kalirai, Ph.D.:** And basically teach us that a subset of what we see in the night sky is not even a part of our galaxy. Those are entire galaxies themselves that have millions and billions of stars. So, you know, today, you know, we're at a point where we've made a remarkable discovery in the last 20 years. NASA built a telescope called Kepler, and that telescope was designed to determine whether or not planets -- whether or not planets like the Earth exist around other stars in the galaxy, right? We knew about the planets within our solar system, but we didn't know if there were planets around other stars. And the results from Kepler are breathtaking. They teach us that not only are there planets around other stars, but all stars are likely to have planets and that most planets that form in the universe are small, rocky objects. The things that look like Jupiter and Saturn are rare. It's really the things that look like Earth and Mars that are more common.

And so now for the first time, we have -- you know, the universe has been kind to us. The universe has given us all of these worlds, and so we have the opportunity to go out there and study these planets and determine whether or not these planets could have life in them. And so we're building the technologies, building the experiments, for example, to, you know, dissect the atmospheres of these planets, determine their fingerprints and look for evidence of gases in their atmospheres that would not exist if there wasn't life on those worlds.

So to answer your question, yes, absolutely. I think the history of space science teaches us that nothing is special. There are hundreds of billions of stars in our galaxy, and there are hundreds of billions of galaxies in the universe. So the number of stars in the universe is a one with 23 zeros after it, and every one of those stars has planets. So there are definitely Earth-like worlds out there, and there are definitely sunlike stars out there, and you will find combinations of Earth-like worlds around sunlike stars that likely had very similar conditions to our own solar system. And so I firmly believe that there's life out there.

00:12:42 **Ken Stuzin:** I want to go in a slightly different direction now, if you'll bear with me. You mentioned Galileo. I took it upon myself to do more reading about Galileo than I had since I was a schoolboy. I'm going to read a quote that is, I think, fairly well known, and then I'd like to get your response. He wrote that in questions of science, the authority of 1,000 is not worth the humble reasoning of a single man. My first comment is that's not a quote from a humble man, and he was, I suspect, not a very humble man, but this notion that a single individual could help change the arc of science and therefore history. It's pretty awe-inspiring, I suspect.

00:13:25 **Jason Kalirai, Ph.D.:** Yeah. So that's the scientific method, right? Most scientists in the world are pursuing their own research programs, and they quickly become experts in their own domain. So they build up their research groups. They have students and postdocs that they mentor. And then when they challenge a new paradigm or they challenge a new problem in space exploration, they're often, you know, developing the technologies or using an asset to take measurements that are at a level of detail and a level of clarity that just hasn't exist before. So within that study, you are bound to learn something brand new that will overthrow existing models or existing theories of how people thought things work.

So there are hundreds of research papers being published, you know, every week in space science themes, and it's really exciting, right? It's really exciting, because we have a lot of different tools at our disposal to make those advances. But sometimes what happens is, you know, those papers -- and this is certainly the case with Galileo, and it's been the case with other scientists -- sometimes it takes a while for us to adjust and for us to accept that scientific discovery because it's so earth shattering. It's so different from what people believe that it requires some type of validation. It requires some additional empirical evidence, you know, so it can take time.

So, you know, a good example of this is there was a scientist, Eugene Parker, who postulated the existence of a solar wind, you know, 60 years ago. And, you know, it took a while for the science community to accept that. And, you know, for 50 years now, 50-plus years, the space science community has prioritized the knowledge that would be gained by building a spacecraft that could actually fly through the sun's atmosphere and study the sun up close by achieving that. And it took us 50-plus years to come up with an implementation that could actually succeed to do that science. And engineers worked. They built the technologies. We built the engineering. We came up with a very creative and novel enabling orbit for the spacecraft that would get it closer and closer to the sun. And then two years ago, we launched it. It was called Parker Solar Probe. We actually named it after Eugene Parker, the scientist that postulated the existence of the solar wind, and we're now answering questions that have been lingering for more than 50 years. So it takes time, but absolutely a single scientist writing a single science paper, making a discovery, can change an entire field.

00:16:00 **Ken Stuzin:** One of the things that I find most interesting is that the big problems that you all are facing can't be done by individuals at the end of the day. And I think one of the fascinating things we talked about was the notion of global cooperation among countries. And, you know, this Brown Advisory podcast has really been focused on issues of polarization in society globally. And yet, space seems to be an area where people work more closely together, where there is a long history of international cooperation. And so we're going to jump maybe from Galileo to the modern era, and I'm fascinated to get your thoughts on a little bit of history of space cooperation, you know, the space race, sort of inherent rivalry between the U.S. and the old Soviet Union. So I'd love to get your thoughts on that and maybe bring us up closer to the future.

00:16:56 **Jason Kalirai, Ph.D.:** Yeah. So, Ken, I agree with you. We live in a polarized world, and I think space exploration is a wonderful theme and a pursuit that binds us. And, you know, the challenges and the problems that we're trying to address in space exploration are some of the biggest that we face and on the grandest scales. And so we really need the brightest from around the world to pull together and work together to solve those challenges.

But I'm also not surprised that space exploration has that. If you just take a look at the view of our planet, of Earth from space, and contrast it with our day-to-day interactions with our environment, it's very different, right? So as we're going about our day-to-day lives, I kind of feel like we've binned up everything on planet Earth. You know, you look at the news cycle right now, and we're talking about COVID-19 and certain states spiking up and, in certain countries, the trends coming down. You look at battles and wars and political discussions, and they're all driven by our kind of human-made binning of the planet.

When you look at Earth from space, you see something very different, right? You see a fragile place. You know, it's one world. There are no borders. There are no states. There are no countries. It's land, ocean, air and life. And so just that alone, like the perspective of what almost everything and almost everyone on the planet thinks about and interacts with every day, is seen very different from a space-based perspective than an Earth-based perspective. And so I think that alone helps bind us. We're in it together. We need to work together to understand our world and to improve it.

00:18:40 **Audio clip:** In July of 1975, after two years of training, the United States and the Soviet Union launched spacecrafts into orbit.

00:18:48 **Audio clip:** Both control centers, Moscow and Houston, have given a go for docking.

00:18:53 **Audio clip:** Here's Walter Cronkite on the CBS Evening later that day.

00:18:57 **Audio clip:** The United States and the Soviet Union, after decades of Cold War conflict, found a unity in space they've not been able to achieve on Earth. And it was signified by a handshake.

00:19:08 **Jason Kalirai, Ph.D.:** But if you look at the rest space, right, if you go beyond our planet Earth, it's even stronger, because there's no ownership, right? On Earth, there is ownership. The bins are real. They have consequences. Countries have laws and rules and political systems and different currency, etc., but in space, none of that exists. Nobody owns the moons of Mars, right? It's a collective ownership, and it's knowledge of what's happening in space and how it impact Earth -- that's the global pursuit.

00:19:41 **Ken Stuzin:** We always talk about the importance of STEM, more STEM, better-trained young people coming out, great jobs that could be enjoyed by young people with those kinds of backgrounds. And it seems to be a sort of a national outcry, that if we had more of our young people trained in STEM,that this would lead to better jobs, better outcomes. There's a whole, I think, virtuous circle in terms of what those jobs would mean. What are your thoughts or ideas on that?

00:20:12 **Jason Kalirai, Ph.D.:** So, Ken, I agree, and I worry a lot about the pipeline of young people coming into STEM, coming into scientific fields and building that technical workforce. Because, again, you know, the kinds of questions that we're answering are intrinsically very hard and, you know, we need the best and brightest of the next generation to come into science. So when I think of this -- you know, STEM is, of course, science, technology, engineering and math. I have four kids, right? When I teach my kids about STEM, it's not so much as focusing on those specific domains as separate areas, but really thinking about projects that can make a difference in the world and help the world and humanity that naturally bring together those ingredients. I see them as ingredients of projects that we need and of solutions that we need to challenge it.

So, you know, we were talking earlier about a telescope, and a telescope is a great example of STEM, right? It's driven and motivated by bold science goals. It requires the development of new technologies. These things are engineering marvels. They bring together new solutions to very complex challenges, and operating it successfully and having it actually achieve that science requires precise mathematics.

So when I think of, you know, getting kids excited about that, I think there's several elements to that. So one is -- one of the things that we often focus on is how do we get kids excited about STEM, or how do we get kids excited about science, and I think that's actually the wrong question. I think a lot of young people are naturally excited about science. They have the natural curiosity. You know, just look at a 3-year-old or a 4-year-old or a 5-year-old. They're filled with curiosity and trying to determine how things work. You're born with it. And so I think parents need to really foster and encourage that and challenge children to understand why things are the way they are and to figure out how they work, right? I mean, you know, you flick a light switch on, right? There's a physical process that's happening between your hand hitting that light switch and the light turning on. You should understand it. And you'll come across things in your day-to-day life that you can dig into better and satisfy that thirst, that curiosity.

So I think as kids get older, the curiosity that they naturally had when they were younger about science and engineering needs to be fostered, and there's many factors for why you might lose it. And so I really think that our schools need to do a much better job of linking community scientists and engineers into their classrooms, into their curricula. You know, I visited hundreds of classrooms to talk to kids about science and space science. And even at the middle school level, there are oftentimes when I am the first scientist that those kids have ever met, right? So how can we possibly expect them to become scientists or engineers if they've never met one and they're already in middle school?

And then another part, I think, is the stereotypes, right? So in their world, a scientist might be so far removed from what they do in their day-to-day interactions and they don't have any access to them that I think you've lost the opportunity. And that's sad, because there are incredibly talented individuals that might never get the chance because just the links aren't there between the elementary and middle schools and the universities in those communities, or maybe they're there, but they're just not strong enough.

00:23:35 **Ken Stuzin:** Do you think, Jason, that in this day and age, when, I think, all of us see more the public persona of the scientist as sort of characterized by someone like an Elon Musk. Is Elon Musk, as a character, the kind of brilliant, flamboyant, essentially scientist/capitalist? Is that the kind of -- is that the equivalent of a professional athlete who excites kids to try to do something? Is he good for science, or is he a bit of a showman?

00:24:06 **Jason Kalirai, Ph.D.:** I think you need both, right? I think he is not the typical scientist or the typical engineer, right, but I think you need both. You know, his vision is very important, right, I mean, his vision and his ability to challenge norms and, you know, building something where there's a renewed interest in technology, in science, in engineering. And his ability to grow a technical workforce with the new opportunities that it creates is very important, and there's a lot of innovation in that.

So I think the growth in the private industry being involved in space exploration has really just been amazing. It's been awesome, and it's creating a lot of new opportunities for a lot of people and also for our global efforts to travel into space and expand our understanding of space. I think we're going to see a lot more of those partnerships going forward. And by the way, it's a true government-private partnership. You know, a lot of the things that you see, SpaceX and other private companies, doing, you know, was stimulated and started by those companies but is also being supported by NASA, and so that partnership is very, very important.

00:25:14 **Ken Stuzin:** When you think about these companies, you mentioned SpaceX or I think Blue Origin, even Virgin -- Virgin Galactic -- you said it's good. It's good for science. Do you worry about -- from a regulatory perspective -- that people are meddling in things that perhaps they shouldn't be, that it's getting in the way of traditional scientists such as yourself, or is it, from your perspective, more of an issue of the more the merrier?

00:25:40 **Jason Kalirai, Ph.D.:** I think there is a downside, and I think we do need a little bit more regulation. We need some rules and some controls. You know, an analogy is, you know, the air flight industry. You have the FAA that, you know, provides a lot of the oversight and some controls. So, for example, a big debate right now in the astronomical community, in the space science astronomical community right now is that, you know, as we build a lot more satellites and we launch a lot more satellites -- so, for example, SpaceX has a program to bring global Internet to the world, which is awesome, right? I mean, this is amazing. But the way that they're going to do that is by building thousands of spacecraft, and these are going to be low-Earth orbiting spacecraft that are going to be working in concert with one another to ensure that every place on earth has Internet access. But what that does is it also pollutes the night sky, you know. So when you look up from the ground at the night sky, you'll see these satellites with the naked eye. And when you look through a telescope or you're taking an image, you know, doing ground-based astronomy, you'll have streaks basically that are cutting across your image.

You know, so there are issues like that, but, you know, the parties are all being responsible. They're working together. So when we have, you know, worldwide astronomy conferences now, companies like SpaceX are at those meetings. They sit on panels and they talk about the ways that they can mitigate the amount of light that those spacecraft are producing and the way -- even changes to the engineering design or changes to the orbits of the spacecraft that can help, you know, maintain our pristine view of the night sky and not impact other scientific goals.

00:27:16 **Ken Stuzin:** Jason, I'm going to tell a little story about myself when we first chatted. We were talking in the context of collaboration, global collaboration for the betterment of everyone, and you started to talk about what I would describe as an anti-asteroid planetary defense initiative. And when you first started chatting about it, I thought you were sort of making fun of the liberal arts grads in the room, but that's not the case. Could you talk a little bit about that? I find that absolutely fascinating and literally right out of the movies.

00:27:50 **Jason Kalirai, Ph.D.:** Yeah. So planetary defense is looking at the threat of asteroids that could have a catastrophic effect on life, and so this happens, right? The earth is being peppered by asteroids all the time. Once every two weeks, we get hit by an asteroid that's about a meter across. You know, once a year, we get hit by something that's about the size of a table, a little bit bigger than that. And once a decade, or once every few decades, something larger comes in. A recent example was in a town in Russia called Chelyabinsk, which is a town that contains more than 1 million people, there was an asteroid about seven years ago that exploded right over the city of 1 million people, and it released 20 to 30 times as much energy as the atomic bomb from World War II. There were -- a lot of people were injured. There was a lot of damage in the city.

So the worldwide space science community has come together and created a program called Planetary Defense. So this is an international effort. There are meetings being organized every year to prepare and respond to a potential impact of an asteroid. This include response drills, how international coordination between governments would happen, etc., and there are missions being developed now to mitigate those impacts. A good example is a mission called DART, the Double Asteroid Redirection Test. This is the first flight mission in planetary defense. It's being built by NASA.

00:29:14 **Audio clip:** Welcome back, everyone. NASA wants to crash into an asteroid on purpose. What they're hoping is that it could potentially save the planet. So do it, they need this spacecraft. It's called a DART, which stands for Double Asteroid Redirection Test.

00:29:28 **Jason Kalirai, Ph.D.:** We're going to take a spacecraft, and we're going to collide that spacecraft into an asteroid, not asteroid that threatens Earth. It's just a small asteroid. And we're going to move the orbit of that asteroid. So we're going to prove that we can use a spacecraft to deflect an asteroid. On that asteroid, there's an international collaboration from the Italian Space Agency called LICIACube, where they have CubeSats that are going to deploy from DART before it collides into that asteroid and observe that impact. And now the European Space Agency has agreed to build a follow-on mission called Hera that's going to go and observe the system and the resulting impact crater and measure the asteroid's mass following DART.

So, again, this is a great example of an international program that aims to find everything that's out there, catalogue all near-Earth objects that can pose a threat, understand their characteristics, figure out what their properties are, what their trajectories are, so if they were to hit Earth, we could predict what the damage was going to be and then third, mitigate it, right? Do something about it. Build the technologies that allow us to mitigate it. So in the future, if 20 years from now we have an asteroid that's headed straight for Earth, we could build a whole bunch of DARTs, for example, line them all up, fire them at that asteroid, slow it down so that the Earth essentially gets out of the way because it's orbiting around the sun, and the asteroid flies by and doesn't impact our planet.

00:30:54 **Ken Stuzin:** Jason, we're long-term fundamental investors, and we, frankly, view investing very much as a team sport. I'm not suggesting that our endeavors are equivalent, but it strikes me that there are parallels between the way we think as a team of investors and your approach as a space scientist. Could you touch on how you think about the long-term collaborative nature of space exploration?

00:31:20 **Jason Kalirai, Ph.D.:** You know, we've talked about the importance of space exploration and the fact that it requires a lot of very creative, brilliant minds to come together. You know, the other thing is, you know, it's -- I think it's universally accepted as being very important that it enjoys a tremendous amount of support. So, for example, if you look in the U.S. -- again, we started by talking about the polarized world that we live in and, you know, the differences that we see between Democrats and Republicans and, you know, people according to their political parties. But space exploration is something that has enjoyed a tremendous amount of, you know, congressional bipartisan support. You know, NASA's budget has been on the rise for many years. There's kind of a universal understanding and appreciation of the importance of this, and we have multibillion-dollar investments in budgets across different countries to explore by space, and much of that is driven by science. And the wonderful thing about science is science doesn't change when administrations change or members of Congress change. You know, we talked about these decadal surveys. So these decadal surveys lock down the biggest scientific challenges that we face, and that doesn't change because of administration changes. So those reports end up dictating what we're going to do. There's a little bit more of a longevity to that, and that's really good.

00:32:40 **Ken Stuzin:** It seems to me that space exploration is a wonderful model for all of us to think about with respect to putting the petty things behind us and working together to solve the big issues, the big challenges. So I want to thank you. That was absolutely a fascinating discussion. I think your insights will be helpful for all of us, even the many nonscientists who will be listening to this podcast. So thanks again. It was terrific and great fun.

00:33:07 **Jason Kalirai, Ph.D.:** Thank you, Ken. I appreciate you guys having me.

00:33:11 **Ken Stuzin:** Thank you so much for joining us as we continue this effort to seek out insights that help us understand our rapidly evolving world. Be sure to turn in for our next NOW conversation. It will be a very important one, I think. My colleague, Keith Stone, will host a roundtable discussion on how venture capital can address racial inequality. Until then, be well and stay safe.