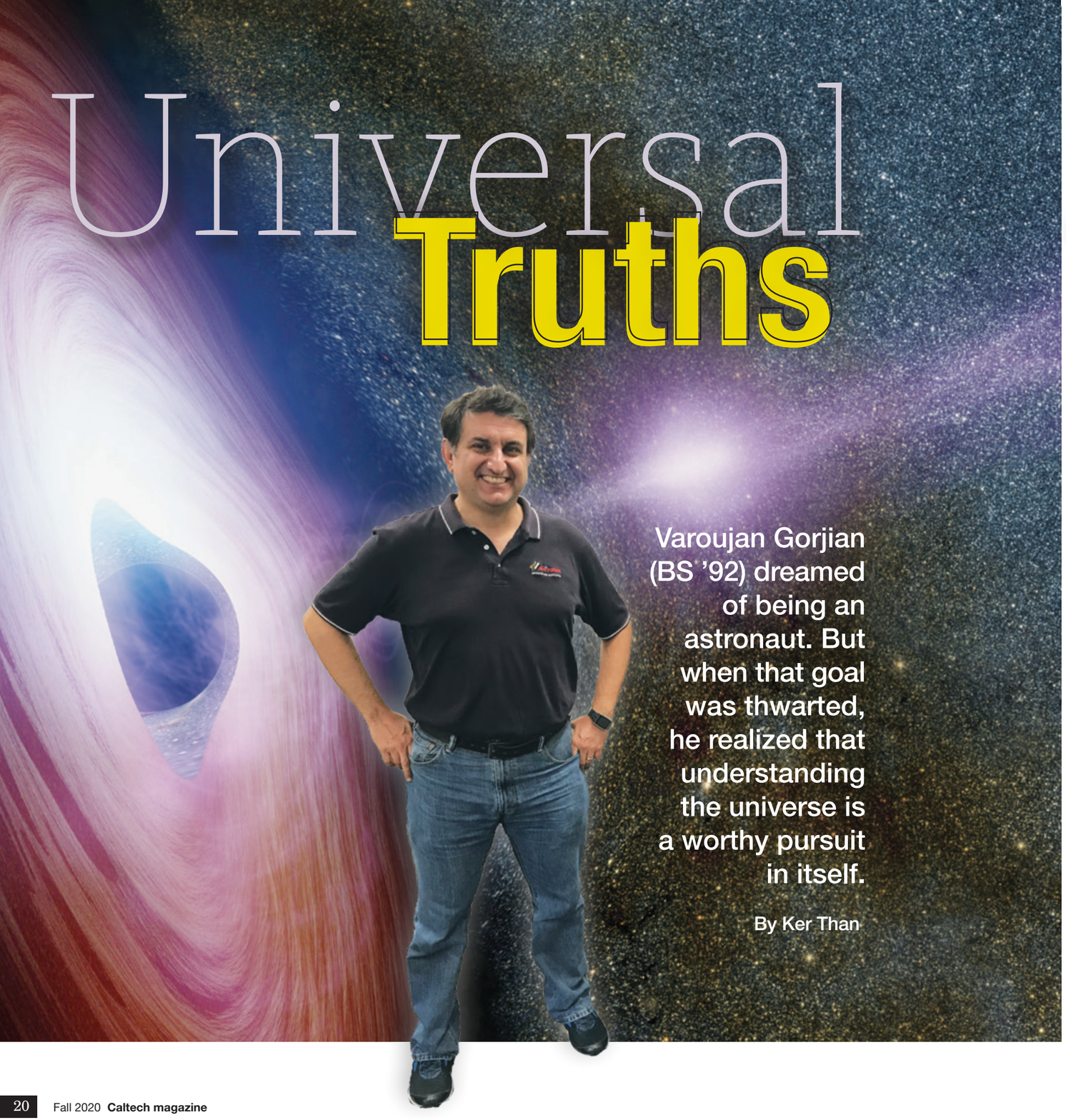
Universal Truths



Varoujan Gorjian (BS '92) dreamed of being an astronaut. But when that goal was thwarted, he realized that understanding the universe is a worthy pursuit in itself.

By Ker Than

A profound truth about the universe stares each of us in the face every night, says astronomer Varoujan Gorjian (BS '92). It's accessible to everyone, no telescope required, and to experience it, one need simply look up.

"You can know a lot about the universe by going out at night, looking up at the night sky, and seeing that it's dark," says Gorjian, a research scientist at JPL, which Caltech manages for NASA.

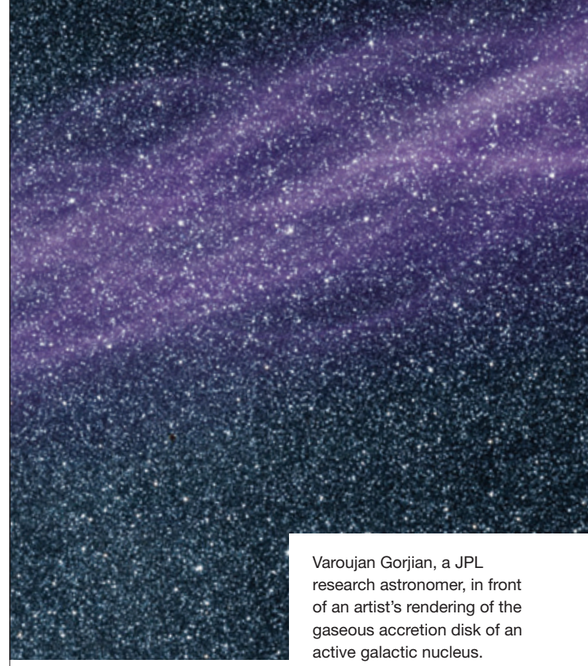
That darkness, Gorjian explains, is a powerful clue that the universe cannot be both infinitely old and infinitely large. It is not, in other words, the eternal, ever-present universe, unbounded and populated by limitless stars as imagined by astronomers of old. If the universe were infinitely old and endless, filled with never-ending uniformly distributed stars, then the light from even the most distant bright objects would have reached Earth already. As a result, the night sky would be a blazing wall of glittering starlight. (An analogy is standing in a dense, never-ending forest; turn to look in any direction and there will be trees in your line of sight.) The fact that what greets us instead when we look up at night is speckled darkness tells us that one of these assumptions is wrong.

This observation is known as Olbers' paradox, named after the 17th-century German astronomer Heinrich Wilhelm Olbers. "Scientists now think that the universe is likely infinite in extent," Gorjian says. "Therefore, given the paradox, it must be that the universe is not infinite in age, which tells you that there must have been a Big Bang. There must have been a beginning."

Gorjian likes to bring up Olbers' paradox when he introduces the wonders of space and science to laypeople, an area in which he is unusually talented. This gift is on full display in a *Wired* video in which Gorjian was challenged to explain black holes to individuals with a wide range of expertise, including a 5-year-old.

"[Gravity is] what keeps us on the earth," Gorjian tells the child. "The main thing about black holes to remember is, [just like] how the earth holds you down, the black hole pulls you in as well."

Gorjian's fascination with space traces back to childhood. As a boy, he recalls "bouncing off the walls" after a family visit to the London Planetarium. Perhaps not surprisingly, the young Gorjian was also a Trekkie. An Armenian born in Iran, he would watch old episodes of *Star Trek* dubbed in Farsi with his older brother, Zareh. The siblings called the show "Mr. Spock," or the "Spock show," after their favorite character. Gorjian says he was drawn to Spock because of the character's scientific bent and also because, being half human and half Vulcan, Spock was an outsider. Gorjian empathized with this aspect of Spock, especially after his own family moved to Los Angeles when he was 10 following the Islamic revolution in Iran.



Varoujan Gorjian, a JPL research astronomer, in front of an artist's rendering of the gaseous accretion disk of an active galactic nucleus.

"This merged character was what I was," recalled Gorjian in a NASA interview. "I was this mesh of cultures. Spock has these two sides to him; for me there were even more sides."

Because of his love for space, the young Gorjian longed to become an astronaut. "Lots of kids want to be astronauts, but most sort of grow out of it. I never quite did," he says with a laugh.

This dream drove Gorjian to major in astrophysics at Caltech, where he made friends he is still in touch with today. "There are five of us, and we recently got together to mark the 30th anniversary of when we all started at Caltech together," he says.

Gorjian credits his participation in Caltech's Summer Undergraduate Research Fellowships (SURF) program with giving him his first real taste of science. He worked with astrophysicist George Djorgovski to study the evolution of galaxies and cosmologist Tony Readhead to investigate the cosmic microwave background, the faint cosmic background radiation that is the leftover heat signature from the Big Bang.

"I was most impressed by Varoujan's enthusiasm and dedication. We accomplished a lot in that first summer," Readhead says.

"… every person you talk to has a different background and a different set of either misconceptions or outdated conceptions, so you have to account for that when you're communicating."

After Caltech, Gorjian received his PhD in astronomy and astrophysics from UCLA. It was in graduate school that he began to study active galactic nuclei. An active galactic nucleus (AGN) is a super-energetic variant of the supermassive black holes that nestle in the hearts of most galaxies. The energy from an AGN is generated by gas spiraling into a supermassive black hole and heating up as it falls in, a process called accretion. In a subset of these AGNs, powerful twin jets of particles erupt from the poles of the black holes and stretch for light-years into space. The oldest and most energetic AGNs are known as quasars.

During his grad-school studies with Matthew Malkan (PhD '83) at UCLA, Gorjian screened images taken by the Hubble Space Telescope for clues about how AGNs were fueled. "AGNs became my regular, everyday kind of science," Gorjian says.

After he earned his PhD, Gorjian was finally ready to reach for his childhood dream and apply to NASA's astronaut corps to become a mission specialist, a class of astronauts reserved for scientific, engineering, and medical experts. By then, however, his eyesight, never perfect to begin with, had fallen below the requirements and disqualified him. Gorjian, however, was not especially dismayed by this turn of events.

For one thing, he was eager to get on with the rest of his life. "I had just spent six years getting my PhD. If my application had been accepted, it would have meant moving to Houston for another seven years for astronaut training before getting to fly into space. So, I thought, 'You know, I'm OK with this,'" Gorjian says.

Gorjian had also come to discover that what he had considered a means to an end, studying astronomy, had become a worthwhile end in itself, one that brought him joy. "Had I been accepted, I would have done it," Gorjian says. "But this way, I could delve into pursuing astronomy and continue doing something that I enjoyed."

So, Gorjian stayed in California and accepted a job offer as a postdoctoral researcher at JPL working with Michael Werner, project scientist for what would later become NASA's infrared Spitzer Space Telescope. "My specialty had become infrared astronomy," Gorjian says. "At the time, JPL and Caltech, through IPAC and the Spitzer Science Center, were both ramping up in this area."

Varoujan Gorjian explains black holes to a 5-year-old in a 2018 *Wired* video.

After two years as a postdoc, Gorjian was hired fulltime at JPL as a Caltech employee. "That was in 2000," he says. "This year marks my 20th year as a Caltech employee. I have my 20-year pin and everything."

Gorjian has spent most of that time studying AGNs using Spitzer, which completed its primary mission in January 2020. "Every galaxy seems to have a supermassive black hole, and an AGN phase seems to be a vital aspect of that, so AGNs connect you to the galaxies themselves," Gorjian says. "It seems to me that they are at the nexus of a lot of interesting concepts."

At JPL, Gorjian has found himself working alongside Caltech professors who taught him as an undergrad. One of those mentors-turned-collaborators is Readhead, whose lab Gorjian had worked in. "We are studying a most peculiar 'blazar' [a rapidly varying quasar] that has baffled astronomers for the past four decades," says Readhead. "It seems to be located in a spiral galaxy, but its blazar properties are those of a quasar in an elliptical galaxy."

Gorjian also has another close connection at JPL: his brother, who was already a 10-year veteran at JPL by the time Gorjian joined. Zareh is a programmer and computer-graphics artist with JPL's Science Data Visualization Group, where, among other things, he helps convert data gathered by probes around Mars and Venus into cinematic flyovers across those planets' surfaces. "We see each other fairly often," Gorjian says. "For a brief amount of time, our offices were actually on the same floor. When we were younger, some people thought we looked alike, so they would start conversations with me thinking I was him."

Watch the *Wired* video at **wired.com/video/watch/astronomer-explains-one-concept-in-5-levels-of-difficulty**

For the past 15 years, in addition to his astronomy work at JPL, Gorjian has also been closely involved with the NASA/IPAC Teacher Archive Research Program, or NITARP. The 13-month program connects high school science teachers and their students from across the country with professional astronomers like Gorjian to collaborate on original research projects.

"Many science teachers have learned science but are not trained in the process of doing science. Most of them have never been to a scientific meeting," observes Gorjian, who is NITARP's deputy director. "This is like having people who have studied basketball, but have never played basketball, teaching basketball to kids."

Most years, NITARP's teachers and scientists first encounter one another at the annual meeting of the American Astronomical Society, one of the premier conferences in the field. "These meetings are where science is communicated, where scientists are interacting, and where critical new information is being presented," Gorjian says. "We show the teachers what a science meeting is like, in particular what poster sessions are like, and then afterward we write a proposal for a project of our own. This is not a toy project; it's real science."

As part of the program, the teachers and the students are invited to Caltech for four days to work directly with the scientists on their projects. This trip also includes a visit to JPL. Gorjian says a critical lesson that he and fellow research scientist Luisa Rebull, NITARP's director, try to impress on the teachers and students is that science is not just about the answer at the end of the book. "One time, a teacher turned to me as we were analyzing data and asked, 'Is this right?' I said, 'I don't know. If I already knew it was right, I wouldn't be doing it!'" Gorjian recalls. "The idea of delving into data, applying various techniques to learn more about some physical phenomenon … that whole process is what I want them to come away with."

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NITARP's longevity, and testimonies from the teachers themselves, suggest the program is a success. "The collaboration with Varoujan and Luisa has really helped me find ways to work with students to help them engage with data in a more open-minded and nuanced way," says David Strasburger, a high school physics teacher at Lawrence Academy in Groton, Massachusetts, who has participated in the program twice.

"One of the things that makes the NITARP program a really vibrant experience for teachers is its authenticity," Strasburger adds. "These are not canned projects. Varoujan's attitude is, 'We're going to try this, and I hope it works. But if it doesn't work, that's research.' For my students, that's mind-blowing. It helps them realize that doing science is really different from taking science classes."

It also helps, Strasburger says, that Gorjian has a knack for conveying complex scientific concepts to teachers and students alike in a respectful way. "He is impressively able to talk to people at different levels. He meets them where they are and doesn't talk down to them."

Gorjian says science communication is a skill he has purposefully cultivated over the years. "It's like most things: repetition makes you better," Gorjian says. "In this case, it's not repetitions of the same thing, because every person you talk to has a different background and a different set of either misconceptions or outdated conceptions, so you have to account for that when you're communicating."

Gorjian views science communication as a personal responsibility that comes with being someone with the great fortune of being paid to understand the universe. "That's a place of extreme privilege, and to treat that as an ivory tower that only the worthy can come to understand just seems personally wrong to me," Gorjian says. "The vast majority of what we do is taxpayer funded. I feel there is a real responsibility to help the public understand what they're paying for. That part of it has always motivated me."

It also helps that most people are inherently interested in space. "Of all the science topics out there, there are two that everybody is interested in: dinosaurs and space," Gorjian says. "If we as astronomers can help people feel a connection to the greater universe, I think that is a very worthwhile thing to do."