NEIL DEGRASSE TYSON, ASTROPHYSICIST AND DIRECTOR OF NEW YORK'S HAYDEN PLANETARIUM, ANSWERS QUESTIONS ABOUT *ORIGINS*, THE FOUR-PART NOVA SPECIAL HE HOSTS

When he was nine years old, Neil deGrasse Tyson saw the wonders of the night sky for the first time—on the dome of the Hayden Planetarium at the American Museum of Natural History in New York City. The young Bronx native at first doubted that the real sky could possibly be so splendorous, but in due course he found out it was and became an astrophysicist after earning at B.A. at Harvard and a Ph.D. from Columbia University.

Tyson's research interests include star formation, exploding stars, dwarf galaxies, and the structure of our Milky Way. But his first love is conveying a sense of wonder about the universe to the uninitiated, which is why today he is back where he began, at the Hayden Planetarium, this time as its youngest-ever director.

Tyson's superb skills as a popularizer are evident in his numerous books, a regular column in *Natural History magazine*, his many TV appearances and lectures, and in the four-part NOVA series *Origins*, which he hosts, airing Tuesday and Wednesday, September 28 and 29, 2004, from 8 to 10 PM ET on PBS (check local listings). *Origins* tells how the universe began amid chaos and eventually developed the remarkable property called life. The story encompasses much more than the discipline of astrophysics, and therein lies a tale, as Tyson explains below.

Q: In your book *Origins*, you write, "These are auspicious times for learning what's new in the cosmos." What's special about these times?

A: People have grappled with the "origins" questions for thousands of years, but they have not had the means to answer them until now. What makes "now" different is that until now, each branch of scientific investigation has asked its own questions. The astrophysicists have asked, "How did the universe get here?" The biologists have asked, "How did life begin?" The geologists have asked, "How did Earth begin?" The physicists have asked, "What is the origin of the elements?" But only recently have we learned that the answer to the question, "How did we get here?", requires a synthesis of all these branches of science. So today you have people with job titles that have no precedent. You have astro-geologists: people who specialize in life forms that thrive deep beneath Earth's crust, in places geologists had presumed life could never exist. You have astro-biologists: people who are looking for life in places other than Earth. What makes the series unique is the attempt to bring to the public, really for the very first time, a synthesis of all the branches of science that are relevant to answering the question, "What is the origin of our place in the cosmos?"

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Q: How does this special moment compare with past revolutions in science?

A: I think there are many times in our history that one would judge to be special. Einstein's discovery of relativity, I think that was a special time. When Newton discovered the laws of motion and gravity. The Industrial Revolution—these were all special times. Today is no exception. But I think it's a little bit extra special because of the multi-disciplinary nature of the discoveries.

Q: Since the subject involves so many different disciplines, isn't it difficult for a scientist in any given field to get the big picture?

A: Yes, it is. That's why, for example, NASA has established the Astrobiology Institute, a virtual institute that has people plugged in from all different disciplines. They all want to know the origin of life, and they're coming at it from the direction of their specialties.

Q: Do you as an astrophysicist find yourself picking up a biology textbook to brush up on the subject?

A: I find myself looking at biology textbooks with fresh eyes, now that I can think about biology in a more global, cosmic context. And the reverse is happening as well. You have biologists intrigued by the environment on Mars and on Europa—one of the moons of Jupiter that may have a liquid water ocean beneath its frozen surface. So, yes, we are reading each other's books.

Q: The series is especially rich in analogies. Could you talk about the role analogies play in giving people insight into some of these phenomena?

A: I think analogies are the educator's tool to convey what is otherwise a complex subject or phenomenon in ways that are either tangible or digestible to the general public. To pull off a good analogy, the "analogizer" needs to be plugged into what matters in the prevailing culture. Otherwise, you're not communicating. So, personally, I make sure that I see the latest films that everybody is watching, that I look at least once or twice at the latest television programs, that I hang out with people of all ages—kids, teens, adults—so that I know what language the world around me speaks. And only then can I hope to be able to communicate with the audience, rather than just lecture to them.

Q: What are some of your favorite analogies?

A: Here's one we do in the film. Gravity in the universe gathers what might otherwise be big gaseous clouds into stars and planets. Well, that's good for life, which emerges from the complex chemistry that stars and planets make possible. It's kind of like creating a soup broth. You start with a broth that's not very concentrated in its flavors. Over time, as water evaporates away, you concentrate the flavors so that at the end you have this solution that titillates the tongue much like the condensation of materials in the universe can titillate the organic chemistry that leads to life. People know what it's like to have things simmering on the stove, and you walk by and say, "Mmmm, that smells good!" You don't say that at the beginning; you say that towards the end. I like food analogies best because we eat practically all

the time, being warm-blooded creatures. So there's always going to be some encounter you have with food, where if I make the right analogy, you're going to be eating and you're going to be thinking about the cosmos.

Q: It happens whenever I'm eating a Milky Way.

A: Not only the Milky Way, but you also have the Mars Bar! There's tremendous penetration of cosmic language into our culture.

Q: You grew up in New York City, which is hardly known for its starry sky…

A: Nary a star to be found but the sun in the daytime.

Q: So what sparked your interest in this field?

A: The Hayden Planetarium was one of them, creating a sky that was so rich in stars that I thought it was a hoax. I was nine years old at the time. The embarrassing part was even in adulthood I would go to mountain top observatories that have some of the clearest skies in the world, and I'd look up at the brilliant star-filled night sky, and I'd say to myself, "This is so beautiful, it reminds me of the Hayden Planetarium."

Q: There must be a lot of kids who are inspired by the Hayden Planetarium in just that way, but very few of them go on to careers in astrophysics as you did. Now that you are director, are you trying to change that?

A: No, we cannot have everybody become a scientist. What a boring world that would be! We need artists, we need musicians, we need police officers, we need politicians. What you want to do is make sure that no one grows up without acquiring a deep appreciation for their place in the cosmos. If I succeed at that, I'm done. Some of them might become scientists, but that's not what I'm after. I'm after deepening the scientific literacy of the electorate.

Q: Since we need all these other professions besides scientists, how important is scientific literacy?

A: I don't have the data, but it may be true that all those people who would have become scientists do so anyway and are not held back by the scientific illiteracy of everyone else. The problem is, science is all around us. It affects global warming. It affects stem cell research. It affects whether we support a space program or not. How about pesticides? Are they good or are they bad? How about irradiated foods? You have people who have knee-jerk reactions to all of these issues, without knowing how to think about the problem and thereby make an informed decision. That worries me. So if I can get people excited about learning something about science so that they can see the enlightened state that science literacy brings upon them, then maybe they'll take an interest in learning about other issues that have political import.

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Q: Program three of *Origins* is about the search for extraterrestrial life. So far, there is no hard evidence that life exists beyond Earth. Do you think that many scientists display a blind faith that it will turn up?

A: The faith that people have in there being life elsewhere in the cosmos has arguments in defense of it. For example, that life on Earth is made of the most common ingredients in the universe; that, as time goes on, we learn that life is hardier than we had ever given it credit for being, and therefore the diversity of conditions which we find on the surfaces of planets and moons may not be so diverse as to prohibit life, because now we know life can survive under many different circumstances. We also know that life on Earth began relatively quickly when it had the opportunity, within a couple of hundred million years, and that's nothing on a five-billion-year time scale. So, however hard it may be for us to figure out how to make life, nature didn't seem to have much problem with it. If that's the case, and you look at how many stars there are in the universe, and by extrapolating from our own solar system, how many planets there might be in the universe, it would be egocentric to suggest that we are alone. I suggest that the faith that we are not alone is not a blind faith; it is a faith anchored in supporting evidence that argues strongly for that possibility.

Q: As a planetarium director, how much do you have to rely on speculation about aliens to get people interested in astronomy?

A: I have found that one does not require aliens to get people interested in the universe. It can happen through the sight of craters on Earth's moon through binoculars, or the sight of Saturn's rings. Look at the hits to the Jet Propulsion Laboratory's website for the Spirit and Opportunity rovers on Mars—ten billion hits over a three month period, vastly exceeding the hit rate that NASA has ever received since it began maintaining internet sites. Those people didn't go to the site because they were attracted by intelligent aliens; they're going there because it's exploration. And look at the coverage that every beautiful picture from the Hubble telescope gets. So I think the need to invoke aliens to stimulate public interest is overrated. There's too much else about the universe that is extraordinary and exciting: black holes, for example, or the extraordinary fact that our galaxy is going to collide with the Andromeda galaxy, or the fact that one day the Sun is going to expand and engulf the orbit of the Earth. These are fascinating future facts. When you convey these to kids, they never forget them.

Q: The Presidential commission that you're on is about to issue its report [President's Commission on Implementation of United States Space Exploration Policy, issued on June 16, 2004]. Is there a tie-in to the subject of origins?

A: By all means. Much of what drives the exploration of the solar system today is the search for water and the search for life. So origins in the context of the search for life is fundamental to much NASA activity today. NASA also has some part of its portfolio investigating the Big Bang and the origin of the universe as a whole, rather than just the origin of the solar system, or of Earth, or of life. So the answer is yes.

Q: How realistic are the prospects that the commission's recommendations will be funded?

A: Well, it's just money. If you put taxpayers together according to how they feel about NASA, there'd be a subset that says, "We should spend money on Earth and not in space." If you then ask those people, "For every tax dollar, how much do you believe we are spending on NASA programs?" typically they'll respond 20 cents, 30 cents, up around there. And if you tell them that it's seven-tenths of a cent, they don't believe it. But it's true. And so, if you pose the question like this, "If all it took was a penny out of your tax dollar to completely fund our space program to the moon, Mars and beyond, would you do it?" I think you'd get 100 percent participation.

Q: Will it happen?

A: It's a matter of money and politics at this point. We've tried to address those issues in the report, recognizing that NASA, historically, has been nonpartisan—not even bi-partisan, but nonpartisan—and that nonpartisanship ought to stay. If it does not, I think the plan is doomed. We should all take ownership in the space program.

Q: You mentioned the Spirit and Opportunity rovers on Mars. Since our robots are getting better and better, what is the argument for sending people into space?

A: I wear two hats in life. One of them is as a scientist, and wearing that hat, there is never any reason to send people into space. Just send robots; they cost one-tenth as much as a person. That's the view shared by most of my colleagues in the scientific community. But I also wear the hat of someone who sits at the intersection between scientific discovery and public appreciation of science. At that intersection, I see things that excite the public. One is that astronauts are the only celebrities I know who people will line up to get autographs from without knowing what their names are. It's simply to get the autograph of someone who's gone into space. I was born in 1958, the same week that NASA was founded as an agency. And when my colleagues who are five or six years older or younger than I am say that we should only send robots into space, I ask them, "What got you interested?" They invariably say that it was the manned space program of the 1960s. So, it's a little disingenuous to deny the next generation that inspiration. If you only want the scientific returns, there is no discussion; you just send robots. But the thrill of exploration is something that historically has never actually involved scientists. Columbus wasn't a scientist. Magellan wasn't a scientist. Marco Polo wasn't a scientist. Lewis and Clark weren't scientists. They were explorers. So we shouldn't lose the idea that going to a place because you've never been there before has value. In it are the seeds of inspiration for the next generation of people, and I don't want to deny them that inspiration.

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