what is enlightenment
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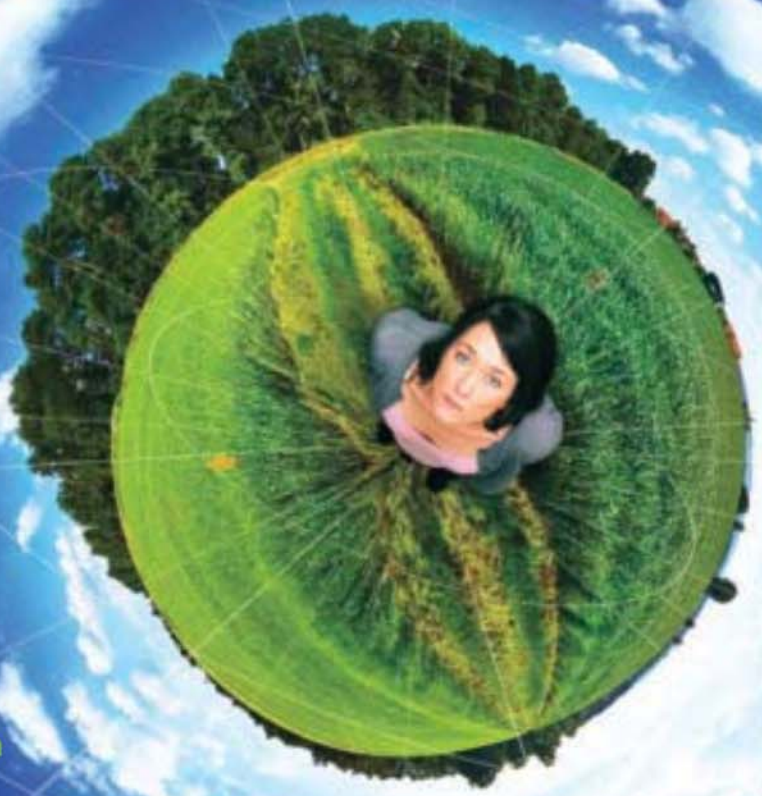
WELCOME TO THE CENTER OF THE universe

Science zeros in on the cosmic significance of consciousness



Chopra Unplugged
Off the record with a mythic spiritual icon

Atheists with Attitude
A field guide to the new enemies of God

Absolute Health
And the elixir of exercise

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what is enlightenment contents

A View from the Center of the Universe

An interview with Joel R. Primack and Nancy Ellen Abrams

Ever since Copernicus proved that the universe doesn't revolve around Earth, humanity's place in the cosmos has steadily continued to shrink. But according to physicist Joel Primack and cultural philosopher Nancy Abrams, we may be far more central to the universe than we think. *WIE* speaks with this dynamic husband-and-wife duo about the fascinating ways in which science is coming to understand our true cosmic significance, revealing a surprising new context in which to answer the perennial spiritual questions: Who are we? and Why are we here?

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Living in the Dark

Featuring Neil deGrasse Tyson • Paul Davies • Janna Levin Deno Kazanis • Bernard Haisch

Cosmologists say that ninety-six percent of the universe's mass is actually *invisible*, consisting of enigmatic entities called "dark matter" and "dark energy." The question is, what is this stuff? And why are some physicists invoking Eastern philosophy to explain it?

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The Mythic Life and Times of Deepak Chopra

He is the most famous face in the world of East-meets-West spirituality. But what's the real story behind Deepak Chopra's success? In this candid interview with spiritual teacher and *WIE* founder Andrew Cohen, Chopra offers a never-before-seen look at his remarkable life, proceeding from his formative years in India to his rise in the ranks of the Transcendental Meditation movement to the dramatic separation from his guru that set him on the path to spiritual stardom.

by Andrew Cohen 86

The View from the Center of the Universe

An Interview with Joel R. Primack & Nancy Ellen Abrams

By Elizabeth Debold

In the last few decades, the cultural conversation about science and religion has become less a scholarly debate and increasingly like a barroom brawl. Atheists and theists are wrangling on the radio, in print, and on every possible bandwidth. The prize is a big one: Who *are* we? Where do we come from? Our core identity as humans is at stake. Are we God's children, or are we random accidents in an indifferent universe? In other words, does our existence matter to something larger than ourselves?

In the midst of this polemical slugfest, something quite remarkable is emerging from a growing chorus of scientists whose love for and appreciation of our creative cosmos may eventually lead beyond this polarization. The Hubble and other space probes have brought us stunningly gorgeous

pictures that inspire wonder at what we are a part of: incandescent nebulae that are the cradles of stars and glowing supernovae that forge the elements from which we are formed. The universe is far more vast, explosively creative, eerily beautiful, and mysterious than anyone could ever have imagined. The scale of what we are in the midst of—the vast dark expanses of space, the infinitesimally small distances traced by subatomic particles, and the stretch of space-time that extends back for billions of light-years—is nothing less than awesome. As astronomer Carl Sagan once said: "A religion that stressed the magnificence of the universe as revealed by modern science might be able to draw forth reserves of reverence and awe hardly tapped by traditional faiths. Sooner or later, such a religion will emerge."

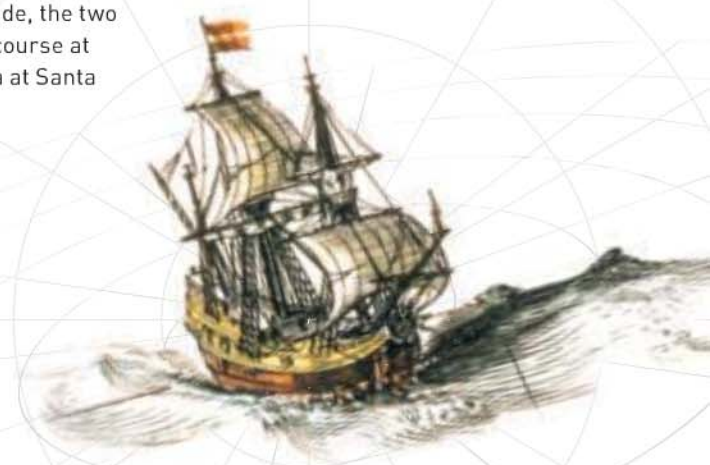
But for such a religion to bind itself to the human heart, it has to tell us how to relate to this overwhelming picture that science shows us. Where do we fit in? Are we merely passive witnesses to the unfolding drama of the distant stars? Most materialist scientists demur at this point, believing, as Sagan did, that although the universe can be central to us, we are not central to it.

That's why we were more than a little intrigued when Joel Primack and Nancy Ellen Abrams' tour de force of contemporary cosmology, *The View from the Center of the Universe*, landed in our office some time ago. These authors are saying that human beings actually *are* central to the cosmos—and that the latest research in science can show us how. They don't mean that we are at the *geographical* center of the cosmos but that we are central along a variety of fascinating dimensions that we are only just beginning to be aware of.

This dynamic husband-and-wife team is uniquely qualified to awaken us to a new view of the cosmos. Primack, a noted physicist, was one of the principal originators of Cold Dark Matter theory, which is part of the accepted understanding about how structures form in the universe. Dark matter is invisible stuff that, according to the theory, fills most of the cosmos and exerts a gravitational pull on the matter we do see. In 1988, Primack was made a Fellow of the American Physical Society and has recently served on a National Academy of Science committee to define the next phase of research that NASA should undertake. Abrams is a philosopher, historian of science, lawyer, policy analyst, and songwriter. She has consulted globally on how nations can make intelligent policy decisions in areas where scientific research is crucial but controversial. But it is her interest in the boundary between myth and science that has led to such a fruitful partnership with Primack. For the last decade, the two have co-taught a popular course at the University of California at Santa Cruz called "Cosmology and Culture," which was the basis for their book.

Primack and Abrams aspire to change culture through this new cosmology. They are on a heroic quest to create a new, scientifically accurate creation story that will inspire us to leap beyond the conflict and division that threatens this planet. "If we intend to navigate Earth's coming transition . . . with sanity and justice, we will need to inspire high creativity, intense commitment, and immense stores of enthusiasm and raw hope," they write. "To perform what look like miracles, humans need big and inspiring ideas."

Abrams and Primack assert that their work can give rise to a new spirituality. According to their definition, to be spiritual means experiencing our connection to the cosmos through scientific understanding. Yet the sheer awe at the miracle of existence that these two committed materialists tap into and convey breaks the boundaries of science and leads us beyond. While they would never use the word "God" themselves, the majesty of their vision brings us in touch with the kind of wonder that humans throughout history have always associated with the timeless realm of the transcendent.



A NEW THEORY OF THE COSMOS

WHAT IS ENLIGHTENMENT: *In your work, you explain that, for the first time in history, we are developing a picture of the universe that might actually be true. What are we learning about the cosmos?*

NANCY ELLEN ABRAMS: Let me first step back a little to say what we're trying to do. Every culture we know of has always assumed that they're at the center of the universe. What does that mean? It means they understood something very deep about themselves, but they never understood anything very deep about the universe. They just looked out, saw the stars, and interpreted them in accordance with what worked for their culture. They didn't have any knowledge of what was beyond the visible stars. They put themselves at the center of the universe because that's what works for human beings. In every culture, this is the basis for understanding how reality is put together, how we fit in.

Now for the last four hundred years, since the time of Newton and Galileo, people have not been able to do that. In the Newtonian view, Earth is just a random planet of a random star in a place that is nothing special. So we couldn't see ourselves as central to the universe anymore. Though we still have religions that go back to much earlier pictures of the universe, they have been, to a great extent, in conflict with Newtonian science.

For several centuries, we've had this conflict between what science has told us about our place in the universe and the need of human beings to explain our world in a way that makes us central and, therefore, makes us matter.

JOEL PRIMACK: But now we're beginning to have a theory that makes sense of what science has observed about the cosmos, so we can ask the question that people are really interested in: What does this all mean for us?

WIE: *What is this new theory? How did it come about?*

PRIMACK: Cosmology was for centuries the laughingstock of science. It was the field in which the ratio of fact to theory was practically zero. There were lots and lots of theories and hardly any information that would enable us to validate those theories. This has been true throughout almost all of the twentieth century, up until the mid-1990s. Then a huge amount of new data started to come in through our wonderful new instruments—not just the famous Hubble Space Telescope but, for example, the Hipparcos satellite. It isn't as well known, but it allowed us to reliably age date the oldest stars. As the data came in, we realized that many of our assumptions had been wrong. For one thing, the distance of the oldest stars and therefore their age had been overestimated; it turns out that they are about twelve billion years old, not sixteen billion years as we had thought. And in 1997 and 1998, two independent teams unexpectedly discovered that the universe has been expanding faster and faster for about the last five billion years. This led us to theorize that there must be something we cannot see that is making the universe expand so quickly. We call this "dark energy," which is a property of space itself, a repulsion of space by space that speeds up the expansion of the universe. We have inferred from this and lots of other evidence that the universe is composed mostly of invisible stuff: dark energy and dark matter.

The universe is more vast, explosively creative, eerily beautiful, and mysterious than anyone could ever have imagined.

WIE: *If dark matter is invisible, how do we know that most of the universe is made of it?*

PRIMACK: People realized as early as the 1930s that the visible matter could not possibly be all there is. The galaxies rotate much too fast to be held together by the gravitational attraction of the matter that we are able to see. Many discoveries, by Fritz Zwicky, Vera Rubin, Mort Roberts, and others, have convinced us that most of the matter in galaxies and clusters of galaxies is invisible. That's the stuff we call dark matter.

I've been working on dark matter for quite some time. I'm a coauthor of the basic paper, published in 1984, that proposed the Cold Dark Matter theory. We had very little data to support it until the 1990s. Now as the data comes in, the detailed predictions of the Cold Dark Matter theory are being confirmed again and again. There's *no* data that's inconsistent with this theory on the large scale of the universe.* All the data confirm what the theory predicted about things like the big bang radiation, the distribution of galaxies, galaxy formation, and so on. The predictions of the theory were usually made well in advance of observation, and the observations as they're coming in keep confirming the predictions in tremendous detail.

*Not all cosmologists would agree with Primack's statement. For a variety of views on dark matter and dark energy, see page 80.

This is the first time that cosmology has been in this kind of situation. It's normal for a fairly advanced science, where it can make predictions and the predictions usually come true. But in cosmology this is absolutely revolutionary. Every few months we get major new observations, and these observations keep confirming the predictions. This is what gives us scientists confidence that we just might be on the right track.

WIE: *What is dark matter? And how does it work?*

PRIMACK: First of all, there's nothing very mysterious about how dark matter works—it works just like ordinary gravity. The mysterious thing is that most of the mass in the universe is this invisible stuff. Dark matter is our friend. Dark matter starts in the very early universe with very slight differences in density from one spot to another spot. They're so slight that they're like the difference between the surface of a soccer ball and a bacterium on that soccer ball. It's a very, very slight difference. We think that those differences were caused by phenomena that occurred on a quantum scale in the very earliest stages of the big bang, the period that we call "cosmic inflation."

Dark matter is our friend. It's what holds all of the galaxies in the universe together.

But anyway, gravity has the effect that it tremendously amplifies small differences in density. A region that's slightly denser than its surroundings expands more slowly. A region that's slightly less dense than its surroundings expands slightly faster. While the dark matter in those regions that are a little denser than average does expand with the expansion of the universe, it happens more slowly so that it eventually gets significantly denser than its surroundings. And the part that becomes denser than its surroundings collapses a little bit and becomes a lump of dark matter that stops expanding. The universe continues to expand around it, but that dark matter lump stops. Within that region, ordinary matter can fall to the center of the dark matter. As it falls in, it can rotate faster and faster, like an ice skater pulling in her arms. Physicists call this "conservation of angular momentum." It makes the galaxies rotate. That's how we get these beautiful spiral galaxies that are obviously rotating. Since the universe has been expanding for billions of years, those regions that start out slightly denser become galaxies—or clusters of galaxies on a bigger scale. Those regions that start out slightly less dense than average become voids, regions where the universe doesn't seem to have any galaxies.

Dark energy is causing the expansion to go faster and faster on a large scale. And dark matter is preventing galaxies from expanding. It's protecting the galaxies against the tremendously destructive force of the dark energy that pulls things apart. That's why I like to say that dark matter is our friend. Dark matter keeps our galaxy and all the other galaxies together.

WIE: *Is there a correlation between what you're calling dark energy and the original creative impulse that initiated the big bang?*

PRIMACK: We think so. But that's one of the big mysteries, because we don't really know what dark energy is. We are pretty sure that in the very earliest stages of the big bang, the universe was expanding extremely rapidly—this is cosmic inflation, which I mentioned earlier. It's not like ordinary expansion but is an exponential expansion where in a given amount of time the size of a given region doubles, and then, in the same amount of time, it doubles over and over. Now the universe is starting to do this again under the influence of dark energy. So we think that there may very well be a connection between the tremendously strong dark energy that may have been driving cosmic inflation at the very beginning of the universe and the dark energy that's operating today.

WIE: *So while the dark energy is causing the universe to expand, the dark matter pulls the star dust in the universe together to create the stars and the galaxies. Is that right?*

PRIMACK: That's right. The dark matter lumps are holding everything together. The special thing about ordinary atoms, as opposed to dark matter, is that when they bang into each other, which naturally happens once in a while, they radiate away some of their energy and thus fall into the center of a dark matter lump. The very first stars were created this way out of hydrogen and helium, which came from the big bang. Clouds of atoms fall together, get very dense, and thus become stars. At the end of their lives, a tiny fraction of their mass becomes star dust—particles of carbon, oxygen, nitrogen, and other heavier elements. Then in the next generation, the heavier elements can form into planets that circle the stars.

We actually see this process going on now. Thousands of planetary systems are actually forming. We can see this with our space telescopes. So we're quite sure that this is in fact what happens. This is probably how our own planetary system formed around a late-generation star. This only happens

The Invisible Texture of the Universe

This extraordinary image shows the projected distribution of dark matter in a 3-billion-light-year cross-section of the universe. Each level of magnification gives us a closer look at the "cosmic web" of dark matter filaments (blue), which string together billions of small and large galaxy clusters (yellow).

This cosmic cluster is made up of more than a thousand galaxies, each of which contains hundreds of millions of stars.

in the middle of giant dark matter halos, which are spherical blobs of dark matter. When you think about a galaxy, you see these beautiful spirals, but you should imagine that on a scale ten times bigger than the galaxies that we see, there are these giant dark matter lumps that are actually holding the galaxies together against the destructive force of the dark energy that's pulling things apart on bigger scale. Nancy has a beautiful way of describing this with a nautical analogy.

ABRAMS: Sometimes in my talks I explain it in this way because it brings it all a little closer to home: Imagine that the entire universe is an ocean. The ocean is dark energy, which fills the entire universe. On that ocean, there sail billions of ghostly ships made of dark matter. At the tops of the tallest masts of only the largest ships are tiny little beacons of light. Those beacons of light are what we see when we look out at the stars and galaxies in the universe. We can't see the ships and we can't see the ocean. But we know they're there through theory, through Joel's theory specifically, the theory of cold dark matter.

> All of the heavier elements represent only one-hundredth of one percent of what exists. We're made of the rarest stuff in the universe.

Because we have this theory and this new picture of the universe, we can know that those invisible things are there and that those little bits of light are not just hanging there. They are the beacons on the ships, which represent the galaxies that we actually see.

AT THE CENTER OF THE COSMOS

WIE: *In this new scientific picture that you are presenting—what you sometimes call the Double Dark theory, which includes dark energy and dark matter—you say that we are cosmically central and that we're living at a pivotal time. This cosmic centrality is what you mean by "the view from the center of the universe." Can you explain some of the key ways that we human beings are central to the cosmos?*

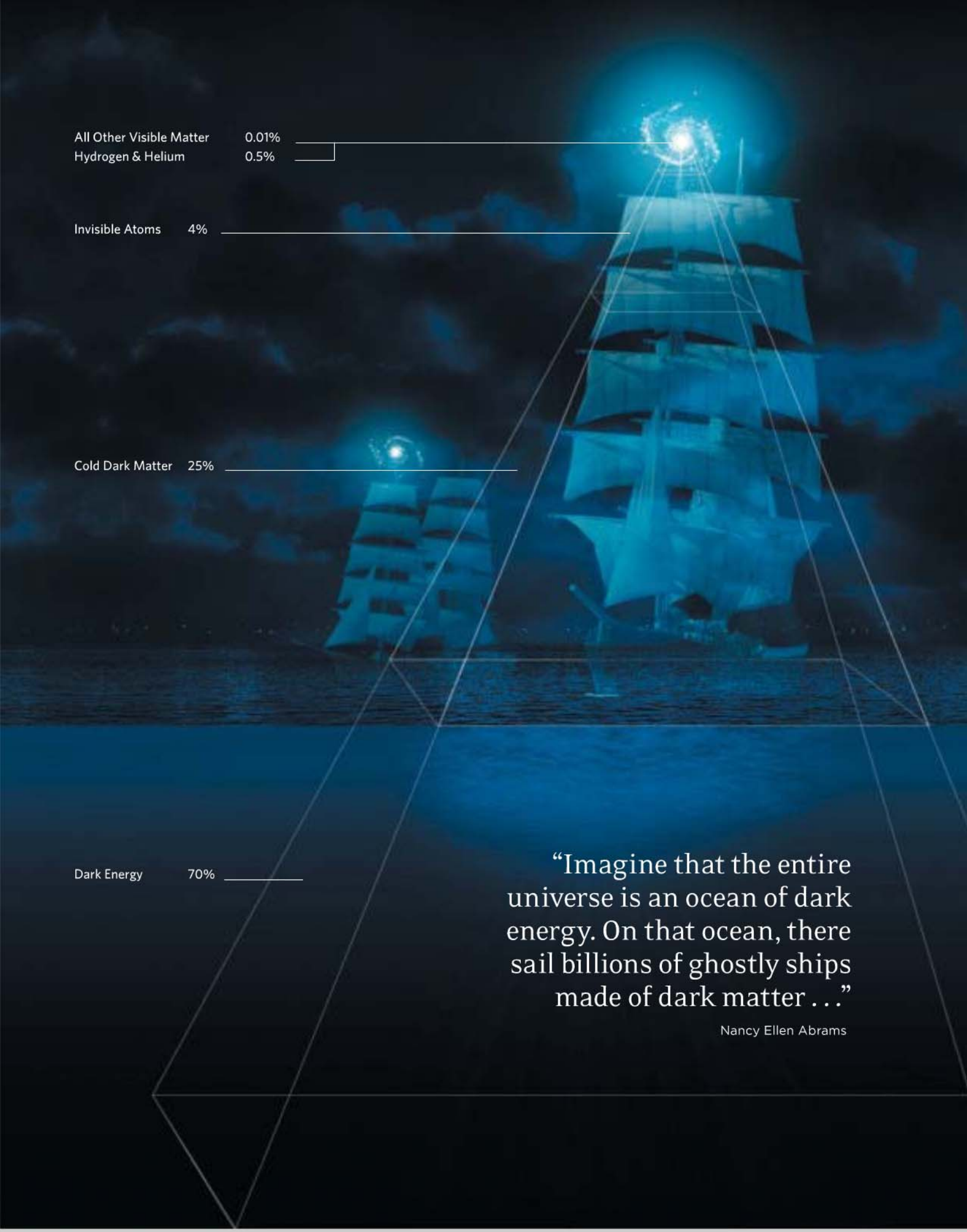
PRIMACK: Let me give you a brief list. First, we're made of the rarest stuff in the universe. Atoms only make up less than five percent of the stuff of the universe. Dark matter has at least five times more mass than all the ordinary matter that we know. The rest is dark energy. At least seventy percent of the mass-energy of the universe is this dark energy stuff, which is really mysterious.

So it turns out that atoms are relatively rare. And almost all of the mass of atoms consists of hydrogen and helium. All the heavy elements—carbon, oxygen, nitrogen, phosphorus, sulfur, iron, and all the way up to uranium—these are made in stars and in supernovae, when stars explode at the end of their lives. As I said before, these heavier elements are spewed out as star dust.

We are made of these heavy elements. People like to call it CHON, which stands for carbon, hydrogen, oxygen, and nitrogen—the most common elements in living organisms. Of course, you can't make living creatures without a fair amount of the other heavier elements too. All of those were made in stars and have been collected together into very special places, like our planet Earth. That's what we are made of. All of the heavier elements put together represent only one-hundredth of one percent of what's in the universe. We're the rarest stuff in the universe.

ABRAMS: To show how important our place is in the universe, we have created what we call the Cosmic Density Pyramid. It's based on the pyramid on the back of the dollar bill. The base of it is thirteen rows of bricks, and then there's a floating capstone with an eye in the middle of it. Everyone knows this symbol. It was put on the back of the dollar bill to represent something completely different—the thirteen original colonies with the Eye of Providence looking favorably on this venture of a new country. But the pyramid was an even older symbol when the U.S. government started using it. We have taken this symbol and reinterpreted it. The age of the symbol reflects the fact that symbols like this really work for human beings. People like them; they resonate with them. But our interpretation makes them realistic and accurate.

We've reinterpreted the pyramid to represent all of the visible matter in the universe. The heavy base of the pyramid is just hydrogen and helium, which is what the stars are made of. That's almost *all* the atoms in the universe. Even though they're very, very light, they still weigh far more than all the star dust, which is what that tiny floating capstone is made of. The eye in the capstone represents intelligent life—the portion of the star dust that is able to see this whole thing, reflect on it, to find some meaning in it. That eye is far out of proportion to the



"Imagine that the entire universe is an ocean of dark energy. On that ocean, there sail billions of ghostly ships made of dark matter . . ."

Nancy Ellen Abrams

amount of star dust that exists. If we did represent intelligent life in scale with everything else, it would be almost invisible, a little tiny point at the top. But that eye is really the most important part of the pyramid. It's us.

Then we've expanded this picture from the back of the dollar bill to be much, much bigger. Below ground, there's an *immense* hidden dark pyramid, which represents the invisible atoms, dark matter, and dark energy.

So even though we are tiny, tiny, tiny—we're up at the very topmost point of the pyramid—we are supported by everything below us. We could not exist without the huge amount of dark matter that's below the surface or without the dark energy that is responsible for keeping this whole universe growing.

Human beings are central to the cosmos—and the latest research in science can show us how.

PRIMACK: We're also in the middle of all possible size scales. The human size scale is almost exactly in the middle between the smallest possible size, something physicists call a Planck length, and the entire visible universe, the largest thing we can see. This must be true of all intelligent life.

WIE: *Why do you say that?*

PRIMACK: Well, all atoms are about the same size, and you need to have an awful lot of atoms to have the complexity of the human mind, which is the most complicated thing we've ever discovered in the universe. You can't have that kind of complexity if you're as small as, let's say, an ant. You have to be pretty big; you have to have a lot of atoms.

You might think that bigger is better—that if humans are smart, then a creature the size of a mountain would be even smarter. But large creatures like dinosaurs or whales are so big that there's a noticeable delay from when information is sent out from their brains and when it gets to their tails. It's crucial that information be transmitted quickly. You can't think faster than information can be transmitted. The way thinking is done, both in brains and also in supercomputers, is that the really intense processing is done in small regions where the data can be transferred back and forth very rapidly. If you want to build a big supercomputer, you hook together a lot of chips. But all the hard work is being done in the chips. What that means is that if there's a large thinking organism, it's going to be basically a community of smaller minds. The thinking will be done by the smaller minds. The speed of communication—ultimately the speed of light, which is the fastest that data can be transmitted—limits the size to about that of a human.

To summarize, we're made of the rarest stuff in the universe. We're on the midsize scale where things are really interesting. We're a lot smaller than galaxies and the universe. We're a lot bigger than the really small size scale of atoms and the interiors of atoms.

ABRAMS: We decided to give a name to this middle range of size scales that humans are a part of. We chose the name Midgard. We wanted to give it a name because it is so special. It's the range of size scales that we have intuitive understanding of—from about the size of an ant up to about the size of the sun. For most people, that range is reality, even though it actually is not reality; it's only a tiny patch of it. We picked the name Midgard because in Norse mythology it is the realm of civilization and stability—the human world in the middle of the world sea. Off to one side is the realm of the giants, and off to the other is the realm of the gods.

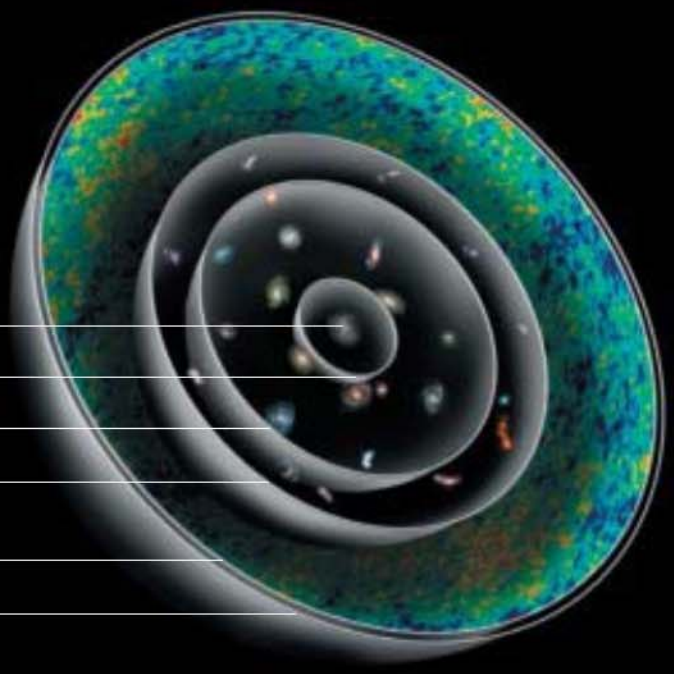
Now this is, of course, metaphorical. Nobody should ever imagine that we're trying to take this literally, but metaphorically, it's really quite a good description of the size scales in the universe. Outside this midrange of size scales, there really is the land of the giants—giants of galaxies and superclusters of galaxies on the cosmic horizon. These are things that we can really only think about; we can't ever experience them directly. The same is true in the small realm. We are totally dependent on the very small realm of individual living cells and the much smaller realm of atomic particles and so forth. Those were here first. They are what we are made of. In that sense they are, as we like to call them in our book, the "wee gods." We really are sandwiched in between these two other realms.

For most of human history, no one knew about these two realms. They *only* knew about Midgard. It's only with the advent of great scientific instruments and theories, like quantum theory, that we have actually been able to say, "This is really what the universe is like on these other size scales." This has only happened in the last century. We now know about the realm of the wee gods and the realm of the giants. We know about this through science.

PRIMACK: Let me continue with the ways humans are central by jumping to time. It turns out that we live at the midpoint of cosmic time. We live very close to the time when the universe is switching over from slowing down its expansion to speeding up its expansion. This is the best time for observation of the distant universe. As the universe's expansion speeds up, the distant galaxies are disappearing from our sight. We scientists

A spherical representation of cosmic time

This diagram shows us how, from the perspective of time, we're at the center of the universe. As Abrams reminds us, "When we look up at the night sky, we are not just looking out into space—we're looking back in time." The image of a distant galaxy that we see through a telescope is actually the light that this cosmic form emitted billions of years ago. In the figure, each concentric sphere, moving outward from today, represents an earlier epoch in the evolution of the universe. The farther away from us a sphere is, the farther back in time are the galaxies and other objects that we observe in that sphere, until we reach the outermost layer, which represents the background radiation generated by the big bang itself.



1. **YOU ARE HERE!** (Today)
2. Our Sun Forms (4.5 Billion years ago)
3. Big Galaxies Form
4. Bright Galaxies Form
6. Cosmic Background radiation (400,000 years after the big bang)
7. Cosmic Horizon (big bang)

like to say that this is the best possible time to observe the distant universe, so fund us quick!

Actually, of course, this will remain true for millions of years, but it's something that we're just beginning to appreciate. We live at the midpoint of our solar system's life. It began about four and a half billion years ago; it will end in five or six billion years when the sun turns into a red giant star and then ultimately a white dwarf.

We're also living in the middle of the best time for Earth. Earth only got an oxygen-rich atmosphere about half a billion years ago—thanks to microorganisms. The sun is steadily heating up, which is what midsize stars like the sun always do as they age. In about half a billion years, the sun will become so hot that, quite apart from global warming due to greenhouse gasses, it will evaporate all the oceans, and Earth will lose its water. The hydrogen will be separated from the oxygen at the top of the atmosphere, the hydrogen will be lost, and Earth will become a dune planet.

Incidentally, this fate could be averted, or at least postponed, if our distant descendants figure out how to move Earth farther away from the sun. My astronomical colleagues just figured out how to do this in principle. It involves reorienting the orbits of some large comets. This isn't something that we need to worry about right away, because we're talking about many hundreds of millions of years in the future. But this shows that we're in the middle of the best period of our planet.

We're also at the end of the exponential expansion of humans on Earth. During the last century, humanity increased its numbers by a factor of four. The size of the human population doubled not once, but twice, over the last hundred years, which is the first time in the history of humanity that ever happened. It can never happen again. In fact, there are strong doubts that Earth could handle a doubling of the current human population. So we've reached the end of this rapid increase of our population—and we're obviously reaching the end of the even more rapid increase of our impact on the planet.

Thus, we're living at a very special moment from *all* of these different perspectives: from cosmic to the solar system to Earth to human. This brings us to a total of six different ways that we're in a central position in the universe, starting with being made of the rarest stuff, plus the fact that we're in the middle of all size scales, and then the four different ways that we're living in a central moment in time.

Let me just mention one more: We're at the center of the observable universe. Now that's nothing special, because any

observer is at the center of their observable universe. We all see a spherical universe around us, and in that sense, the old medieval cosmology with Earth at the center of a set of crystalline spheres was right. But the way we understand this now is that we're at the center of spheres of time. We don't just look out in space; we look back in time. Looking out, we see the galaxies as they were longer and longer ago. The same would likely be true of other intelligent creatures in other places in the universe—they would see themselves at the center of the observable universe too. But we're realizing these things for the first time.

WIE: *In your book, you call this perspective the "cosmic spheres of time." Nancy, you've said that we are in a special place in the universe in relation to these cosmic spheres of time. Our special place arises from the relationship between space, time, light, and consciousness. You also note that without consciousness, there is no visible universe. Could you say more about what you meant by this and how it relates to our centrality?*

ABRAMS: The visible universe is what we see. It's what we're conscious of. There's something out there, and we humans have to *interpret* what it is. Now that we actually have a serious scientific theory and a lot of data to support it, we're in a position to tie our *need* to give a meaning to the universe to what we actually *know* about the universe. This is what's really so extraordinary about this point in time for us.

Astonishingly, in this new picture, in all the ways Joel mentioned, we actually *are* central. We're just not central in the way people assumed, which was a geographic centrality. That is obviously not true. There is no geographic center to an expanding universe. But nevertheless, we're central in all these really interesting, subtle, and very meaningful ways that, of course, no one could even conceptualize before we had modern cosmology.

So we're in an extraordinary position from the point of view of human meaning because we're now at a place where we can satisfy this deep need to understand ourselves as central to the universe. We can make it scientifically rigorous and accurate at the same time. *That's* what has never been possible before. That's what we really need to develop now.

It's not obvious how to do this. We've given an interpretation in our book of one way to look at it, but this is really going to require the whole culture—artists and writers and so forth—to collaborate with it. We need to interpret this new picture of the universe in ways that are meaningful to us, that inspire us, and that really light our fire.

CONSCIOUSNESS IN THE COSMOS

WIE: *As you have been explaining, the cold dark matter theory tells us that most of the universe is invisible. You've said that without consciousness, we couldn't see anything. What is the role of consciousness in the universe?*

ABRAMS: The first thing that I think people don't realize is that everything we say about the universe is really about our *understanding* of the universe. We don't really have any way of knowing *anything* out there, except through our own minds.

PRIMACK: All we see is light. We make the interpretation that there are stars out there rather than tiny holes in the dome of the sky through which the light of heaven shines. The idea that those are distant stars was a discovery, as was the realization that those stars themselves have a life and a death and that the really distant things are galaxies and quasars. All of these are discoveries. They're not the least bit obvious. We basically construct the universe as we discover more things to interpret. Now we have the ability with our satellites above the atmosphere to see parts of the spectrum of radiation that could never be seen by our senses: gamma rays, x-rays, ultraviolet, infrared, and even radio waves.

We depend on a combination of fancy technology and theoretical interpretation to make sense of this universe. If that isn't human consciousness, I don't know what is.

ABRAMS: Consciousness is what makes all this real for us. Everything that we are doing is for *us*. Everything we say about the universe, even the word "universe," is a human construct. We couldn't possibly know anything without using our own abilities to metaphorically create meaning.

WIE: *I believe you have said that human beings are the perfect size in the cosmos. Does this relate to our capacity for consciousness?*

ABRAMS: I don't know that we said we're perfect—but we are the right size to have complex thoughts. Whether you consider that perfect or not is really a matter of taste. There are actually a lot of people out there today, environmentalists particularly, who think that Earth would be better off without human beings. The animals would survive, and the planet would be greener. All of the bad things that we're doing wouldn't be happening. I personally think that that's a terrible misunderstanding of our entire species and what our potential is. We're not perfect by a long shot, and we make terrible mistakes. But we are able to do something that nothing out there that we have ever encountered anywhere in the whole universe can do. We may be the first. It may just be that Earth is the planet that is going to have to support this astonishing experiment, for better or for worse.

The experiment of intelligent life is giving the universe its own way of looking at itself. All of us together—we and any intelligent aliens that might be out there—we are the consciousness of the universe. We *are* the way the universe reflects on itself, and without us, the universe is utterly meaningless and will forever be meaningless. A beautiful planet could be here with animals and plants, but the whole thing would be meaningless. Those environmentalists who imagine this planet from their point of view as a pristine beautiful Eden are giving the planet meaning. Without us, no one's going to be imagining that.

PRIMACK: On the other hand, we also have the ability to think through the implications of our actions. One of the things that we learn from cosmology is the enormous time scale before us and into the future. We are the product of 13.7 billion years of cosmic evolution. Our planet has billions of years to go before the solar system is destroyed by the sun turning into a red giant star and then a white dwarf. There will be many thousands of billions of years of evolution in the future of the galaxies. In fact, our own galaxy will get brighter and brighter for approximately six trillion years. The future before us and our descendants, if we're smart enough to have any, is immense. What we do in this brief period at the end of the human inflationary expansion on Earth can make a tremendous difference in the long run. We've just begun to appreciate this, but it's not too late to have the results come out in good ways rather than bad.

We are the way the universe reflects on itself. Without us, the universe is utterly meaningless.

WIE: *So this is another way that we are living at a pivotal time on this planet?*

ABRAMS: We're living at a pivotal time only if you understand how big time actually is. We're always living at a pivotal time from some sort of political point of view: Is it going to be the Democrats or Republicans? Is the Iraq War going to end or is it going to go on another ten years? Those are pivotal events on some size scale. But the size scale we're talking about is far, far larger. In the very distant future, the Milky Way is going

to merge with the Andromeda galaxy. In fact, our local group of thirty-some galaxies is going to come together and merge. During that period of time, the rest of the universe is going to be expanding so fast that we are hardly going to be able to see any other galaxies at all. Thus in the very distant future, our visible universe may really consist of only one huge galaxy, which Joel and I like to call "Milky Andromeda."

If the human race has gone on to solve these little short-term problems that we are facing now, and has continued to evolve in order to colonize the Milky Way, then we will, in effect, have colonized the entire visible universe. That's future number one.

Now let's assume, because we don't know about them, that there aren't any intelligent aliens. Let's assume that the fate of the universe is up to us. So future number two is that the Republican Party continues to debate whether Jesus and the devil were brothers or not and people are completely distracted from seeing what's happening as Earth warms up. We don't cut back on our use of resources because of greed and short-term views. We have huge wars, plagues, and so forth, and the human race is reduced again to where it was thousands of years ago. We have to start all over again, or maybe we are totally wiped out.

In that case, future number one is completely wiped off the possibility charts. This is what we mean by a pivotal moment, because we, right now, are the people who are going to be determining which of those two immensely different futures could actually come about. Unless you can see cosmic time, unless you can see a really long time into the future and realize how important our existence may be, you can't possibly appreciate future number one as a possibility.

WIE: *I've heard you say very eloquently that our time seems ordinary to us but it's going to be mythic to future generations if we act responsibly.*

ABRAMS: Either way it's going to be mythic. Either way.

PRIMACK: Our descendants will never forgive us if we mess up Earth.

ABRAMS: If we don't save it—because we're already messing it up. We have a huge responsibility. We're acting as though Earth is just here—as if *we* found it and it belongs to us. But *we* are here because of billions of years of other animals fighting and struggling so that their children could grow up and

reproduce. All of life is a struggle. We are benefiting from the struggles of our ancestors going all the way back to that first cell. We were not handed this Earth. That's why some of these religious myths are so terribly destructive. "Oh, God handed it to us and said to us, 'Okay, it's up to you now, take care of it.'" No, it wasn't handed to us. We have arisen out of it. We're part of this enormous flow, and we have every obligation to pass it on to our children and to our very, very distant descendants who can take over the whole galaxy.

A COSMOCENTRIC VIEW ON BEING HUMAN

WIE: *Part of what you're alluding to is a point that you make in your book about how our moral and ethical frameworks are not appropriate to the scale of time and the consequences that we're actually working within.*

ABRAMS: That's right. We have to realize that all human beings are essentially the same, if you look at it from a cosmic point of view. We are completely preoccupied today with very, very trivial differences. The Shiites versus the Sunnis. The Mormons versus the Evangelicals. Blacks versus whites. These are silly, trivial differences. Yet our entire culture is completely preoccupied with these trivial differences between human beings and is not seeing that, as human beings, we have this immense potential. But we really need to see ourselves as one.

Another thing that we say in the book is that there *is* an "us versus them," but it's not my civilization versus your civilization or my race versus your race. Us versus them is intelligent life versus the laws of physics. That's what we really have to deal with.

WIE: *What do you mean by that?*

ABRAMS: It's not between us; it's between all of us humans and nature. That's what we really have to negotiate with; that's what we really have to take seriously. We need to identify ourselves with a much larger group. We need to identify ourselves with intelligent life and not with some tiny little ethnic group. As long as we identify ourselves with tiny little ethnic groups, we cannot see how precious this incredible experiment is on planet Earth. All we see are the little differences. When you appreciate your place in the real universe, these little things really subside in importance, and we can find the unifying elements that could really save our planet.

WIE: *It gives a lot of dignity to being human.*

ABRAMS: Yes, we have to see the dignity in it. All of us humans are bunched up on one planet, so we look extremely common to ourselves. Humans are incredibly precious. There are so few intelligent beings in this immense universe. Just because we happen to be bunched up on Earth, doesn't make us any less precious.

WIE: *When you say that it's between human beings and nature, are you saying that human beings are separate from nature?*

ABRAMS: No, we're talking about human beings realizing that we have to live in harmony with nature. We have to pay attention to nature. We have to learn to understand her ways. That's science.

WIE: *Earlier you spoke about Midgard, the midsize realm of creation that is between the infinitely small and the unimaginably large. In a talk that you gave to NASA, you said that the only way we can know these larger cosmic realms and the subatomic realms is through science, and the only way we can experience them is spiritually. What do you mean when you say that we have the capacity to experience these realms spiritually?*

> You never find meaning without looking at the big picture. And cosmology is the biggest picture we have.

ABRAMS: Basically, what we're saying is that you cannot experience these things directly. You can learn about them and know about them intellectually. Scientists do this. We are trying to find what our place is in this universe—how do we understand our place in the expanding, double dark universe? Throughout all of history, people have needed to experience their place in the universe because it gave them grounding, made them feel that their lives were real and that they mattered. It was the basis of their various religions. We still are the same kind of people. We really do need meaning. And we need meaning that is grounded in the best picture of reality available to us in our time. Now, for the first time, we have a new picture of reality, and our meaning has to be grounded in that.

We can experience the entire universe spiritually if we realize that, by Joel's and my definition, what spiritual means is experiencing our connection to the cosmos. That is all it means; it has nothing to do with anything supernatural. The universe itself is so much grander than anyone imagined. If we even attempt to feel that we're part of it, that is a spiritual action.

WIE: *Because the enormity of it utterly shatters any notion of self that would merely be personal, ethnic, or cultural?*

ABRAMS: I don't think it shatters it. I think it greatly expands it. We can now realize that we are cosmic beings in a very definable sense. We have a place in this cosmos, and we could have a huge effect on the cosmos, if we play our cards right.

WIE: *How do we make meaning from this new view of the cosmos? As you say in your book, we have the choice to find meaning in our extraordinary place in the cosmos or to continue with the modernist, Newtonian, existential view that we're insignificant specks in the middle of this vast, meaningless universe.*

PRIMACK: We give a number of examples in our book of applying ideas from modern physics and cosmology to human affairs. Take the concept of emergence. We love to teach our students what we call "phase transitions." That's what happens when, for example, ice melts and turns into water or water evaporates and turns into water vapor. These are complete changes of basic physical phenomena, and they simply don't make any sense on the scale of an individual atom or molecule. You can't talk about a molecule of water being frozen, liquid, or vapor. It only makes sense when you talk about large numbers of molecules interacting with one another.

ABRAMS: There is a very simple way of putting this in human terms. Something similar to a "phase transition" happens when human beings are in groups. For instance, individuals who may be very nice on their own, when they are with too many other people who all think one way, can become fanatics. There's this strange thing called "group think" that happens to us, and there are some evolutionary explanations for why this happens. People in these groups are extremely different than they would be as individuals.

PRIMACK: Of course, an example of emergence that we humans are particularly interested in is the phenomenon of human consciousness. It's a deep mystery how this wet organ in our skulls, our brain, somehow creates the experience of being conscious beings. This is a deep question of neuropsychology that great progress is being made on, but it's such a tough question that it's going to take a lot of further understanding before we get there. Clearly, something like emergence must be happening. Consciousness is not just individual interactions between neurons or the individual things that happen in neurons. It's some kind of very complicated collective phenomenon that happens through the interaction of billions of neurons, just as phase transition describes what happens

through the interaction of billions of atoms or molecules.

We're trying to illustrate the idea that physics and cosmology can be an important new source of metaphors. Once you have the idea of metaphorical thinking, you can apply that to very different realms, including human experience and human interaction. That's a way that we can find meaning.

Basically, the bottom line is that you never find meaning without looking at the big picture. You can't understand what a little piece of a picture means until you see the big picture; you see how the little piece fits in. Cosmology is the biggest picture we have. It can help us find meaning by letting us see ourselves as part of a grand story.

ABRAMS: I'd like to say one more thing about the question of meaning. Every culture has had some kind of meaningful story, a story that meant something for them. But what is meaningful changes with the times and with changes in the political and economic and social situations. Today we have far too many people looking for meaning in stories that were useful to their ancestors in earlier times, which cannot create a coherent picture of reality today. The big challenge today is to find the kind of meaning that our ancestors may have found in their stories in a way that is coherent with what we actually know now.

Far too many people are looking for meaning in stories that were useful to their ancestors, but which can't create a coherent picture of reality today.

Science has to be the bottom line. We need to take the best science of our day and build our meaning on that. Because what we're looking for is not just meaning to make us feel good so we can stay home. It's meaning so that we can have an accurate map of reality to save this planet.

We have to build on the best picture of our time and then give that adequate meaning so it motivates us and brings us together, so that when we *do* work together, we are working in harmony with nature.

We have not changed as human beings. We need meaning today just as much as we ever needed it. We also desperately need science because we aren't going to succeed without it. The huge challenge is to pull those two things together so that we have meaning and it is accurate.

WIE: *In the last chapter of your book, you write: "If we take on the cosmic responsibility, we get the cosmic opportunity—that rarest of opportunities for the kind of transcendent cultural leap possible only at the dawn of a new picture of the universe."*
Could you say some final words on that?

PRIMACK: There have been only a few real changes to our cosmic picture. First, the flat Earth was the standard picture of the ancient Egyptians, Mesopotamians, and the Old Testament Hebrews. This changed to the picture of a spherical Earth in the middle of a spherical universe. That's the Greek view, which was standard throughout the Middle Ages. Then there was the transformation from that to the Newtonian picture, which led to this curious situation where, for the last three or four hundred years, most people in the West never even thought about the universe without a certain discomfort.

Now we have the transition to the double dark universe that's based on dark matter and dark energy, where quantum mechanics and relativity are also important. This is a strikingly different picture from any of the earlier ones. Evolution is also key. The universe changes fundamentally in time and on different size scales. These are characteristic features of our latest picture of the universe. Now that we're beginning to understand how this picture fits together, this challenges us to reconceptualize everything. That's a fantastic opportunity for our particular moment in time, and people have not had such an opportunity for many centuries.

Part of the point of our book is to give people the background to start thinking about it and creating new art and literature, and so forth. We've attempted to show some of the ways that this can be done. If we're successful, people will go far beyond what we propose.

ABRAMS: The amazing thing is we have this opportunity right when the world is falling apart. There are a lot of people who are scared of these ideas. They're scared partly because they feel they can't understand the science. We have to understand how the universe works and make our spirituality as real as possible. The whole idea of trying to spend your life understanding your spiritual connection to the universe but not having any interest in how the universe actually works seems to me absolutely bizarre. We need to be coherent beings. That's how it's going to matter. ■

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