

WE ARE DUST OF STARS

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It is believed that life may very well exist on other stars' planets because, on ours, life appeared as soon as the conditions were ripe. The title "We Are Dust of Stars," though poetic, is entirely scientific. But there's no scientific answer to the riddle of the origin of life. When asked about this riddle at a congress of physiologists, the nineteenth-century German scientist Emil Du Bois-Reymond replied, "*Ignoramus et ignorabimus*" (We are ignorant and we shall remain ignorant). And we still don't have an answer. I believe that regarding the origin of life we can only say three things: That God created it, which could be a true or false answer, but not a scientific one. That it came about by itself without any God, which could also be a true or false answer but is also not a scientific one, and it demands as much or more faith the previous one. Or that we don't know, which could be a scientific statement, but it's not much of an answer. 385

What we do know is that life appeared on earth some three or four thousand million years ago. First there were large molecules, which came from smaller molecules, which, in turn, came from atoms that formed at temperatures of twenty million degrees in the hearts of galaxies, which came from hydrogen and helium clouds that emerged from the Big Bang. So we *do* know something: that life came from the Big Bang.

This is the current scientific account of creation. There are other accounts, told in different ways, but which, in the end, tell the same story. The Kuna peoples of Panama say that in the beginning there was nothing but twilight. In the South Pacific they say that only Ta'aroa existed in the great vastness, when there was no earth or sky, no sea or Tahiti, and he became the universe. The Chinese say that in the beginning the Tao had no name; it was named, and creation followed. An Amazon nation says that in that time there was only darkness and there was no river. Others say that he made the

land of Hawaii like a seashell, and the earth began to dance. Another nation says that in the beginning there was only the One without others, and that Being thought and desired to be many. Yet another nation says that there was a pair of twins who taught people how to make fire, how to hunt seals, and how to make love, and they revealed to them the names of things.

What we know from science is that in the beginning there was nothing, and energy emerged, and then matter, which is made up of atoms, and that atoms are joined in such a way that they bind with one another. That's how clusters of atoms came to be. And thus order emerged from chaos. Atoms don't have a fixed form *per se*, they are made up of a nucleus surrounded by a cloud. Molecules do have a fixed form, like the crystal lattice of a snowflake. That is the order that emerged from chaos, an order that became even greater when life emerged from such molecules.

386 The evolution of life advances from the smallest to the largest of things. It goes from the simple to the complex, and the largest is the most complex. Mammals have evolved gradually from reptiles, without a reptile ever giving birth to a mammal. Likewise, life has evolved gradually from non-life. In water or mud, carbon molecules began to create other larger, more complex carbon molecules, and then they began to repeat themselves. And this, little by little, became life. All the way to us.

The universe is uniform. There are only about one hundred elements (one hundred kinds of atoms) in the entire universe. And we are made from such atoms. And so it is with life. All cells have a similar composition. From the one-celled diatom to the blue whale (and humans in between), all living beings are made of the same amino acids—twenty in total. And even from the same kind of molecules that later became the first cell. Although the difference between a molecule and a cell is so great that if a molecule were a car, a cell would be the Ford Motor Company.

We are therefore siblings to all living beings, but also to non-living things. Recently I was reading *Out of Chaos*, a book by Louis J. Halle, a scientist who claims that living and non-living things are merely categories used by our minds to classify beings. We don't consider the crystal of a snowflake floating in the air as being alive, he says, but we do think that of the diatom, a beautiful cell of silica shell with extraordinarily delicate patterns floating in the sea. And yet, the molecules that make up the diatom are not more alive than those of the snowflake. And yet, he adds, that the life of the diatom is ephemeral, and it will soon perish like the snow. But our lives too are as ephemeral as diatoms.

But from a one-celled organism came the many-celled ones. And we don't know how cells have managed to organize themselves and become an octopus, an oak tree, a butterfly. Often they grow in an uncontrolled way, and that we call cancer. We don't know how a fertilized egg contains the instructions for the eye color of a being not yet born. How the egg of a bird contains the map of the earth and the geographical and astronomical knowledge the new bird needs to migrate from one pole to the other without a guide.

The evolution of the universe started with the Big Bang, and life is a continuation

of such evolution. All the way to us. All the beings in the universe were born from the same womb, that highly unlikely event that was the Big Bang. And since then evolution began. The Bible says that God saw that all was good, but He probably said that after a few billion years of evolution. Through evolution, life engendered life, but before that, non-life engendered life. Through DNA transcription errors, variations began to emerge. And thus evolution marched on. Had there never been any mistakes and had everything been perfect, there would have been nothing but microbes. The shift from amoebas to diatoms, to reptiles, to simians, and to us would never have occurred, all steps in an ever greater perception of reality.

We are but agents in the acceleration of evolution, conscious agents. And there is evidence of non-biological evolution. For instance, the human hand evolved into a tool, and for that reason it was not necessary for it to grow more fingers.

This exceedingly vast universe in which we find ourselves began to know itself through us. We are the stars that are now studying the stars.

In the quagmire of the earth the cosmos became alive. And soon after (through humans) it began to understand itself. Through us, whom a scientist has named the most complex of all molecules.

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On this planet, we went from purely chemical reactions to intelligent life, but not for the purpose of being multiple minds, but a single collective mind. They asked an astronaut how earth looks from the moon, and he answered, "Fragile." He also said that no divisions between nations can be seen.

There is something called the "Mediocrity Principle." If the sun is an ordinary star, and planets are an ordinary thing, and the chemistry of our bodies is something that is present in the entire universe, there is no reason why there wouldn't be many others like us.

It may be that in the near future computers may unite us even more. But cooperation has always been around on all biological levels, and it is as ancient as life itself. Asking about the origin of cooperation—it has been argued—is like asking about the origin of life. Cooperation has been a factor in evolution. So has altruism.

"Altruism" is a new term in biology. It existed before but without the new biological meaning it now has. When a hawk is about to attack a flock of thrushes feeding on a field, there is always one thrush that sends out a loud call alerting the others. He is attacked by the hawk while the others manage to escape. That is called altruism. The genes of this altruist bird will not be passed on because he will die prematurely, but those of his closest relatives will. And that makes it possible for another altruist to emerge. That is also what happens with heroes and martyrs.

The first type of economy that emerged was sharing. And sociobiology teaches us that to do good to our neighbor is to do good to ourselves. And the idea that war is inscribed in our genes is a myth of our time.

One difference between human evolution and that of animals is that bees have used the same language for millions of years, while among us, nobody is able to speak Sumerian anymore. The evolution of animals has been fueled by instinct. Our own

evolution has been an effort to overcome instinct.

We are animals made up of chemical elements made up of atoms made up of a mere fog of probability. It is a mystery how chance can be the cause of order. But electrons seem to be able to make decisions, as the nineteenth-century British inventor Henry Fox Talbot argued. And the theoretical physicist Freeman Dyson has stated, "A mind is inherent in every electron."

All species go on dividing and subdividing. Only one went on to become more and more united, us humans. And we joined together to such an extent, that we became cities.

One day in the 19th century, in the Caribbean, a boy was watching the stars from the deck of a ship, and next to him sat the great Cuban hero, José Martí. Much later, at the ripe age of 90, the boy told the Cuban writer Cintio Vitier what Martí had told him about the stars. His story was recorded, and listening to this recording is almost like hearing Martí himself speak. Martí said, "Boy, do you think all of this was made
388 just for us to look at for an instant? Do you not think that perhaps there is something bigger than us? Do you realize what all of that you see up there represents, and that we are part of that? You should therefore understand that that was not made to amuse us, and that we have an obligation towards all of which has been created."

Closer to our own time, John Archibald Wheeler, a theoretical physicist, has asked what purpose a universe without a consciousness serves. And he adds that the universe is the size it is because that way we are able to be in it. Had it not evolved to the size it is now, we would not have been able to be in it. Likewise, argues the British physicist and cosmologist John D. Barrow, our existence is the reason why the universe is structured the way it is.

The mysteries of astrophysics...That physical conditions gave rise to humans is clear. But that man would have produced the physical conditions for his own appearance in the future? Another physicist has stated that the Universe had to create its own observers (such as that little boy watching the stars next to José Martí).

The earth was a ball of molten rock that cooled down. It was only the crust that cooled down, because they say the earth's core is as hot as the sun's surface. And the crust began to develop all kinds of pieces of rock, many of terrestrial origin, while others from outer space. And those rocks were carved by a hominid. Thus, from those flint stones they fashioned axes and spears. The blade of the flint stones dulled the sharpness of man's teeth.

Homo habilis carved stones. But in his evolution, the most decisive factor was not the perfection of tools, but rather, socialization. Or, as we now say, solidarity. Many animals hunt in groups, but they don't share the spoils of the hunt. When a monkey shared his food, he was no longer a monkey but a human. Giving and receiving is also what made us human. Darwin said, "Survival of the fittest." But the fittest are also those with the greatest solidarity. Stephen Jay Gould has stated that evolution happened more through communion than through combat. In the jungle there was no law of the jungle.

Humans have been the only animals to assume an erect posture. Consequently, arms became shorter and legs longer. And they acquired the ability to walk on two feet and developed a “biped ideology.”

Standing on two feet made us intelligent. This happened because our brains were no longer hanging from our bodies, but were rather placed on top of a vertical column, overlooking everything. And our brains became larger and with a bigger frontal area. They grew to be four times the size of a monkey’s brain, and this made the forehead project forwards. At the same time, our hands were not used for walking anymore.

The more man stood erect, the more he used his hands; and the more he used his hands, the more he stood erect.

Fire also helped unite us. It fostered language, the telling of stories around an open fire. Males developed stronger family ties. Had it not been so, humans would have died out.

The penultimate branch of evolution was Neanderthal man. The last was us (to this day). A baby’s clutched fist is due to the mother’s fur that the baby clung to. Apparently, physically speaking, Neanderthal man was more advanced than *Homo sapiens*, but he did not develop the frontal lobes of the brain in the same way that *Homo sapiens* did. That is where the imagination, ethics, and emotions reside.

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We are also the only vertebrates to cultivate philosophy. Tails had not been of much use for a while. Fire was not only useful, but also fascinating. And it still is; that’s why children like playing with matches so much. And we all enjoy staring at the flames in a fireplace. Fire was probably brought in from the depths of the forest, possibly from a burning tree. And it was as if the sun all of a sudden had entered the cave. And we danced around it.

Human beings only exist in groups, only in the form of the human community.

We should also know that the human species is a fortunate species. Take dolphins, for instance. It is argued that they are as intelligent as us, and maybe even more. There are some dolphins that have even learned English—their language of training—in underwater acoustics, which is at times ultrasonic. Their sonars and radars are better than ours. In terms of non-anthropocentric technology, this is great technology. Their brain is more developed than ours. They can see underwater as well as above. Half of their eye is designed for aquatic vision and half for aerial. But they were stunted in their evolution. Since they are aerodynamic, they have no right or left hand. They cannot play the piano or use tools, and they are unable to light a fire because they live in the water.

We still don’t know why we initially stood on two feet. Children’s love of climbing trees is due to that early state of ours. The fact that we no longer climbed trees allowed our fingers to move independently. The thumb and index were therefore able to form a circle. Our eyes had been made for night vision and were big for that reason. Later, they were used for day vision, but they remained large. And then too they were made to see colors. In a monochrome jungle, this was an advantage. A world of colors, in 3D

and available to the touch, made it easier to find the fruits in the midst of the foliage, pick them, and perhaps offer them to someone. That already involved thought: separating the concrete from its undifferentiated surroundings. That already was thought and language. That would become the fruit of knowledge that Genesis speaks of. Be it how it may, the truth is that our color vision is due to the color of ripe fruit.

The backwards-arching lumbar curve made bodies more erect and more beautiful too. Perhaps it was then that they felt naked, with their sex in the middle of their bodies. Eden was in Africa. Did we have to go around dressed from that point on? In Africa, on the shores of Lake Turkana, some of the oldest hominid fossils have been found, and among those fossils, a fig leaf. A fig leaf left its imprint on the now petrified mud. It is said that we lost our ape-like fur in order to feel cooler under the tropical sun, and that the dark pigment of our skin came about because of modesty. The fact is that since then we no longer walk around naked.

390 *Homo erectus* is the stage at which we became humans instead of monkeys. For one and a half million years we were hunter-gatherers with tools, and later with domesticated fire. Paradise was not something given but only offered. Something offered to man and not to animals. And progress too was offered to man, but not to animals.

For eons they gazed at the stars, noticing their regularities and irregularities, and they wondered, "What are they?" Later, they learned arithmetic by counting sheep, an arithmetic that has now allowed us to count galaxies.

Man is also the only animal with buttocks. And because of his erect position, his anus was hidden. Women are the only mammals with permanent breasts, not only breasts that develop for breastfeeding. And also the only mammal with orgasms and that can be in heat all year long. That happened so that the caves would house a permanent love. And also so that children, who are slow to grow, would be taken care of for many years until they could fend for themselves. Otherwise our species would have perished.

Man is also the only animal that smiles. Our lips changed separating from our gums to allow us to smile.

Our nose lengthened forwards, just as our chins, in order to allow us to speak. Our eyeteeth atrophied, which modified the shape of our faces, and also allowed us to speak. Our tongues became shorter than those of monkeys, and this too allowed us to speak. First, there would have been individual symbolic sounds, but later such sounds would have become common to the group. Being together for longer periods inside caves would also have improved communication. Man began to speak, and in so doing, he remembered the past and planned for the future—something unknown to animals—and he also became conscious of himself, of the one who spoke.

He got better and better at walking on two feet and his hands became more skilled at seizing objects. This made his brain grow. And thus the anatomical evolution of *Homo sapiens* came to an end. Anatomic evolution was no longer needed. The nature of evolution changed.

The monkeys that were less like humans got lost in the bush. Did language make

us human, or was it the human brain that created language? They began to have ideas and notions. For instance, the notion of death. He is the only animal that knows he will die.

In the beginning, language had practical ends, but later it was used for myth and spiritual purposes. Man domesticated plants and animals, but before that, he domesticated himself.

Was clothing perhaps fashioned to hide our animal nature? Our bodies no longer had fur, only hair on our heads, to protect our brains from the sun, and on our sexual organs, to highlight them.

He had beautiful eyes, beautiful lips, and beautiful teeth. *Homo sapiens*. It was the evolution of a species to master evolution. The fact that we are responsible is another difference between animals and us, although some human fossils can hardly be distinguished from those of animals.

The Psalms say that God created man only one degree lower than angels. Why then with a rectal intestine and flatulence? And God became flesh in *Homo sapiens*. That was what perplexed Tertullian—that God would have come to light through shameful body parts and would have been fed in a ludicrous manner.

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He is the only animal who knows he will die. But before, until we appeared, all evolutionary change was meant for survival. And I wonder: if our species is the most adaptable of all, will it not also adapt after death? It is not very difficult to imagine that we will become part of a collective consciousness, and that our bodies will become the entire universe.

Even before man was man, from the times of Neanderthal man, we have believed in resurrection. Nevertheless, he still knows he will die. And perhaps it is for that reason that man is the only animal that cries when he is born.

Death too is a factor in evolution. We die so that others may be born. And those people will be better than us. Without death there would be no human species, no species whatsoever. That is, there would be no evolution. Death is a phenomenon occurring in all star systems. But according to Dyson, life is more organization than substance. And that is why it can liberate itself from flesh and blood.

I would venture to say that that life after death would be a non-molecular life. We would be in the last stage of cosmic evolution. Four thousand million years ago chemistry became biology. It is worth asking: In the future, could biology not become something more?

We should consider death to be but another phase of life. Or we should think of death as a form of recycling. As a form of producing new combinations, an organic process. I would say that it is a form of energy conservation. And the same force that pulled us out of chaos is the one that leads us towards death. The physicist Ilya Prigogine has argued that disorder is not the final destiny no one escapes from, but rather something wherefrom order is born.

The birth of the world, the Big Bang, was anti-entropic. Stars are social—they always exist in galaxies. And there is a common cosmology to them all.

Stars are where matter became light. But it is true that among them there are black holes that are made up of nothing. Some think what in the heart of each galaxy there is a black hole where the size is zero and density is infinite. And that we spin with the entire galaxy towards that fatal common center to our death. But some also believe that black holes are also the place where matter is born and dies. That black holes can also be white holes. A black hole here and a white one elsewhere.

Why not think that life is something inherent to the universe, like space and time? The cosmos itself could be a black hole and we are all falling into that hole. But would that not mean that we would reemerge in another reality in the form of a white hole? I think that the fear of death is an error of perspective. What does the starry sky tell us? That we are part of something much bigger, as José Martí told that boy on the deck of a ship.

392 The most universal of all laws is that everything in the universe is born and dies, even stars, even the universe itself. But everything is also born from other deaths, even stars. And I wonder, what will be born from this universe? In the parish of São Félix da Marinha, a small village in Portugal, a priest called Father Torres Maia is always preaching to his parishioners that they shouldn't decorate graves with flowers and that they shouldn't clean them or care for them. When he goes back to his home village, he never visits his parents' grave. And he says, "All graves are empty. There is no one in the cemeteries!"

Black holes are matter without dimensions. White holes would mean that the dead would again regain their dimensions.

I imagine the dead of all nations wondering, "Will it ever be possible to overcome the Second Law of Thermodynamics?" I also imagine God saying, "I hereby fill the entire universe with white holes."

I say that death is good because, were it not for death, God would not have created a universe where all dies and all living beings come about as a result of a death. Only elemental particles don't die, the ones that can't further subdivide and for that very reason they don't disintegrate. They have been around since the Big Bang. In that sense, they are eternal. They are the matter that constitutes our bodies, and we are made up of eternal particles.

That is why it is very telling that we feel death to be unnatural. In the end, we don't believe in death. Man has universally believed in immortality, as I said earlier, even before Neanderthal man. I have declared myself a communist—and continue to declare myself so—but my difference of opinion with the communism that failed somewhere along the way was my belief in our survival after death. And I believe that to be one of the main reasons why such a communism failed—because it rejected immortality.

In the universe, all tends to become something better, something superior to what came before. And that is what we call evolution. And would humans be the exception to such a transformation?

Democritus, the discoverer of atoms, believed that the spirit was also made up

of atoms, although those were “special” atoms. We now know that atoms are not the smallest unit of matter because they can divide further. The ultimate reality are elementary particles. The Nobel Prize laureate Jean Charon argues that it is within them that the spirit resides. They don’t only exist in our bodies, but also outside of them. And they have existed in an infinite number of beings. Since they have spirit, they too have memory and love, and they have become richer with time, according to the individual path of each particle throughout so many beings. One of the particles of our bodies could have been in the body of Socrates, and one in the body of Jesus Christ. This reminds me of Saint Paul’s dictum that we are all part of a single body and that we are the body of Christ. And I also think that this theory, or perhaps Charon’s metaphor, is like a scientific interpretation of both reincarnation and resurrection at the same time.

The British quantum physicist David Bohm has said that everything penetrates everything else, living and non-living matter in the same way. And that it has become increasingly inadequate for us to think merely as individuals. There is a place in the universe where everything is conjoined, Bohm has claimed. For his part, the scientist and author Gerald L. Schroeder says that the union of all in the universe is due to the fact that when the universe was a single point at the time of the Big Bang, we all were together at that point, participating in that total unity without any divisions. However incomprehensible that may seem, the essence of each one of us was already present in that creation. The expansion of the universe triggered a dispersion that masked the fundamental unity of all of us.

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It has been argued that electrons do not exist but, rather, that they have a “tendency to exist.” And yet we are made up of them all! “An eccentric element of the physical world,” is the term the British physicist Paul Davies uses for particles. And we are made up of them. “We live in a universe where there is hardly any matter,” argues Natalie Angier. And Freeman Dyson notes the amazing fact that our solid world made up of stones and trees is built from quantum fields and nothing more. And Schroeder, whom I just quoted, also says that Hollywood would certainly have rejected this script as ludicrous, and yet, it is the truth.

During the Ming Dynasty, someone raised the question of whether there was a great distance between the earth and the sky. Now we can say there is less distance. In reality, there is no difference between evolution and transcendence. Evolution is the aspiration of earth to join the sky.

Computers are made from the same sand found on beaches. (From silica, which is the main component of sand.) And with this lowly sand we have calculated the size of quasars, which, being the size of the solar system, are brighter than a trillion suns and sometimes more than a hundred thousand galaxies. And we have also calculated one billionth of a billionth of the nucleus of an atom.

I find much mystical inspiration and much poetic inspiration in these scientific facts. That is why, for a while now, my poetry has fed on science. I once read in Munich fragments of my *Cosmic Canticle*, a long poem of more than 500 pages made

up primarily of science poetry or poetic science. And I quoted Wheeler, whom I've mentioned already, to the effect that a universe without life would never have been, and that a universe without an observer is not a universe. I also quoted Prosser's theory that everything is everywhere; also what Bohm says about the entire universe being in each one of its parts; what Dyson says regarding the fact that the universe knew we would one day come along; or what Sir Fred Hoyle says about the universe appearing to be a planned work; and Murchi's remark on the fact that mystical abstractions seem to be the essence of matter. It so happened that present at that reading was the director of Munich's Max Planck Institute of Astrophysics, Hermann Ulrich Schmidt, and he invited me to talk with the scientists of that Institute the next day. I believe that it was the American physicist John Archibald Wheeler who, from Berkeley, California, had informed the Institute of Astrophysics of my visit to Munich, following a reading at Berkeley. And that is why the director came to listen to me. That is how the next day I went to visit the Max Planck Institute, which is

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I spent all morning there with the scientists seated around a table, talking over coffee and cookies. We talked about the Big Bang, which one of the scientists believed had never happened; about the Principle of Entropy, which another scientist rejected; about extraterrestrials, whose existence another scientist doubted; about whether time had a real existence; about whether physics and mysticism overlapped more and more, something one of them vehemently denied; about whether we should speak of a "pluriverse" rather than a "universe," since there were many universes, and not just one. I explained to them that my criteria regarding science were not scientific, since I was not competent in that, but that they were poetic instead. Science fascinates me for the poetry and mysticism found in it—if those two things can even be distinguished.

I say the same to you now (and this almost to end my talk) regarding this scientific lecture I have come to deliver. It is scientific in the sense that it is based on scientific facts or scientific theories, but it is material that I have gathered because of the poetry and mysticism I find in it. These are short notes that I have been compiling in the course of my scientific readings, and some I have included in my poems, and others might be included in the future.

I have said that I am interested in science for its poetic and mystical qualities, but I could also mention political and economic issues, which are not absent from my poetry. I don't speak of the religious ones, because I share the view of Father Mário de Oliveira, a Portuguese theologian, who puts the following words in God's mouth: "I am not interested in religion but rather in politics" (which is nothing else than an echo of the Biblical prophets).

Following the demise of socialist regimes, which built up the hopes of almost half the world, we witness now with renewed hope the dawn of a new revolution that has begun to spring throughout the earth. It is the revolution of thousands and thousands of young people who have come together on their own and at the speed of electronic machines. With no political parties or leaders or ideologies, they meet in

a big city one day, and in another one the next. Or in all the cities of the world at the same time, to protest war, neoliberalism, and globalization, and to announce that another world is possible.

It is evolution that is creating all those men and women with an unprecedented concern for making the world a better place. It is an acceleration of evolution. And it is evolution becoming ever more conscious of itself. We are all products of one Big Bang, from the simplest subatomic particles that were the first to join together, to the most complex human societies that also continue to join together. And it would not be scientific to think that we are already the endpoint of evolution. Horses have been around for 60 million years, while man only for two million years. *Homo sapiens*, for less than one hundred thousand years, and civilization—with the invention of agriculture and the domestication of animals—a mere ten thousand years. Can we imagine what humanity will look like in another ten thousand years? And in one hundred thousand years? And in a million years? How can we then say that we have reached the end of history, or that we have reached the end of utopias?

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Evolution has periods of reversal and regression, but, afterwards, there is always a movement forward, even when evolution follows other paths.

All the hairs in our heads have been counted, said Jesus Christ. Now science tells us that the entire lining of our stomachs and intestines is replaced every three days. Could it be that someone is watching over us, someone who has been watching over us since the Big Bang? I think that it is harder not to believe that.

I began by saying that there was no scientific answer to the question about the origin of life. Once a journalist asked Einstein what the origin of matter was, and he did not say a word, but instead pointed to the sky. The German scientist who told this story ends his book *Das Molekül und das Leben* (*The Molecule and Life*) by saying that this finger pointing to the sky is the only scientific answer to the origin of life. And that is also the only answer I can give about life and about what lies beyond.