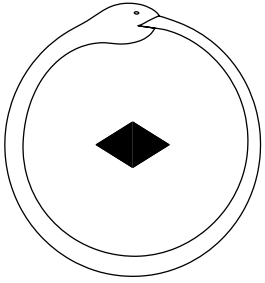




THE MARRIAGE OF
LIFE WITH THE SUN
Marcelo Gleiser



notebooks
SELVAGEM



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This notebook consists of the translation of the transcription of Marcelo Gleiser's talk about the Sun, filmed in Rio de Janeiro. Marcelo's video can be accessed [here](#) as part of the Sun Cycle, which comprises 17 talks.

What a great thing it is to talk about the Sun, because, after all, we are all solar creatures — us and all the life that exists in this planet. It is a privilege to be able to pay a little attention to our main star in the sky.

I'm going to start telling a little about the history of the Sun we know through the sciences of physics and astrophysics. The Sun is a star like so many other stars we see in the sky. And what is a star? A star is basically a ball of the simplest chemical element in the universe, called hydrogen. And what happens? You know that gravity is a force that attracts, so this ball of hydrogen is so big that it is attracted to itself and it keeps compressing.

Once upon a time, five billion years ago, there was a large cloud of hydrogen (mainly hydrogen, but not only) that suffered a certain instability. Why did the cloud suffer instability? Because another star was dying nearby and exploded. And when it exploded, it threw all the matter, which was previously contained within it, into space. All this arrived in this hydrogen cloud, like some kind of wave crashing on the beach. The cloud felt that impact, became a little unbalanced and began to collapse. And then it got denser and denser, because gravity doesn't rest, it is always working. This hydrogen cloud went on compressing. Eventually, it became so dense that the temperature inside its heart reached 15 million degrees Celsius.

And when that happened, the star was born. Why? Because when the star reaches this temperature, the hydrogen is compressed so much that it transforms into another element, called helium, which is element number two in terms of complexity. Hydrogen has one proton and

helium has two. This process is called nuclear fusion, and it is the conversion of hydrogen into helium, in the heart of the star, which generates all the energy, all the light. All the heat we feel here on Earth comes from this nuclear fusion process.

What is amazing about this story is that in this process of life and death of the star, all the chemistry of the universe is produced. And that is so beautiful. All the chemical elements that exist in the universe, the calcium in your bones, the iron in your blood, the carbon in your cells, the oxygen we breathe, all these chemical elements are formed during the life of a star and when it starts to die. Because the star is like that, right? It's kind of like us: there's a birth, there's a life and, eventually, that fuel, which is the hydrogen turned into helium, runs out and the star begins to die. And when the star dies, it dies in a huge explosion.

So, when you grab your arm, give it a pinch and ask yourself "wow, what is this?", these cells – made of carbon, hydrogen and oxygen – are the remains of stars that died more than five billion years ago. I, Marcelo, am 65 years old, but the matter from which I am made, which is actually stardust, is billions and billions of years old.

So, our history, the history of all existing living beings, is directly linked to the history of the universe. And the most beautiful thing about it all is that there is a constant dance of creation and destruction. A star is born, lives and dies. By dying, it gives reason for another star to appear, through this impact. This flow of matter goes from one star to another, and to another, as if it were a chain that spreads throughout the entire galaxy.

Four and a half billion years ago, our Sun began to be born. And the planets? Well, the planets were also born together with the Sun. It's a family: the Sun, the planets, the moons. There's the first generation, the second one and the grandchildren revolving around. There is a whole narrative there, which is the history of our solar system. Our planet Earth, Mars and Jupiter, all these other planets, are in fact remnants of matter that did not fit into the Sun. The solar system, all the planets revolving around the Sun, is what was left and did not become the Sun. All of this matter remained circulating, circulating, like water around a drain, and little by little it began to aggregate becoming planets.

Our planet Earth is the third one closest to the Sun, after Mercury and Venus. Earth is the absolutely magical planet in the solar system. Why? Because the Earth is at a distance from the Sun that allows water on the surface to be liquid. Venus, which is way too close, is 500 degrees Celsius hot, the rocks glow as if it were volcanic magma. Besides that, the atmosphere has a whole lot of sulfuric acid, it smells like rotten eggs. Venus is only beautiful when we see it from afar. There is something of poetry, the 'Morning Star', but up close it is hell itself, literally. Mars, which lies beyond Earth, is an icy, dead planet with a thin atmosphere. It's not a good place either. But the Earth is precisely in this place, in this position we call 'habitability zone'. It is where the planet is close to the star, in such a way that if life can exist, it will exist there. And Earth won the lottery.

We are on a living planet. Now, what is the driving force behind all this life? What generates the energy that drives the entire planet? Our Sun.

And look what an incredible thing, when the Earth appeared it was a big ball of magma. There were no stones, because it was so hot that they melted. But after a billion years, the Earth cooled, ocean waters covered the planet, and three and a half billion years ago, the first life emerged: a tiny bacteria.

When that occurred, the Earth was not very suitable for life, the atmosphere was terrible, there was only carbon dioxide. But then an incredible thing happened: these bacteria, after a billion years of being around, went through a mutation. They changed and accidentally discovered photosynthesis.

Photosynthesis is the marriage of life with the Sun. Through it, the Sun's radiation, the Sun's light, is transformed into energy, which allows these bacteria to metabolise food and, therefore, put oxygen in the atmosphere. Because of the Sun, the atmosphere began to be filled with oxygen. Life was becoming increasingly complex and, eventually, more complicated beings emerged, including us. 300 thousand years ago, more or less, our species emerged.

The entire planet breathes. The Sun emits all this energy that generates the biosphere cycle. Flora and fauna, for example, are incredibly interconnected. The flora receives carbon dioxide and emits oxygen,

while the fauna does exactly the opposite. We need oxygen and we emit carbon dioxide. There is a complementarity of life that transforms the biosphere into some kind of rhythm. In this exchange, flora and fauna need to talk to each other. This is the wisdom of life that comes from the Sun's energy.

Our dance is totally linked to the Sun. So, when we say that the Sun is the great life driver, that's really it. And there is more, it's not just the light and heat from the Sun that are the bridge between that star and us. Because of the nuclear fusion – that I have mentioned at the beginning and that makes the Sun shine –, in its process, particles called neutrinos are generated. They are also nicknamed the ghost particles, because they can pass through everything. Neutrinos from the Sun are passing through us now. But it's not just one that passes. There are trillions and trillions. The trillion is the number one with twelve zeros. Trillions of neutrinos per second passing by you. They are a bridge between the heart of the Sun and your heart.

And without this bridge, without this energy, the Sun would not generate the light it generates and life would not exist. So, I think it is no wonder that every morning people who practise yoga do the Sun salutation. Because without this Sun, nothing would be possible. So, thank you, Sun.

Marcelo Gleiser is a researcher and professor of physics and astronomy at Dartmouth College, author of 18 books and more than 100 articles published in vehicles such as the *New York Times*. In addition to receiving the Jabuti Prize for two of his books, Marcelo was the first Latin American to win the Templeton Prize, considered the Nobel Prize for spirituality.

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SELVAGEM Notebooks
digital publication by
Dantes Editora
Biosphere, 2024
English translation 2024

