

The Story of Us by Aysha Rahman

I'm religious. I believe I exist for a greater purpose, I believe in God, I believe that I am here to serve Him. I believe that God created everything, and that He had good reason for making me a human rather than, say, an ant, or a rock. Or a giant rock orbiting a star. Or a supermassive black hole. But still, being human, I feel kind of irrelevant. I mean, I'm tiny. Not just in the sense that I barely scratch five feet tall, but in the sense that, in respect to the universe at large, I am not so much as a speck of dust. I used to think about this a lot, and while I was satisfied with being important to myself, my head spun every time I thought about outer space and how small I was, how unimportant. It didn't bother me too much--I wasn't devastated at my relatively infinitesimal size or anything--but it was often sitting in the back of my mind, making me feel dizzy on the rare occasions I brought it to the front. My head still spins when I think about the rest of the universe, but not for the same reason. And to show you why, let me tell you a story, one with which you are probably well-acquainted.

Once upon a time, there was nothing--no things, no space, not even time. And then, there was everything. But that everything was condensed into an infinitely dense, extremely hot, extremely tiny point, a singularity. This was the result of the Big Bang, the birth of our universe.

And then a hundredth of a billionth of a trillionth of a trillionth of a second--to put it into numbers, 10^{-34} seconds--after the universe started, it began to inflate. Rapidly. It went from smaller than an atom to the size of a golf ball in almost no time at all. And then it slowed its expansion and began to cool.

A millionth of a second after the Big Bang, the forces of nature separated themselves: gravity, the strong force, the weak force, and the electromagnetic force. The Higgs field, with its signature fundamental particle, the Higgs boson, interacted with other subatomic particles and

gave everything mass. Matter became a thing, and hydrogen atoms formed. Helium atoms formed, too, from those hydrogen atoms, though it would take a while for other elements to exist, and they wouldn't be nearly as abundant. Funnily, that matter, whose amount hasn't really changed in the billions of years until today, made up only 4% of the universe. The rest was dark matter and dark energy, neither of which we fully understand quite yet. The rest of this story will mostly focus on that four percent of ordinary matter.

The universe was pretty smooth and even throughout. But not perfectly. There were clumps in the gaseous universe-soup. Slowly but surely, those clumps grew. When the universe turned about three to four hundred million years old, those clumps of gas collapsed into the first stars. They're called the Population III stars, and they were (probably) massive--possibly anywhere from a hundred to a million times bigger than our sun, which itself is a million times bigger than our Earth. Those stars died. They exploded into brilliant supernovae, expelling the new, heavier elements formed at their cores, like iron. New ones, called Population II stars, formed. They were a little more metallic, as there were actually metals in the universe, thanks to their predecessors. And when many of those stars expelled heavy metals from their cores, they would give rise to the new, metal-rich Population I stars.

Fast forward to five billion years ago. By this time, the universe was filled with stars and galaxies and galactic neighborhoods, and its rate of expansion had increased again so that everything was moving farther away from each other, faster and faster. In a galaxy with about a hundred billion others, a cloud of molecular gas sat. It was relatively uninteresting, until a rather exciting thing, or perhaps *things*, happened. Massive nearby stars exploded. They expelled their masses at rates of up to 67 million miles per hour, or 10% of the speed of light, shining brighter than an entire galaxy for just a few short weeks. These supernovae sent a shock wave through

space, through that cloud of molecular gas. That cloud was spinning about its center, which was moving faster and faster and becoming increasingly hot and dense. The supernovae around it caused the densest regions to collapse in on themselves. At the densest part, the center, a new, Population I star was born. Of course, I am talking about our sun.

The region around the sun was not empty. There was a much cooler disc of dust and gas surrounding it. Closest to the sun, the rarer, heavy metals accumulated to form little rocky objects. Beyond those, larger objects made of lighter elements formed. They would become, respectively, the terrestrial bodies and gas giants of our solar system.

In that area closer to the sun, where those small, rocky objects formed, one object in particular would become quite interesting. As other small bodies smashed into it, it grew bigger and bigger. It was also quite hot. Volcanoes formed, and they were constantly erupting. This little object, which was what we call a planet, formed an atmosphere, but it was nothing like ours today. There was almost no oxygen in it, and the volcanic fumes made the air toxic. More objects kept crashing into this planet, and many were comets. Comets contain ice, and through them, the planet accumulated water in oceans. The water here was special, though--while it was only vapor or ice on other bodies, on this planet, water was liquid. It was not so close to the sun and its heat that the water would vaporize, and it was not so far that it would remain solid ice in the extreme cold. In the words of the great Goldilocks, it was "just right." I'm not, by the way, quoting random fairy tale characters. In fact, the distance from a star where a planet can hold liquid water is called a Goldilocks zone, and this planet was smack-dab in the middle of such a zone.

This just-right planet was the Earth. It was also just right for organic compounds to form. About 3.6 billion years ago, the first life, simple single-celled organisms, arose from these organic compounds. A short two hundred million years later, photosynthesis-performing

cyanobacteria came about. They slowly infused the Earth's atmosphere with oxygen, and life continued to grow in its complexity. It took 3 billion years from the formation of the first life forms, but eventually, life on Earth evolved into animals. And only 200 thousand years ago, a really cool species of animal appeared. That species developed complex social organizations and civilizations and employed simple tools in their daily lives. Those simple tools evolved into much more complex technologies, and eventually these animals that took so long to form on the Earth traveled outside of it. They built vehicles of metal to travel over the Earth, across the oceans, in the air, and, finally, above their atmosphere as they looked to the stars. And among those animals are you and me because this species was homo sapiens, humankind.

This is the story of us. I am a human, and I am irrelevant to the universe at large. But I am still valuable. Because for me to exist, for me to be standing here in front of you, the universe had to go through a fourteen-billion-year long, painstakingly precise process. It started with energy and subatomic particles, then hydrogen, then more elements spit out of stars. It formed our galaxy and our solar system and our planet, which gave rise to life. And then it gave birth to humankind. Humankind, so unimportant to the rest of the universe, but so important to its world. Humankind, that learned and taught and brought its collective knowledge together and used it to build complex societies and civilizations and cultures and technology. Maybe we have done awful things, maybe we don't affect the rest of the universe. But, praise be to God, we are amazing.

I want to share with you a quote by astronomer Carl Sagan from the television series *Cosmos*: "These are some of the things that hydrogen atoms do given fifteen billion years of cosmic evolution. It has the sound of epic myth, but it is simply a description of the evolution of the cosmos as revealed by science in our time. And we, we who embody the local eyes and ears

and thoughts and feelings of the cosmos, we have begun at least to wonder about our origins-- star stuff contemplating the stars, organized collections of ten billion billion billion atoms, contemplating the evolution of nature, tracing that long path by which it arrived at consciousness here on the planet earth, and perhaps throughout the cosmos." If nothing else, take away this: you are the result of billions of years of extraordinary things. You are a rare phenomenon in this universe, and you are so, so important.

To God: thank you for the wonderful experience of existence, for giving me life, and everything else. To my parents: thank you so much for loving me and caring for me in a way that never made me question my significance. It is because of you that I love myself and the universe around me as I do today, because of all the love and wonder you've instilled in me since childhood. May Allah give you only the best. To my teachers: thank you for constantly reminding me to appreciate the world around me. Your wisdom and enthusiasm have been every bit as valuable as the academic skills you have taught me. To my friends: thank you for supporting me and never letting me forget my own significance. You are more important than you will ever know. To the class of 2015: you are as fantastic as the stars that light up our skies, and I can't wait to see the amazing contributions you will make to this universe. And to everyone in this room: thank you for listening.