



Prize Winner

Science Writing

Year 3-4

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Mysteries of the Universe

by Ivan Leong

Hello, this is Astronaut Ivan reporting from the International Space Station! Our universe is a very mysterious place and we constantly seek explanations on why it appears the way it is. Let us take a look at some of my favourite mysteries of our universe.

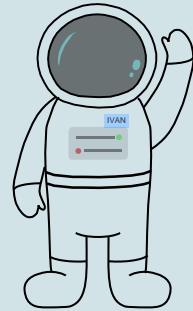


Figure 1: International Space Station (ISS)



Note: From NASA Image and Video Library
(<https://images.nasa.gov/details-s132e012208> ©NASA/Crew of STS-132)

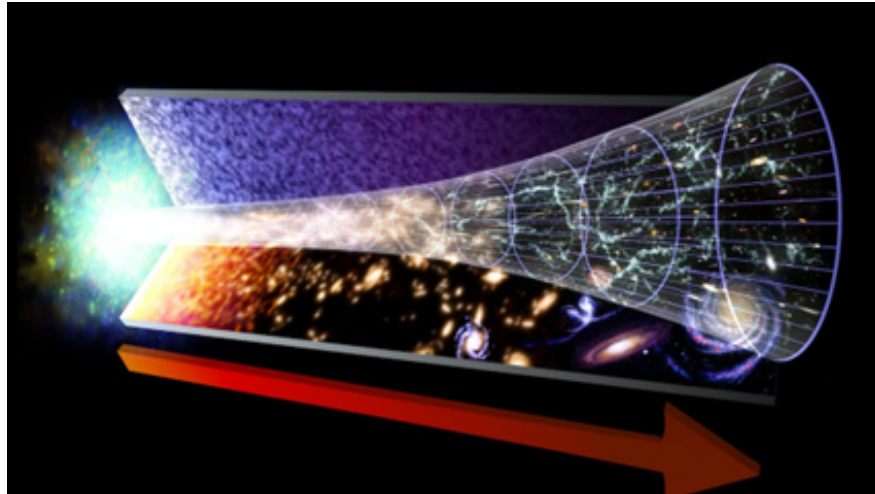
The Big Bang



It is a mystery how our universe began in the first place. 13.8 billion years ago, our universe was in a very hot and compressed state. It all started from a tiny point with immense energy and when the universe began to expand, it was what we called the Big Bang. This process led to the formation of particles and atoms, which then eventually gave us our massive universe today.

Strangely, our universe is still expanding and at an increasingly faster rate. Scientists call it inflation. However, inflation is never smooth. Variations can cause slower expansion. Some regions stopped expanding altogether and collapsed to make stars and galaxies. With our universe expanding continuously, galaxies are moving further apart.

Figure 2: Inflation of universe



Note: From *How could the Big Bang arise from nothing?*
(<https://theconversation.com/how-could-the-big-bang-arise-from-nothing-171986> ©NASA)

Dark Matter

Dark matter is an idea accepted by most scientists but no one has yet to prove it! It is made of unusual particles that cannot reflect, absorb or produce light. Dark matter cannot be seen, nor can be found using electromagnetic waves. We only know dark matter exists because of the effect on the objects around it. Galaxies behave very differently if they do not contain a substantial amount of dark matter. If it is not for dark matter, all the galaxies and bigger structures in the universe will fall apart. Using dark matter, scientists explain the observation of bending light from a source as the light travels towards an observer. This effect is known as gravitational lensing.

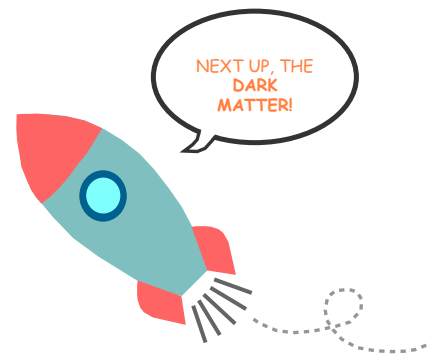


Figure 3: Bending lights due to gravitational lensing



Note: From *Astronomy Picture of the Day, A Horseshoe Einstein Ring from Hubble*
(<https://apod.nasa.gov/apod/ap111221.html> © ESA/Hubble & NASA)

Dark Energy

According to the inflation theory, our universe's expansion is accelerating. However, we also know gravitational force exists and pulls objects together. The only logical explanation of the expansion speeding up is that there is some sort of substance that repulses things, like the opposite of gravity. Scientists call this substance the dark energy. In the standard model of cosmology, scientists believe the total mass-energy content of the universe contains 5% ordinary matter, 26.8% dark matter, and 68.2% of dark energy.



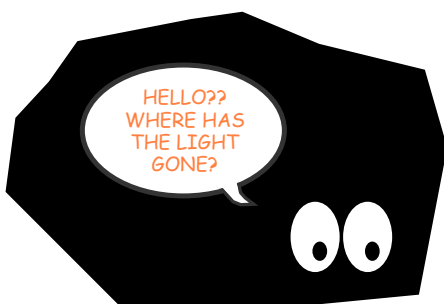
Black Holes

Black holes are created when stars that are at least fifteen to twenty times as big as the Sun end their lives and collapse. Gravity pushes them into a black hole after a huge explosion in a brilliant burst of light called supernova.

Figure 4: Black Hole



Note: From Medeiros *et al.*, *The Image of the M87 Black Hole Reconstructed with PRIMO*, *The Astrophysical Journal Letters*, Volume 947, Number 1 (<https://iopscience.iop.org/article/10.3847/2041-8213/acc32d>)



A black hole is so dense and its gravity so strong that it draws everything inside. Even light travelling at $3 \times 10^8 \text{ ms}^{-1}$ cannot escape from it.

The middle of a black hole is normally known as a singularity. Matter getting pulled into the black hole needs to 'queue', as not everything can fit in it at once. The waiting matter forms a sort of light in a circle called an accretion disc. The matter in the accretion disc circles around the singularity until its turn to get pulled into the singularity. Then it gets stretched before finally falling in.

Figure 5: Black hole swallowing stars!



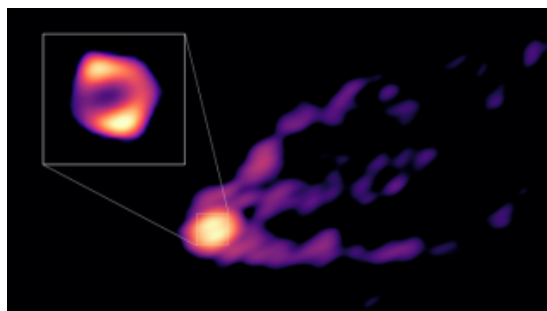
Note: From *Black holes caught in the act of swallowing stars*
(<https://www.science.org/content/article/black-holes-caught-act-swallowing-stars> © NASA)

We can see things because light is reflected from them. Since black holes draw in light, that is why they appear black. The only way to find black holes is to use X-rays. There are about ten million or even a billion black holes in our galaxy alone!

There are three types of black hole, stellar, supermassive, and intermediate. Supermassive black holes are the largest, weighing in at about a million solar masses (one solar mass equals the mass of one sun) or more. Intermediate black holes are within one hundred and one hundred thousand solar masses. Stellar black holes are the smallest, weighing only five to several tens of solar masses.

Did you know that you can get out of a black hole? If a black hole comes by and pulls you in, it will slowly leak your atoms out. Well, if you can survive the stretching and have a few billion years to live, then you could get out alive in the form of radiation...

Figure 6: Black hole spewing



Note: From eso2305 — Science Release, *First direct image of a black hole expelling a powerful jet*
(<https://www.eso.org/public/news/eso2305/>)

Planet Earth

So far, Earth is the only planet in the entire Universe known to have life. We are extraordinarily lucky to have Earth.

Figure 7: Beautiful Earth

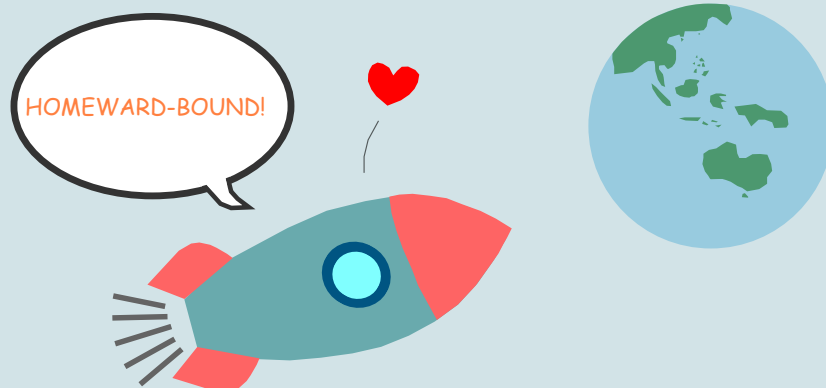


Note: From *History of the Blue Marble*
(<https://images.nasa.gov/details-s132e012208> ©NASA)

Earth is located in the 'Goldilocks Zone', which is a habitable zone with the right temperatures for water to remain in the form of liquid. Without liquid water, there is no life! In our Solar System, no other planets have the right conditions for living things to survive. With the extreme hot or cold temperatures in the other planets, living things cannot exist. Our planet Earth is located at the right distance from the Sun, which gives the right amount of sunlight and warmth. Together with water, oxygen and the right atmosphere, they provide all the conditions that are just right for living things to thrive. Meanwhile, scientists continue to look for other living extra-terrestrials or even simple microbes in the 'Goldilocks Zone' of other stars, but so far none is found and there is no place like our beautiful planet Earth.

Our universe is full of mysteries. Perhaps one day we will find answers to these mysteries, or maybe even more mysteries will appear.

Alright, time to get back to Earth. Goodbye for now!



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