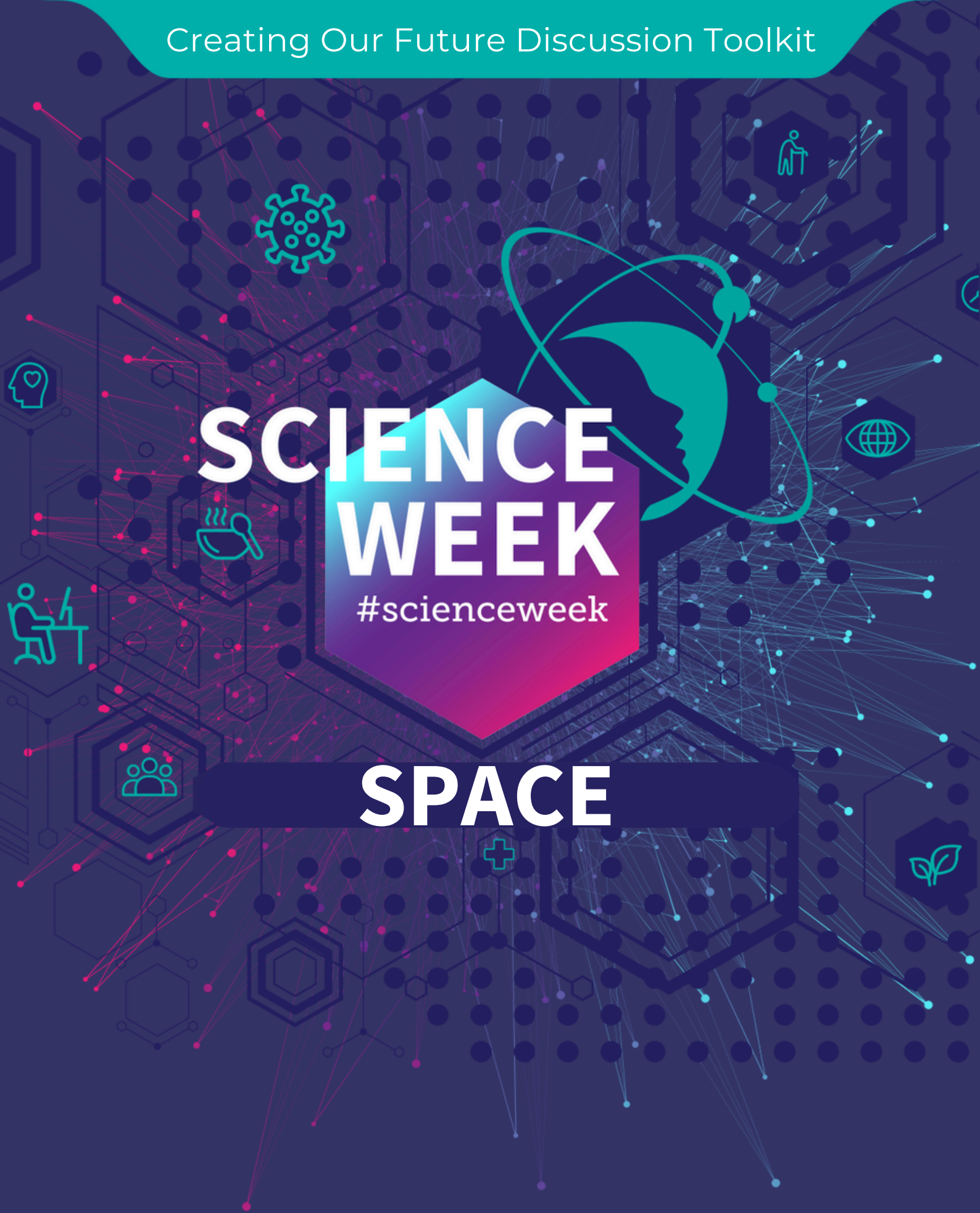
Creating Our Future Discussion Toolkit



SPACE

Ireland esero

Taighde Éireann
Research Ireland

CREATING OUR FUTURE

ABOUT CREATING OUR FUTURE

Creating Our Future is a Government of Ireland campaign to stimulate a national conversation between everyone in Ireland on their ideas on how to make our country better for all. While we might not always think about it, research and innovation affect nearly every part of our lives. The COVID-19 pandemic in particular has shown the importance and value of research and innovation in our lives – medically, socially, politically, and economically. Ideas are the starting point for all research and innovation. Anyone, anywhere, can have an idea that inspires research and innovation. It could be based on an opportunity or challenge that someone has identified in their own life, for their community, for Ireland or for the world. Or it could be based on a topic that someone is curious or passionate about.

Creating Our Future wants to hear them all – in particular from our young people. All ideas will be captured and will help inform the future direction of research and innovation in Ireland.

Secondary school students are invited to take part in this national conversation on research. Research carried out in the present will have an impact on your future, and you have the opportunity to have your say on research that will help to make a better future for all in Ireland.

Some of us are excited to go back to exactly the way things were before the pandemic, others have found recent times to be a relief and want to keep the changes we've experienced, others want to hold on to some of the changes but not all of them. Our impact on the environment has improved in so many ways, such as air quality, and yet deteriorated in others, such as the use of single-use plastics. Remote working is the new norm for a significant number, this has directly impacted on quality of life in the positive and the negative for so many, for others it has resulted in a serious hit to livelihoods as footfall in office areas drop. Throughout this journey, the public has been largely united in turning to science for the data to inform decisions for today, and to bring hope for tomorrow.

Use these discussion toolkits in the weeks leading up to Science Week to debate and discuss STEM topics with your class that will affect our future, from changes in the fashion industry to using technology to enhance our cities and communities.

During Science Week, submit your own idea to creatingourfuture.ie to help researchers in Ireland to create a better future.

This toolkit provides background and discussion stimulus on the topic of space, including space exploration, space flight and satellites. You'll also learn about the ways in which we currently can observe the universe and some factors that may put this at risk in the future.

There are video and news sources linked throughout the document to help stimulate the conversation.

INTRODUCTION AND BACKGROUND

The future of Space: Satellites and Space Science

Our fascination with space – whether it focuses on colonising distant planets, using satellites for profit or educational purposes, or unpacking complex weather patterns – shows no signs of slowing down. One of the largest growing sectors in space is in satellite technology, machines that are launched into space and move around Earth or another body in space. The first artificial satellite to orbit Earth was Sputnik 1, launched into an elliptical low Earth orbit by the USSR on 4 October 1957 as part of the Soviet space program. A great deal has changed in the past 60 years. Soon after Sputnik's launch, the military realised that spacecraft would be great for reconnaissance – spysats. These are now commonplace. Satellites have offered great benefits for ordinary people, too. Unique data from satellites are essential for understanding and monitoring our environment, and are increasingly important for daily applications. But with this exponential growth and reliance on satellites, there are other aspects of the satellite industry that may impact the planet negatively.

Satellites orbit Earth in three distinct regions about the planet: Lower Earth Orbit (LEO), Medium Earth Orbit (MEO) and Geostationary Earth Orbit (GEO). LEO satellites occupy the lowest orbit of all satellite types, often between 800 – 1,600 km above the surface.

This proximity to Earth makes them ideal for very high speed, low latency communications, often exhibiting a delay of just 0.05 seconds. A record number of satellites were launched into space in 2020, driven by the deployments of LEO broadband constellations. Companies are placing satellites into orbit at an unprecedented frequency to build 'mega-constellations' of communications satellites in Low Earth Orbit (LEO). These mega constellations would guarantee network coverage anywhere in the world, which has benefits for developing countries. In two years, the number of active and defunct satellites in LEO has increased by over 50%, to about 5000 (as of 30 March 2021). SpaceX alone is on track to add 11,000 more as it builds its Starlink mega-constellation and has already filed for permission for another 30,000 satellites (You may have read about this previously in our Smart Communities toolkit). Others have similar plans, including OneWeb, Amazon, Telesat, and GW, which is a Chinese state-owned company. The current governance system for LEO, while slowly changing, is ill-equipped to handle large satellite systems.

Medium Earth orbit (MEO) satellites orbit at a lower altitude than GEO, usually occupying the space between 5,000 and 12,000 km. Their relative proximity to Earth means they achieve far lower latency than GEO units, making them suitable for high-speed telephone signals and similar missions. Geostationary Earth Orbit (GEO) satellites, also sometimes called geostationary satellites, orbit at around 35,000km above the surface, they move at the same velocity as the Earth and on a path that is parallel to the Earth's rotation. As such, they appear to be stationary in the sky.

The use of data from satellites now constitutes the most lucrative sector of the space industry, that is, jobs on the ground, not in orbit. ESA's suite of Earth Observation satellites programmes help us monitor our planet as well as help shed new light on societal and economic changes currently taking place owing to the coronavirus pandemic. As a member state of ESA, Ireland has access to Earth observation data gathered by their fleet of satellites. This data is currently used for digital processing of images in Irish business, research institutes and other non-profit platforms.

Other data also helps with disaster recovery: authorities can ascertain the extent of hurricane, flood or fire damage; they can also see where roads are blocked by mudslides. Satellite farming is another valuable tool which satellites can send text messages to subscribers alerting them to adjust their irrigation based on data received about land conditions. Some developing countries have also harnessed the power of satellites. India led the way in demonstrating a space programme relevant to developing countries.

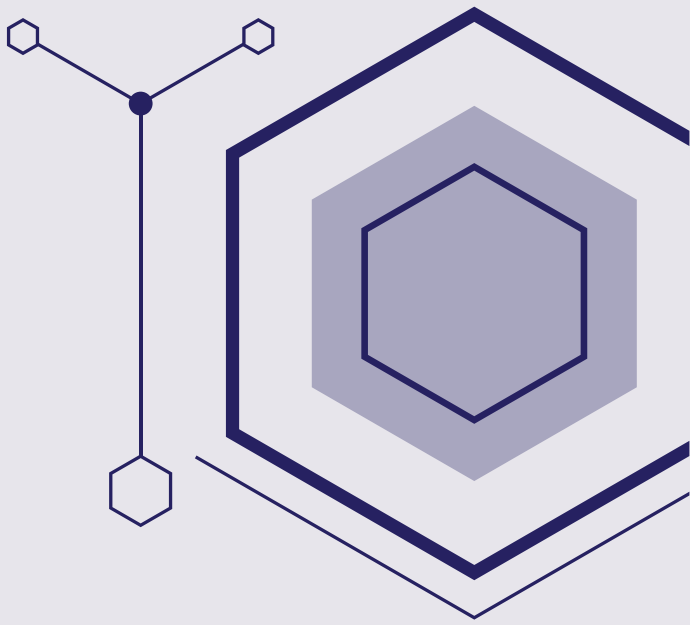
However, with this rapid increase in satellite technology, there are consequences to our planet that affect every Earth citizen. The development of mega-constellations of satellites risks multiple tragedies including tragedies to ground-based astronomy, Earth orbit, and Earth's upper atmosphere. In the past few years, astronomers have raised concerns about the growing number of satellites being launched — especially the megaconstellations. When satellites streak overhead, they can disrupt naked-eye observing and astrophotography, as well as observations by professional telescopes.

The term Space debris (also known as space junk, space pollution space waste, space trash, or space garbage) has been used to describe defunct artificial objects in space—principally in Earth orbit—which no longer serve a useful function. These include derelict spacecraft, including satellites. In addition to derelict man-made objects left in orbit, other examples of space debris include fragments from their disintegration, erosion and collisions or even paint flecks, solidified liquids expelled from spacecraft, and unburned particles from solid rocket motors.

Space debris represents a risk to spacecraft. In a recent report from ESA (September 2021) on space debris, there are 36,500 debris objects greater than 10cm to be in orbit, 1 million objects between 1cm to 10cm and 330 million objects between 1mm and 1cm.

We are living in one of the most exciting times for astronomy thanks to advances in technology challenging the way we perceive the night sky. As we look into the depths of space, we are also able to look back in time and explore how life began. In 1990, the NASA and the European Space Agency launched a telescope called the Hubble telescope which continues to orbit Earth, about 300km above us. What makes this telescope special is that it was the first telescope to be launched into space. And a telescope in space far surpasses ground-based telescopes because our atmosphere distorts and blocks the light that reaches our planet. Hubble has been observing the universe for over 31 years. It has taken over 1.5 million observations of the universe, and over 18,000 scientific papers have been published with its data. It has contributed to some of the most significant discoveries of our cosmos, including the accelerating expansion of the universe, the evolution of galaxies over time, and the first atmospheric studies of planets beyond our solar system. It is anticipated that Hubble will last for many more years and will continue making groundbreaking observations, working in tandem with other space observatories including the James Webb Space Telescope to further our knowledge of the cosmos.

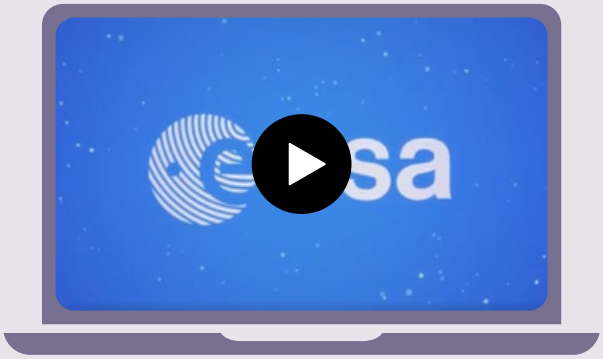
Scheduled to launch on an Ariane 5 from Europe's Spaceport in French Guiana in late December 2021, the James Webb Space Telescope (Webb) is the next great space science observatory. An international partnership between NASA, ESA and CSA, it will add invaluable knowledge about the universe. The telescope will have an aperture of around 6.5 metres and carry a suite of infrared cameras and other astronomical instruments. Located 1.5 million kilometres from Earth and held at the L2 Lagrangian point, where the gravities of the earth and sun balance, this telescope will allow us to look back into the universe like never before.



DISCUSSION STIMULUS

1. Satellites

Having watched this video from the European Space Agency, how do you think satellites impact your life every day? What do you think are the advantages and disadvantages of satellites?



Source: The European Space Agency

Further Reading

Galileo – Europe's global navigation satellite system

Read more

ESA: Observing the Earth

Read more

ESA: Earth Observation Missions

Read more

The business of satellites

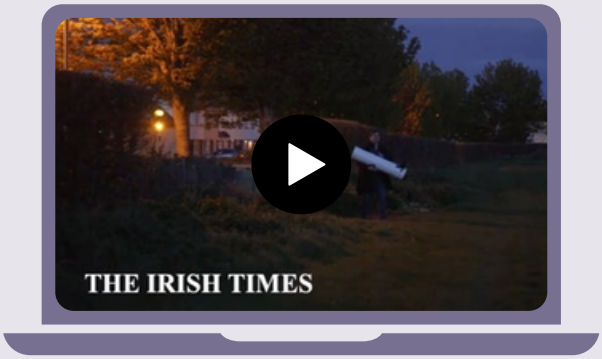
The business of Space is rapidly developing and more and more private businesses are getting involved in the sector. These businesses always seek to recoup the cost and to return a profit which places a very different emphasis on a mission in comparison to a government-led space agency. How can we better control the space satellite industry, to ensure that we protect our planet and citizens?

Read through the various Irish businesses working with the European Space Agency.

Read more

If you were to set up a business using data from satellites, what would you focus on?

Watch this report from The Irish Times about the impact of mega-constellations of satellites on astronomy and space debris:



Source: The Irish Times

How can we enforce better laws to ensure that space companies prioritise people and our planet over profit?

Further Reading
The Irish Times - Elon Musk's Starlink could take wonders of night sky away from us

Read more

Forbes – The Pros and Cons of Privatizing Space Exploration

Read more

Silicon Republic - Irish companies racked up €11.5m in ESA contracts last year

Read more

The costs of space
The cost to run the European Space Agency every year is equivalent to one cinema ticket per citizen. Some people believe that there are bigger problems to solve here on Earth? The implication is that humanity has enough to worry about, and maybe space is too expensive in light of all these issues. Others say that space exploration positively contributes to solving these problems. What do you think?

Further Reading
World Economic Forum: How many space launches does it take to have a serious climate impact?

Read more

Interactive Light Pollution Map

Read more

2. Space Science: James Webb Telescope

The mission: This video provides a summary of the launch and initialisation of the James Webb telescope after it launches later this year from ESA's spaceport in French Guiana. The telescope is scheduled to launch in December 2021.

Source: European Space Agency, ESA

Space exploration takes many years to execute- development of the James Webb telescope began in 1996 for a launch that was initially planned for 2007 but the project had numerous delays and cost overruns, and underwent a major redesign in 2005. The telescopes construction was completed in late 2016, after which its extensive testing phase began. In March 2018, NASA further delayed the launch after the telescope's sunshield ripped during a practice deployment. Launch was delayed again in June 2018 following recommendations from an independent review board. Work on integration and testing of the telescope was suspended in March 2020 due to the COVID-19 pandemic. Problems with the Ariane 5 launch vehicle have now pushed the launch date to late December 2021.

Can you appreciate why these missions take so many years to execute? If so, consider the various departments involved in a mission and the skills required to get a space mission to launch.

Science experiments on board

The Dublin Institute of Advanced studies were involved in the development of one of the four instruments onboard the James Webb telescope, the MIRI instrument. This video from ESA provides further details about the purpose of this experiment.

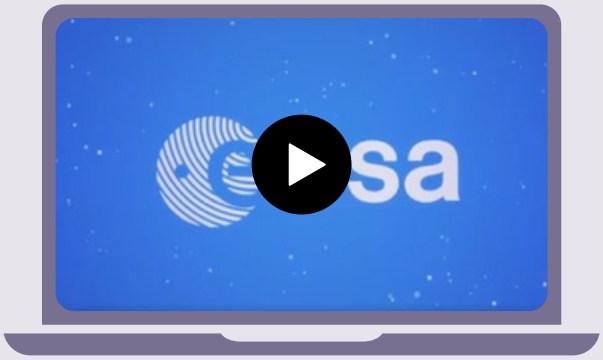
Source: European Space Agency, ESA

What do you think about Ireland's involvement in this ground-breaking telescope?

Ireland's involvement in ESA space missions

This video from ESA shares the first data received from the ESA science mission to the sun, the Solar Orbiter mission, which launched in February 2020. Irish companies EnBio and Captec contributed to the mission and Irish researchers have access to all the data and images received by the spacecraft.

What would you like Ireland to achieve in the next 10 to 15 years?

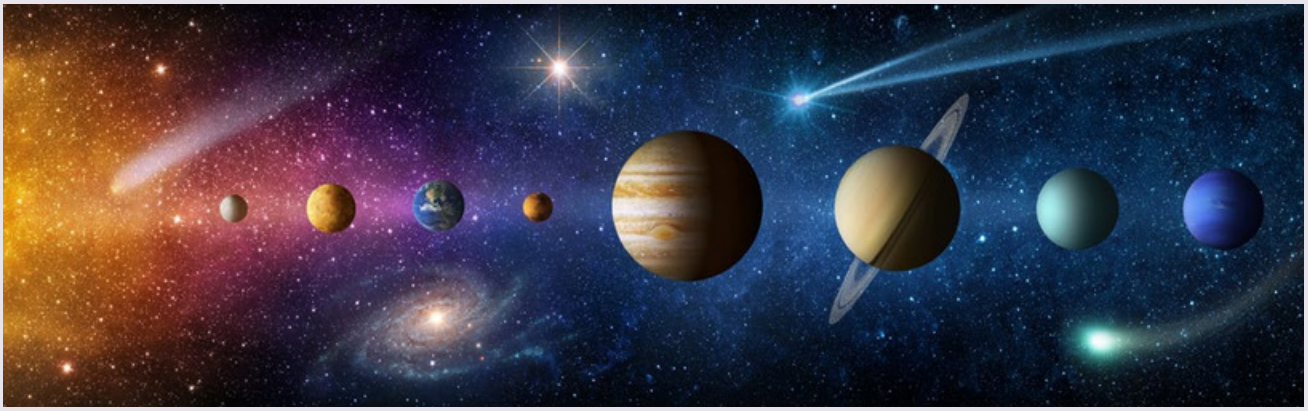


Source: European Space Agency, ESA

Further Reading

Ireland Space Policy

Read more **Read more**



Guiding Questions

a. How do you think space debris could be better managed by the private space companies as well as space agencies?

b. Do you think that it's important to provide internet access to developing countries? If so, how can we ensure that these countries pay a fair price from their internet provider?

c. Do you think that in the future we will continue to use satellites to communicate across the world? if not, what alternatives do you think might be cleaner and more environmental solutions?

d. Do you think that space can help us in solving big issues such as climate change? More specifically do you think Irish space companies can help with these issues? Why or why not?

e. We do not have equality of internet access in the world and the mega constellations of SpaceX Starlink, and other companies seek to redress this imbalance. But these providers will charge countries for this access. Do you think it is possible to have truly equal connectivity throughout the entire world?

f. Ireland is a member state of European Space Agency. Do you think that this is a well-known fact by many people? How can we better inform people about the contribution Ireland makes to space exploration?

g. Do you see any challenges/difficulties in planning and executing a space science mission?

h. How can the satellite industry and space agencies be more responsible in the protection of our planet?

Additional Resources

ESA - Space debris by the numbers

Read more

Satellite skyglow may make it impossible to avoid light pollution

Read more

UKRI - The future of astronomy: five new ways to observe the universe

Read more

ESA - Webb

Read more

ESA - Europe's role in Webb

Read more

Irish Examiner - James Webb Space Telescope to enable people to see universe 'like never before'

Read more

Dublin Institute of Advanced Studies - May 2012 – First instrument for the James Webb Space Telescope (JWST) is completed and handed over to NASA.

Read more

ESA - About space debris

Read more

Ireland's Biggest Brainstorm - have your ideas heard!

Now that you have discussed space, take five minutes to think of an opportunity or challenge you see for yourself, your community, Ireland or the world on this topic.

These can be captured in the classroom using this template and emailed to creatingourfuture@sfi.ie or if you have access to a computer lab log on to creatingourfuture.ie and submit your idea directly on the website.

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