

I BET YOU DIDN'T KNOW...

There is lightning at the edge of the Solar System

Prof. Dudley Shallcross, PSTT CEO, links **cutting-edge research** with the **principles of primary science**



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In a recent paper, scientists Karen Aplin and Georg Fischer have looked at data from *Voyager 2* and consider if it is possible for instruments based on Earth to look at lightning occurring on both Uranus and Neptune, the two ice giants at the end of our solar system.

The *Voyager 2* spacecraft that visited these two planets in the 1980s was not able to detect lightning flashes, but it did detect radio waves (similar to thunder) as it passed by. From this the scientists were able to conclude that lightning strikes on Uranus and Neptune do occur, although Neptune provided fewer instances of data.

Most people will have experienced lightning at some point in their lives. We know that lightning can be very dangerous and when lightning strikes an object, e.g. a tree or a tall building (Figure 1), it can cause a lot of damage.

Figure 1. Lightning strikes tall buildings in New York.



Questions for children to consider:

Why does lightning cause such damage?

Lightning is associated with violent storms; there is often heavy rain when there is lightning, and we can often hear thunder too. There are around 40-50 lightning flashes a second on Earth, about 1.4 billion flashes per year. However, they are not spread evenly around the Earth but are concentrated around the Equator. Here the heating from the Sun is most intense and leads to the generation of storms, through the rising of hot moist air that meets cold air above. The formation of clouds that results from the rapid updraft of air leads to ice formation, and through a process of *electrostatic charging*, this leads to regions of positive and negative charge. A lightning flash occurs when the static negative charge held in the cloud is discharged through the air to the ground suddenly. In other words, lightning is a giant discharge of electricity from the sky to the ground. This is why it is extremely dangerous to be outside in a lightning storm, as injuries caused by lightning can be very severe and even cause death.

Why do we see lightning first and hear thunder later?

Light travels much faster than sound. Sound needs a *medium* through which to travel, the sound energy being passed as a wave from molecule to molecule – it travels at around 340 metres per second in air, faster in liquids and fastest in solids. Light energy is carried by particles called photons that can travel through a *vacuum*, enabling them to travel much more quickly – around 300,000 kilometres per second. Simple experiments that children could carry out to measure the speed of sound are described in the accompanying Teacher Guide.

How does lightning support life?

Although lightning can be very dangerous, it is really important in supporting life on Earth. Plants need nitrogen to make proteins and although we live in an atmosphere that is rich in molecular nitrogen (N_2), plants cannot use this nitrogen because it requires a lot of energy to break the $N\equiv N$ (triple bonds) that occur in nitrogen gas. However, a lightning strike contains a lot of energy and can cause nitric oxide (NO) to be formed from N_2 and oxygen (O_2) in the air (Figure 2). This NO can be transformed by chemical reactions in the atmosphere to a form that plants can absorb, and when it is deposited to the ground, it fertilises the plants. Of course, there are no plants on Uranus and Neptune, but investigating the activity on planets in our solar system is important for our understanding of the Solar System of which we are a part.

Figure 2. Lightning strikes create heat energy that can break the bonds in N_2 molecules in the atmosphere, beginning the process to transform it into usable nitric oxide for plants.



The Teacher Guide that accompanies this series of *I bet you didn't know...* articles on planets includes activities that enable children to learn more about the Earth and space, the processes of science research and to develop their own enquiry skills.

Activities that are relevant to this article include:

- Calculating the speed of sound
- Investigating static electricity
- Investigating how clouds are formed

GLOSSARY

electrostatic charging

an imbalance of electric charge on the surface of a material. Inside all atoms are smaller charged particles called electrons. Electrons can move between atoms to form an electric current in conducting materials; in insulating materials, friction can cause charges to move between atoms, so some have too many and others too few electrons.

medium

any substance ('matter') that is dense enough to allow energy to be transferred through it

vacuum

space in which there is no matter

Voyager 2

Voyager 2 is a space probe launched by NASA on August 20, 1977, to study the outer planets

The paper that inspired this work was:

Lightning detection in planetary atmospheres.

By Karen L. Aplin¹ and Georg Fischer².

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