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Bringing Nobel Prize Physics in the Classroom

"Exploring Aurora Borealis through electromagnetism in primary education"

Astroparticle group

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Background information for teachers

- Knowledge of the atom's structure (atoms consist of a nucleus containing protons and neutrons, surrounded by electrons). Protons are positively charged particles and electrons negatively charged.
- What is a magnetic field.
- Know how to implement Oersted's experiment.
- What cosmic rays are.
- Knowledge of Earth's magnetic field and also of Sun's activity (solar flares, solar wind etc.).
- Knowledge of the Northern Lights (why? how? where? when?)

Overview of this lesson pack:

Name of the activity	Electromagnetism and Northern Lights
Topics introduced	Electromagnetic field, Earth's electromagnetic field, solar wind, Northern Lights (Aurora Borealis), cosmic rays
Curriculum Connection	Greece: *Science* 6th grade: chapter "**Electromagnetism**", "Thermal radiation" Also: 5th grade: chapters "The structure of the atom", "Static electricity", "The electroscope". *Art & Language* (cross-curricular approach)
Reference Demonstrator	https://www.youtube.com/watch?v=nHn5OO1t1yc https://www.youtube.com/watch?v=RqSode4HZrE https://www.youtube.com/watch?v=mgUZwoR0gcE
Age of students	11-12 years old
Duration	2 hours (90 min.)

Overview of this lesson pack:

Type of activity	Experiment in the classroom based on the inquiry-based form of learning
Description of activity	Teacher activities: a) Demonstration and implementation of Oersted's experiment, b) Motivating students to think and talk about the effects of an electromagnetic field and what happens when cosmic rays interact with Earth's electromagnetic field Student activities: a) Discuss and write down their conclusion from Oersted's experiment, talk about electromagnetic fields and b) use the newly acquired knowledge to discuss about Earth's electromagnetic filed and how it can be affected from cosmic rays and specifically solar activity
Equipment requirements	Materials for Oersted's experiment (magnetic needle or compass, insulated wire, 1,5 Volt battery), PC with internet connection, projector.
Prior knowledge for students	Knowledge of the atom's structure (consists of protons, neutrons and electrons), cosmic rays (radiation coming from outer space).

Background and overview of the “Aurora Borealis”, “Magnetic forces and magnetic fields” and “Magnetic reconnection” demonstrators:

The “Aurora Borealis” demonstrator describes the natural phenomenon of Aurora, which occurs when charged particles originating from the plasma emitted by the sun (solar wind) interact with Earth’s magnetosphere. It explains that solar wind can disrupt satellites and can be harmful for astronauts but Earth is protected by its magnetic field. The electrically charged particles which strike the atmosphere excite the oxygen and nitrogen atoms, causing them to light up in the beautiful colors of an Aurora. Finally, it encourages students to discuss about the places where we can see the Northern Lights and express their ideas about what happens in other planets.

Video: https://www.youtube.com/watch?v=nHn5OO1t1yc

The “Magnetic forces and magnetic fields” demonstrator explains that when a charged particle moves through a magnetic field, a force on the particle can occur. Students can see a beam of electrons inside the cathode ray tube, which is filled with argon gas (that’s why the beam is visible). After bringing a magnet near the beam, the beam deflects which shows that there is a transverse force due to the magnet on the moving electrons. Therefore, students will discuss the result of the interaction between charged particles and a magnetic field and hopefully, get a better idea of how and why Aurora occurs.

Video: https://www.youtube.com/watch?v=RqSode4HZrE

The third demonstrator, “Magnetic Reconnection” shows how the solar wind causes the magnetic field of the Earth to be drawn into a giant teardrop shape, squashed on the side closest to the sun and drawn out into a long tail on the side farthest from the sun. The magnetic field in the near-Earth region shrinks rapidly, accelerating the charged particles toward Earth. Some follow spiral paths along the magnetic field lines connecting the north and south magnetic poles to the upper edge of Earth’s atmosphere. The aurora light occurs when the charged particles collide with atoms and molecules of gases in the Earth’s upper atmosphere. This video can help students have a better picture of how this is happening.

Video: https://www.youtube.com/watch?v=mgUZwoR0gcE

Exploring Aurora Borealis through electromagnetism in primary education

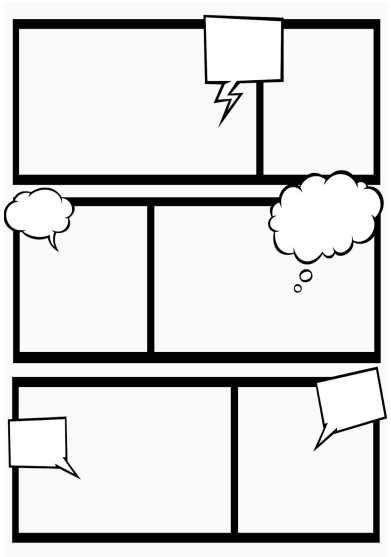
- What do you think we see in the pictures? (brainstorming)
- Give your title!

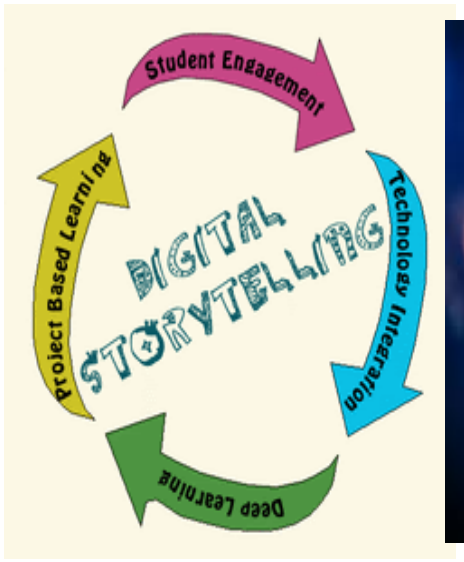
Travelling thousands of years back in time…

Imagine you live near the Arctic Circle long before scientists explained the Aurora Borealis phenomenon.

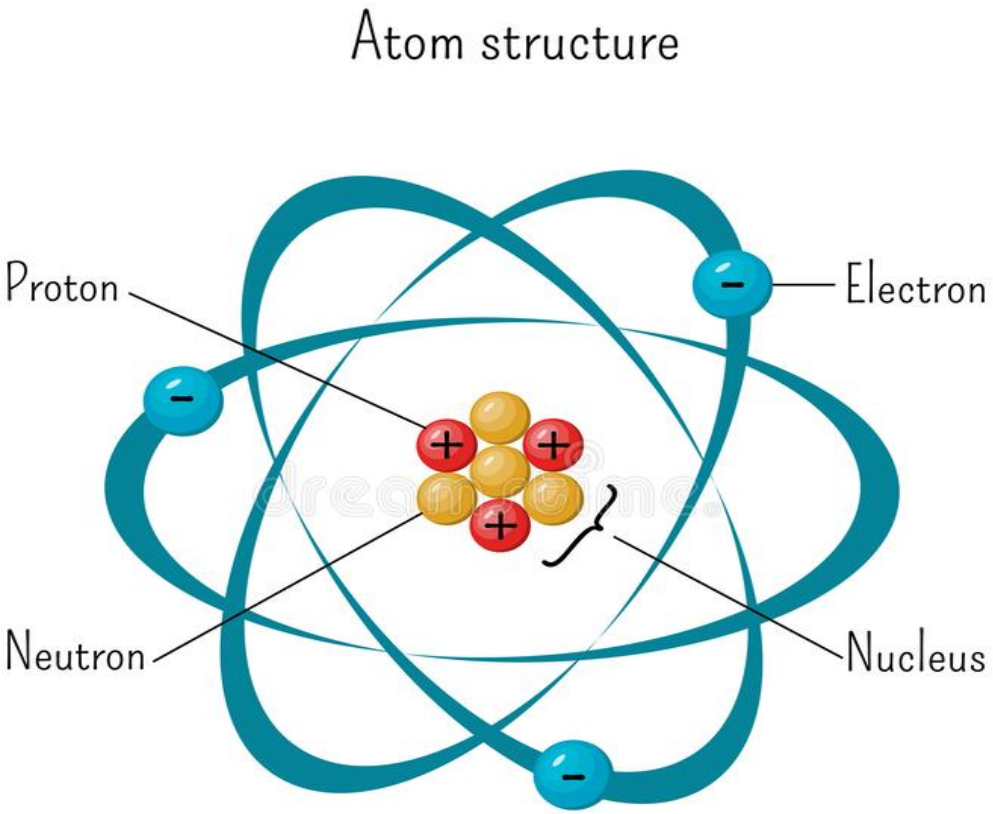
Write the myth of your tribe explaining what you see in the sky.

Choose a way to present it:

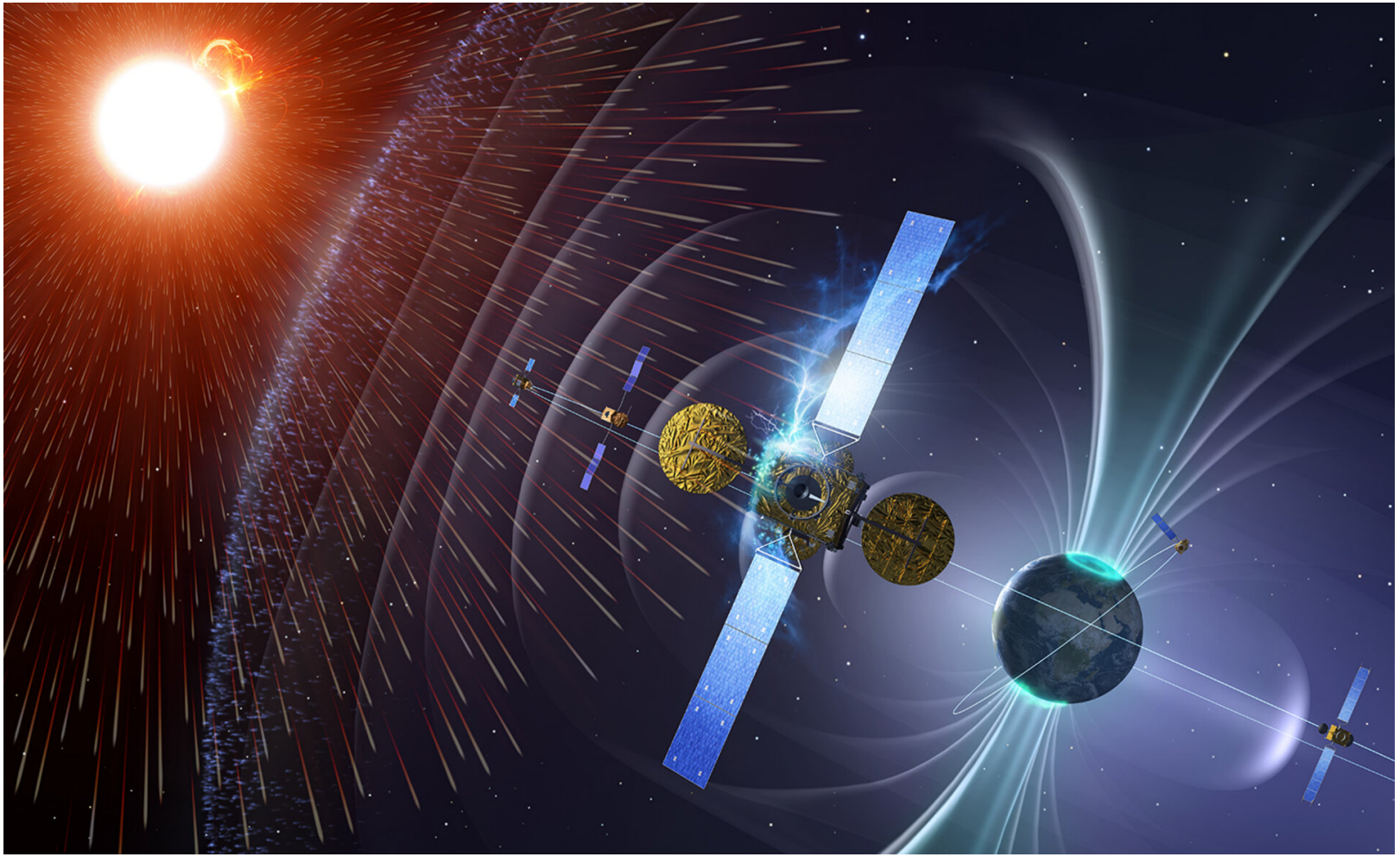




Returning back in 2021, let's make sure we remember that…



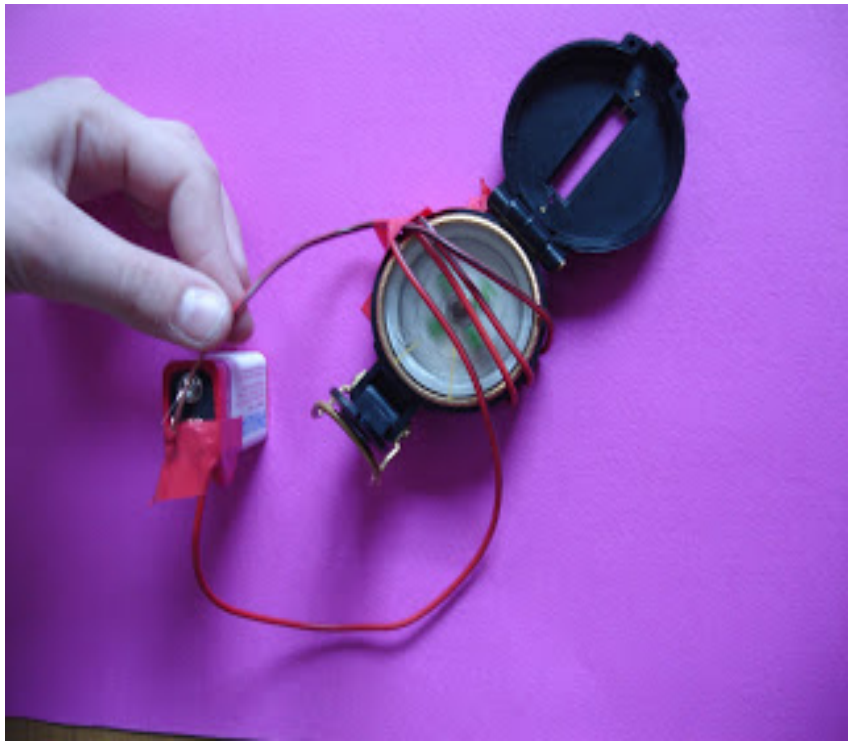
…and that…



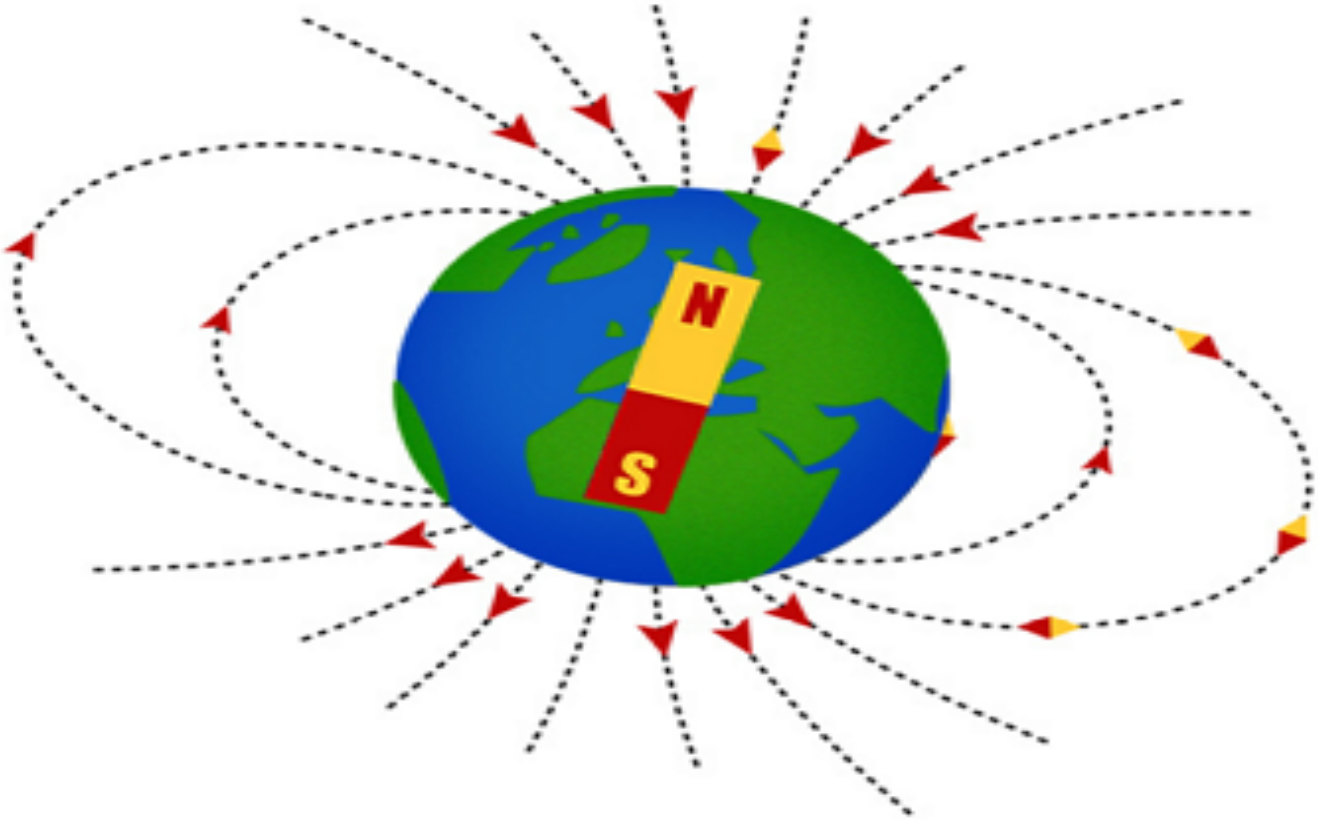
Let’s see what Oersted found out!

Materials

- magnetic needle or compass
- insulated wire
- 1,5 Volt battery
- tape

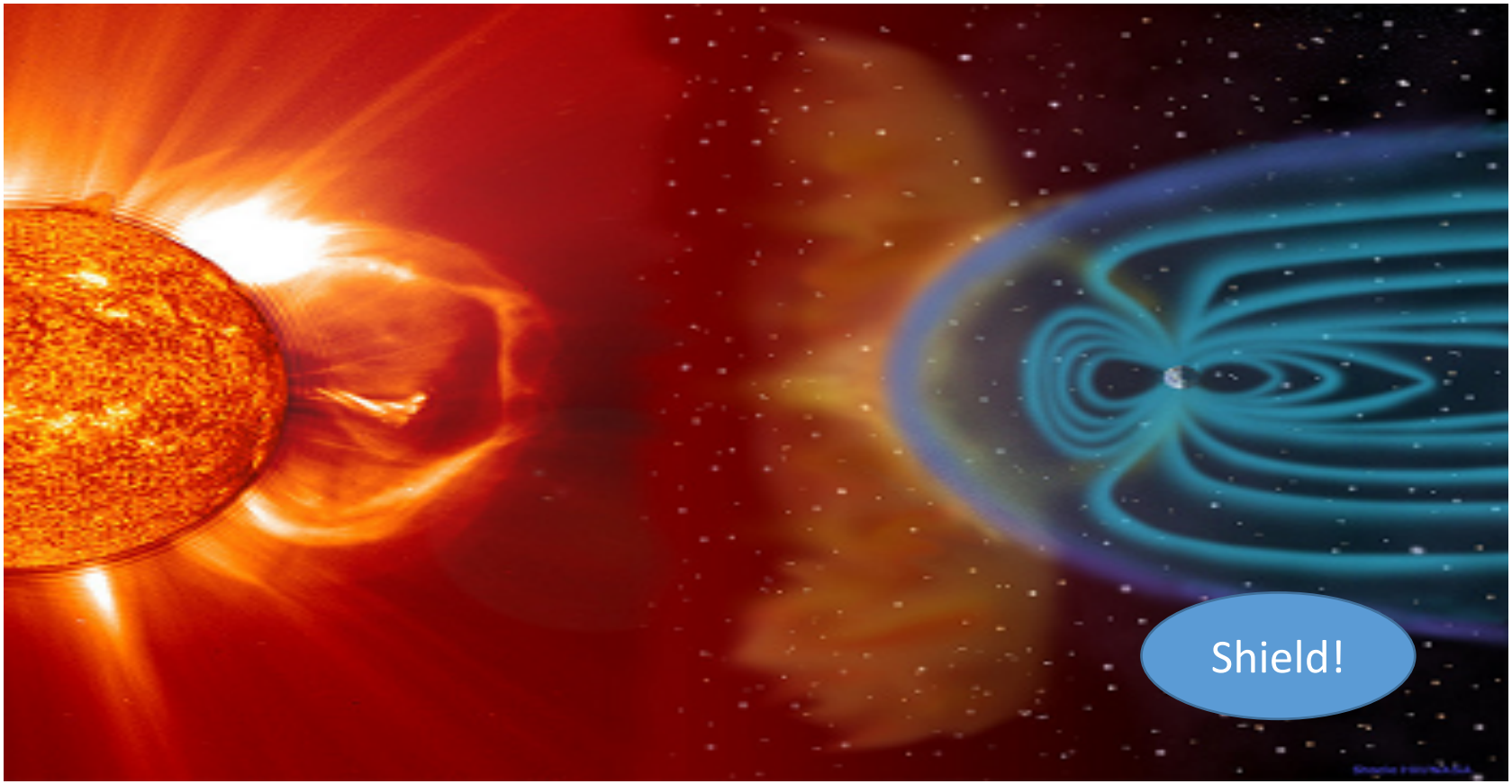


What do you observe?

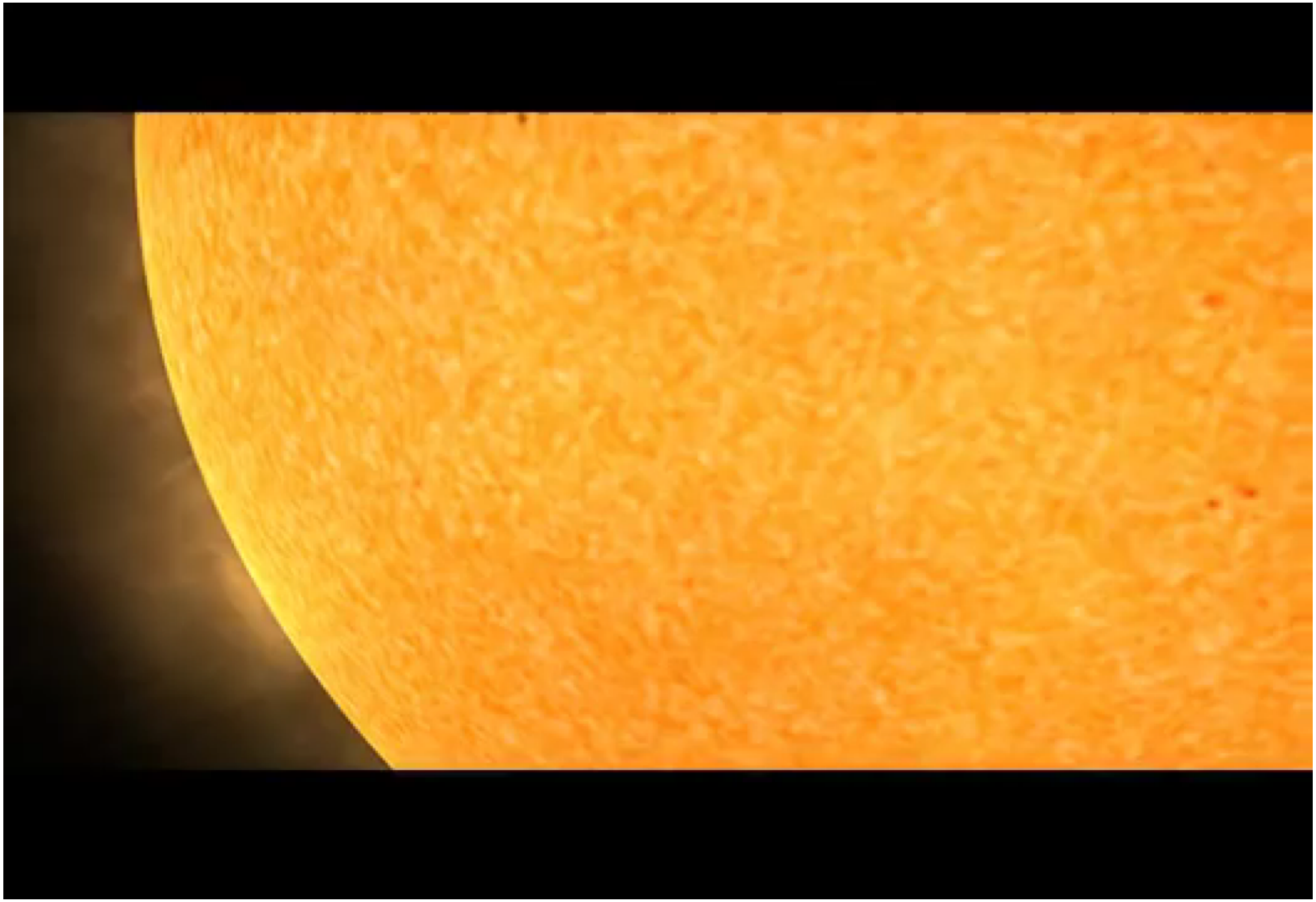


Earth has a molten iron core that rotates quickly, turning it into a giant magnet. We can imagine the magnetic field like a huge bubble surrounding earth, protecting it from dangerous radiation.

An epic battle!



Highly energetic, charged particles carried by the solar wind - bits of plasma, shot out from Sun's corona into space and heading towards the Earth!! https://www.youtube.com/watch?v=mgUZwoR0gcE



Construct your own "Aurora Borealis" paintings!

Pastel Aurora from NASA

https://spaceplace.nasa.gov/pastel-aurora/en/

Imagine you are a journalist preparing your ***questions*** *for a scientist that will visit your school to talk about Aurora Borealis!*

For your time and attention!!!