Solar Slingshot Game

How does space weather effect Earth?

Age: 10 +

Activity Time: 2 min

Prep Time: 20 min

Summary

Participants act as the Sun, using a slingshot to send foam balls representing coronal mass ejections (CMEs) soaring through the solar system towards the Earth. Every time a CME successfully impacts the Earth, it counts as an aurora. In the modified version, the CMEs and Earth are magnetized and the participant throws the CME from a few feet away, attempting to get it to stick to the pole of the Earth.

Objectives

- Participants learn that CMEs are physical material ejected from the surface of the Sun and are distinct from solar flares.
- Solar flares are bursts of light that are sometimes emmitted with CMEs.
- CMEs take 1-3 days to reach the Earth, unlike solar flares which arrive in 8 min.
- Not all CMEs reach the Earth.
- The CMEs that do reach Earth cause aurorae and can disrupt satellites.

Materials

Slingshot Activity:

- ❑ Foam balls
- ❑ Slingshot
- ❑ Safety goggles
- ❑ Foam ball representing Earth (alternative: draw or print Earth on paper)
- ❑ Permanent marker (optional)
- ❑ Paper clips
- ❑ Tape
- ❑ Scissors

Add for Modified Activity:

- ❑ Eight ¼ " round neodymium magnets
- ❑ 8" alnico bar magnet or other strong magnet

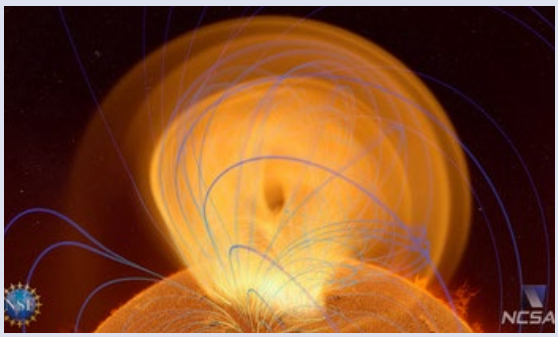
SAFETY NOTE:
Even with soft projectiles, slingshots can impart considerable force! Use the safety precautions listed for the slingshot activity, or use the modified magnetic activity to ensure that your activity is safe.

Science Background

A coronal mass ejection, or CME, is a large blob of charged solar material and magnetic field that is ejected from the surface of the Sun out into space. CMEs frequently originate in areas of the Sun where there is lots of magnetic activity, such as a sunspot or a filament.

CMEs are frequently associated with solar flares. Solar flares are bursts of light and energy, so they travel at the speed of light. Coronal mass ejections are made of particles, and therefore move slower than the speed of light. They still move pretty fast, around 1000 km/s, and are able to reach the Earth in 1 to 3 days.

The light from any solar flare that occurs on the Earth-facing side of the Sun will always reach the Earth, since light is emitted in every direction. CMEs, which are made up of particles and magnetic fields, are emitted directly away from the Sun's surface and travel outwards in one direction. The CME will only hit Earth if it is in the direct path. The Earth takes up only 1/2 of one degree of the 360 degree field into which a CME can be emitted. For this reason, the energy from solar flares can more easily impact the Earth.



Solar Flares and CMEs can have a variety of effects on the Earth. If a CME hits the Earth, it can cause the upper atmosphere near the poles to be charged, resulting in the northern and southern lights (aurora borealis and aurora australis). Solar flares can cause the Earth's atmosphere to thicken (by increasing the ionization of the atmosphere) which interrupts long wave radio signals necessary for airplane travel. The CME and the energy from the solar flare can both result in excess charging of nationwide electrical grids, causing power outages. They can also have a damaging effect on satellite communication and GPS systems, rendering navigation systems unreliable.

Procedure - *Slingshot Version*

1. Create a coronal mass ejection target. Print and cut out a small image of a satellite. Unbend the outside arm of a paperclip and tape this to the back of the cutout. Stick the satellite into the side of the foam Earth and place it atop an overturned cup to create a coronal mass ejection target.

2. Use a sharpie to label your foam balls 'CME'. Draw a few '+' and '-' on the CME with permanent marker to indicate that coronal mass ejections are comprised of charged particles.

Procedure - *Slingshot Version*

3. Mark where the student representing the Sun should stand to launch their CMEs. Explain to each student that coronal mass ejections are made of charged material from the surface of the Sun that travels through the solar system and can sometimes hit Earth.

4. Have the person playing the Sun don safety glasses and ensure that the area behind the Earth is clear. Have the Sun launch all the CMEs and try and hit the Earth. Each successful hit counts as an 'aurora.'

5. Explain to the students that CMEs can interrupt satellite electronics, but that the satellites themselves remain suspended around the Earth.

Safety Note:
While the foam balls used in this activity are relatively soft, a slingshot is capable of imparting a considerable force. To prevent accidents:

1. **Each person who uses the slingshot should wear eye protection.**
2. **The area behind the target should be free of people.**
3. **An adult should be present to at all times to provide instructions and supervise participants.**

The magnetic version of this activity below can be done as an alternative.

Procedure - *Magnetic Version*

1. Cut a small hole in the bottom of the foam Earth and put the 8" Alnico bar magnet through the poles.

2. Create a magnetic CME by cutting out small holes in the surface of the foam ball and inserting a small round neodymium magnet and covering with tape. Do this for all 8 small magnets.

3. Set the Earth target up affixing to a surface at appropriate height with tape.

4. Have students stand a couple feet back and try to hit the Earth with the CME so that it sticks to one of the poles.

5. As above, explain that coronal mass ejections are made of charged material from the surface of the Sun that travels through the solar system and can sometimes hit Earth.

Watch a video tutorial of this activity on YouTube:
http://bit.ly/CMEgame

Find out more by watching our space weather webcast:
http://bit.ly/Webcast4-SpaceWeather

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