Blobs in Space
Dave
Dooling
The Traveling Gizmo Show
Poster
Blobs in Space: An introduction to space weather and satellite engineering

Blobs in Space uses a faux sci-fi movie poster and a foam head wearing sunglasses to draw learners to a serious issue: the power and communications grids that make modern society possible are increasingly vulnerable to blobs — coronal mass ejections and other space weather events — from the Sun. Blobs in Space is a hands-on activity that connects STEM concepts to the Polarimetry to Unify the Corona and Heliosphere mission. At its heart are polarizing filters, the special sunglasses that will let scientists observe how blobs evolve and then improve space weather predictions.

Blobs has three major components that can be presented standalone or as an integrated sequence. The first two have been presented at STEM events at schools and public space festivals. The third has had a limited demonstration. It builds on an earlier activity where students assembled a quarter-scale model of the New Horizons probe. The entire activity is designed with blind/visually impaired (BVI) students in mind. It also addresses a number of perceptions, such as space being empty or satellites having the fire thrusters to stay in orbit.

This multi-disciplinary approach complements grade 1–5 Next Generation Science Standards, including:
• PS4 Waves and their Applications in Technologies for Information Transfer,
• PS1 Matter and its Interactions,
• ESS1 Earth's Place in the Universe,
• ESS2 Earth's Systems,
• ESS3 Earth and Human Activity,
• PS2 Motion and Stability: Forces and Interactions,
• PS3 Energy, and
• ETS1 Engineering Design.

Introduction covers basic solar phenomena and space weather.
1. Loops vs. Veils: Chenille sticks and tulle fabric on a ball represent coronal loops as we once perceived them and as Dr. Anna Malanushenko's vision.
2. Connect the Dots: Chenille sticks and printouts mimic sunspots and magnetic fields.
3. Solar Ribbons: A ribbon atop a chenille stick arcade represents a solar prominence. Learners twist a Slinky to mimic magnetic reconnection.
4. Turning out the lights: Learners experiment with magnets to twist plasma (a shielded UV germicidal lamp) and create the aurora (the scan pattern in an old B&W TV). Moving a magnet across wires makes a bulb glow brighter, simulating EMP effects on the power grid. A dancer's veil waved across a 2-inch foam ball (Earth) illustrates the relative scale of a CME sweeping over the magnetosphere.

How to observe the Sun covers the basics of light, waves, diffraction, and polarization.
1. A card with an embossed sine wave illustrates the wave nature of light and plane polarization of the electric vector. Craft sticks glued to form a fence mimic the conventional model of how polarizing filters work.
2. Learners observe reflection from overhead lights in small sheets of glass (4x5 pictures frames with matt black paper in back). Sunglasses show how reflection is polarized and how that depends on the angle of incidence, the heart of observing electrons in the solar wind.
3. Learners now are introduced to a model of the PUNCH nanogrid filters (aluminum tape strips on glass) and use a full-size model of the PUNCH polarization filter wheel to observe how different filter angles produce differing brightness.

Dissect a satellite is crafted like a biology class where dissecting a specimen and discussing each part's role shows how the whole organism works.
1. I start with a 12-inch classroom globe with a ring matching the PUNCH orbit. I explain how satellites stay in orbit and how we use Earth's irregular gravity to produce sun-synchronous orbits. This leads to why the PUNCH spacecraft have their particular design, including why we built four satellites rather than a single one (though this will come in the future).
2. Learners disassemble half-scale models based on CAD plans for the actual spacecraft and implemented with available materials ranging from a gift box to poster boards. Opening the top reveals components, which are removed as learners discuss how they think each is used. For example, learners handle a power drill to feel twist/counter-twist, which is used by reaction wheels (represented by wooden wheels) to control attitude. An LED bulb viewed between two pencils shows bright light diffraction that must be eliminated by baffles in front of the camera. At the conclusion, I unite the parts with an animation of the CAD model (which also reveals details that the model has to omit) and images of the flight hardware.

The author is a member of the PUNCH outreach team and has assisted in developing activities for BVI learners and presented PUNCH at several STEM events.

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