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Revealing Magnetic Fields

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Revealing Magnetic Fields

Why is Mercury so dense? Why does such an old planet still have a magnetic field? Much of what scientists know about Mercury is quite puzzling. NASA's Mariner 10 was Mercury's original visitor in 1974 and 1975, but the spacecraft saw essentially the same side of the planet on each pass, leaving scientists with even more questions. Unlocking Mercury's mysteries is crucial to understanding how the planets, especially terrestrial or rocky planets, in our solar system formed and could help scientists learn even more about Earth's planetary history.

To find some of these answers, scientists and engineers spent nearly two decades developing new techniques and designing a spacecraft with the ability to survive the extreme conditions of Mercury. This new spacecraft MErcury Surface, Space ENvironment, GEochemistry and Ranging, or MESSENGER, is made of lightweight composite materials that can withstand the extreme temperature range on Mercury's surface.

Since its launch in 2004, MESSENGER has performed flybys of Earth, Venus and Mercury. By the second flyby of Mercury, the spacecraft had imaged about 80 percent of the surface and made discoveries about how Mercury's crust was formed. In March of 2011, MESSENGER changed its pathway and became a part of Mercury's orbit. Seven specialized instruments onboard the spacecraft collect data about Mercury, including detailed information about Mercury's magnetic field.

Magnetism is a universal force of nature. Magnets attract or repel other magnetic objects. A magnetic field is the space around a magnetic material where its force of attraction, or pull, is felt. Magnetic fields are invisible, but can be detected by the interaction between the magnet and another magnet or magnetic material. Many of the planets, including Earth, Mercury and Jupiter, have magnetic fields. Instruments like the Magnetometer on MESSENGER, investigate these fields by producing a three-dimensional model of the planet's magnetosphere, or magnetic field.

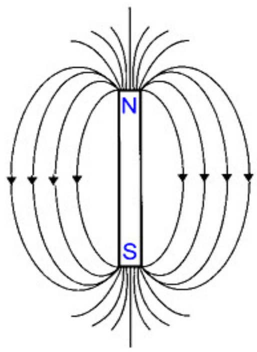
Mercury's magnetic field is thought to be a miniature version of Earth's. MESSENGER's flybys of Mercury confirmed a smaller magnetic field similar in shape to Earth's dipole field. Dipole means the magnetic field is strongest at the north and south magnetic poles, just as it is for a bar magnet.

Objective:
To observe the magnetic field around a bar magnet

Materials:

- bar magnet
- iron filings
- small, clear plastic box
- piece of white paper
- digital camera (optional)
- other types of magnets (optional)

Engage:
Ask participants to place the white paper on a flat surface. Place the bar magnet onto the piece of paper and then place the clear plastic box on top of the bar magnet. Carefully sprinkle the iron filings in the box so that the area around the bar magnet is covered. Tap the box to make the pattern appear more clearly. Observe the pattern of the iron filings. Document the patterns with a digital camera. Try different types of magnets: a circle magnet, a cow magnet, a horseshoe magnet. Compare the magnetic field patterns.



Magnetic field lines of a bar magnet with (dipole) north and south poles.

Explain:
To learn more about Mercury, MESSENGER and magnetic fields, watch the NASA eClips™ video segment, *Real World: Mercury's MESSENGER Reveals Mysteries*, which can be viewed or downloaded at: http://www.nasa.gov/audience/foreducators/nasaeclips/search.html?terms=%20%22MESSENGER%20reveals%22&category=0100&disp=grid.
This segment can be watched in high definition using the following direct link to YouTube/NASA eClips: http://youtu.be/p4KKFj8dZlw.

To follow the MESSENGER Mission, explore NASA's Eyes on the Solar System web site, a 3-D environment that uses NASA real mission data to allow the user to control time and space: http://solarsystem.nasa.gov/eyes.

Extend:
To learn more about the planet Mercury watch the NASA eClips™ video segment, *Real World: Mission to Mercury*, which can be viewed or downloaded at:
http://www.nasa.gov/audience/foreducators/nasaeclips/search.html?terms=%22Real%20World%3A%20Mission%20to%20Mercury%22&category=0000&disp=grid.
This segment can be watched in high definition using the following direct link to YouTube/NASA eClips: http://www.youtube.com/watch?v=_F7qFUmKJHE.

Ask students to build a three-dimensional model of the magnetic field they observed. How might the model be constructed? What materials might the students need? What information would scientists learn from a 3-D model that they could not learn from a 2-D image? (Examples: students may want to insert a magnet into a foam ball or suspend a magnet inside a clear plastic cup.) Additional activities may be found at the NASA Solar System Exploration web site: http://solarsystem.nasa.gov.

Additional relevant NASA eClips™ segments may be found at www.nasa.gov/nasaeclips.