Activity 17 – Soda Bottle Magnetometer and D-component

The NASA Imager for Magnetopause-to-Aurora Global Exploration (IMAGE) developed a simple Soda Bottle Magnetometer to inexpensively study changes in Earth's ground-level magnetic field during magnetic storms. The operation of this simple $5.00 instrument can be directly related to the THEMIS display measurement of the magnetic 'D-component' which indicates the east-west magnetic variation angle.

Materials:

-- One clean 2 liter soda bottle
-- 2 pounds of sand
-- 2 feet of sewing thread
-- A small 1-cm magnet

-- A 3x5 index card
-- A 1 inch piece of soda straw
-- A mirrored dress sequin, or mirror.
-- Super glue (be careful!)
-- 2 inch clear packing tape
-- A meter stick
-- An adjustable goose neck high intensity lamp with a clear, not frosted, bulb.

Resources:

Magnet Source - They offer a Red Ceramic Bar Magnet with 'N' and 'S' marked.

Darice, Inc. 1/2-inch round mirror, item No. 1613-41, $0.99 for 10.

Extensive details for construction, calibration and operation can be found at the IMAGE education website:

http://image.gsfc.nasa.gov/poetry

Procedure

1 - Clean the soda bottle thoroughly and remove labeling.

2 - Slice the bottle 1/3 of the way from the top.

3 - Pierce a small hole in the center of the cap.

4 - Fill the bottom section with sand.

5 - Cut the index card so that it fits inside the bottle

6 - Glue the magnet to the center of the top edge of the card.

7 - Glue a 1 inch piece of soda straw to the top of the magnet.

8 - Glue the mirror spot to the front of the magnet.

9 - Thread the thread through the soda straw and tie it into a small triangle with 2 inch sides.

10 - Tie a 6 inch thread to the top of the triangle in #9 and thread it through the hole in the cap.

11 - Put the bottle top and bottom together so that the 'sensor card' is free to swing with the mirror spot above the seam

12 - Tape the bottle together and glue the thread through the cap in place.

13 - Place the bottle on a level surface and point the lamp so that a reflected spot shows on a nearby wall about 2 meters away. Measure the changes in this spot position to detect magnetic storm events.

Student's Name _____ Date _____

How strong does a magnetic storm have to be before it is detectable with a simple soda bottle magnetometer?

Basic Idea:

During a magnetic storm of severity Kp = 8 or 9, the Themis data display will show large changes in the magnetic D-component. This means that, if you had a sensitive compass, you would see your magnetic bearing change by the number of degrees indicated by the THEMIS D-component display. The soda bottle magnetometer works like a compass and directly shows the change in the magnetic bearing as the reflected spot of light from the magnetic sensor card swings away from its normal quiet-time position. Depending on the severity of the magnetic storm, this deflection can amount to several centimeters or more if you are careful to set up the magnetometer correctly in an undisturbed environment.

1 - Wait for a strong magnetic deflection in the D-component on the THEMIS display, and simultaneously look for a large deviation in the light spot position on the soda bottle magnetometer.

2 - In a table, note the magnitude of the D-component deflection on the THEMIS display, and in a separate column, the number of centimeters of a soda bottle magnetometer deflection of the light spot. (Use the accompanying blank table) Provide table, and make additional copies as needed. Even better, enter the data into a Microsoft EXCEL spreadsheet!)

3 - Try to include the time of maximum D-component deviation, and include in your table the severity of this magnetic storm in terms of the Kp and Dst indices, which you can find at:

Kp today = http://www.sec.noaa.gov/rt_plots/kp_3d.html

Dst today = http://swdcdb.kugi.kyoto-u.ac.jp/dstdir/dst1/q/Dstqthism.html

4 - Correlate the Kp and Dst values for magnetic storms with the THEMIS D-component and soda bottle deflections to 'calibrate' your observations. How many degrees of soda bottle deflection equal one degree as measured by the D-component? (Hint: Draw a graph with the D-component on the vertical and soda bottle deflection on the horizontal axis and find the slope of the line through the data.)

Soda Bottle Magnetometer Data Table for

Month _____ Year _____

Sample	Day	Local Time	UT	Deflection (cm)	Degrees	THEMIS 'D' Component
1						
2						
3						
4						
5						
6						
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