The Magnetopause: Bringing Space Physics Into a Junior Lab

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Magnetopause Lab
This project describes our attempt to introduce physics students to Space Physics by using the magnetopause as the topic of a sophomore-junior physics lab. As shown in Figure 1, the magnetopause is the boundary between the region of space dominated by the solar wind and the region dominated by the Earth’s magnetic field (the magnetosphere).

Figure 1: A simple diagram of Earth’s magnetosphere.

The magnetopause is an apt topic to use to expose students to Space Physics because it can be introduced at a fairly elementary level, after which more complicated models can also be examined. This approach to introducing the magnetopause allows students to use their existing physical intuition, but also gain experience with more advanced methods.

Fitting Spacecraft Observations
Recent work on the magnetopause location has focused on fitting the spacecraft observations of the magnetopause location under various conditions to empirical expressions. In the satellite data portion of this lab, students compare predictions from Shue et al. [1998] to their interpretations of the satellite data.

3. Simulation
In this section of the lab, students run the BAT-R-US [Hansen et al., 2002] simulation on supercomputers at the Community Coordinate Modeling Center. Students find subsolar points for a dozen solar wind conditions and fit their data to equation 2.

Finding the Magnetopause Location
Students upload parameters describing variations in the solar wind conditions. They plot the simulation results and search for signs of the magnetopause in the results.

4. Spacecraft Data
In this section of the lab, students search for magnetopause crossings for three sets of data chosen from several spacecraft (Geotail, Polar, the GEOs satellites, and the L satellites) and several events.

Example: Geotail - 10/31/2003

Students have gotten reasonable results from the current lab, but there are still difficulties with:

- Finding the subsolar point in simulation results
- Help students deal with lack of certainty — the answers are not always clear.
- Interpreting ion data
- Find events where the boundary crossings are more clear in the ions.

6. Future Improvements
Students have gotten reasonable results from the current lab, but there are still difficulties with:

- Finding the subsolar point in simulation results
- Help students deal with lack of certainty — the answers are not always clear.
- Interpreting ion data
- Find events where the boundary crossings are more clear in the ions.

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