SPACE ENVIRONMENT, 2023-2024 Given: Dec. 07, 2023
Instructor: ZKaymaZ Report Due Date: Dec. 29, 2023; Time:23:59
LAB WORK-3 22 days

PURPOSE OF THE LAB WORK-3: In this Lab Work, you will learn about the magnetopause motion in response to varying solar wind pressure and IMF Bz component in the magnetosheath region using spacecraft observations.

ATTENTION POINTS BEFORE THE START:

- DATA: You will use part of the data you used for your LabWork-02.
- Reminder→LABWORK02: Students who have an odd student number will use THEMIS-C spacecraft
- Reminder→LABWORK02: Students who have an even student number will use THEMIS-B spacecraft.
- You can use any software to carry out the statistical analysis for your work such as excel, matlab, pyton, fortran, C etc.
- In your work, use data in GSM (Geocentric Solar Magnetospheric) coordinate system to plot vectoral data (Bx, By, Bz, Vx, Vy, Vz).
- Use unit of (electron-volt-eV) for temperature data for your statistics in Table-1. 1eV= 11600 Kelvin.
- Communicate frequently with the assistant/lecturer as you progress in your labwork.

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1. **Explain** what the magnetopause is in your own words. Use any diagram/figure/sketch to explain how it forms. Explain what are the signatures that you used to determine the magnetopause for your event. Explain what controls its motion.
2. **Explanation:** Magnetosheath is the region where the shocked solar wind is dominant. It is still the solar wind but its characteristics were changed at the bow shock. In this labwork, you will use the data in the magnetosheath region as the solar wind and IMF data. **NAMELY, YOU WILL ASSUME BZ IN THE MAGNETOSHEATH PART OF YOUR EVENT IS IMF BZ** and density, velocity and temperature in the magnetosheath are equal to the solar wind density, velocity and temperature. Below we will use this terminology as IMF Bz for Bz in the magnetosheath and solar wind density, velocity and temperature for the density, velocity and temperature in the magnetosheath.
3. In this LabWork, you will also assume that the solar wind comes and hits the magnetopause at the subsolar point and the magnetosheath data is taken along the subsolar line.
4. You have already downloaded the data in your LabWork-2 event. You are assumed to have the following data in your computer already: magnetic field vector (Bx, By, Bz, B_{tot}), velocity vector (Vx, Vy, Vz, V_{tot}), density, total temperature.
5. **Calculate the dynamic pressure** using ONLY the data in the magnetosheath.
6. **Calculate the magnetopause distance** (Rmp) at the subsolar point using the velocity and density data in the magnetosheath (as explained in item-2).
7. **Make stacked time series plots of** IMF Bz (shocked IMF Bz) component of the magnetic field, Pdyn and Rmp in the magnetosheath. Use unit of (nT) for Bz component, (nPa) for pressure, and (Re) for Rmp.
8. **Interpret the plot in item-7** by describing the variations you see in all panels and the reaction in Rmp in response to Bz and Pdyn. How do they change? Do you see any correlation in your data? What type of correlation can you identify? What do you expect and what do you see?
9. **Make a scatter plot of the magnetopause distance** calculated in item (6) versus dynamic pressure calculated in item-6. Plot dynamic pressure on the horizontal axis in units of (nPa) and Rmp in the y-axis in units of (Re).
10. **Interpret the plot in item-9** by describing the variations. How do they change? Is there any correlation? What can you say about the correlation between these two parameters, i.e. Pdyn and Rmp? Do you see the variations agree with the expectations from the theory?
11. **Make a scatter plot of the magnetopause distance (Rmp) versus Bz in the magnetosheath (namely shocked IMF Bz).** Note AGAIN that this Bz component in the magnetosheath will be used as Bz component of solar wind. Plot sheath Bz (shocked IMF Bz) on the horizontal axis in units of (nT) and Rmp in the y-axis in units of (Re). Insert Bz=0 line on your plot.

12. **Interpret the plot in item-11** by describing the variations. Is there any correlation? What can you say about the correlation between these two parameters, i.e. Bz and Rmp? Make your interpretations for Bz ≥ 0 and Bz < 0 separately. Compare these two cases. Is there any difference on the correlation between Bz ≥ 0 and Bz < 0?
13. **Now,** using your magnetopause stand of distance (Rmp) obtained in item-4**, calculate the auroral latitudes (Λ)** that the aurorae might occur. Use degree (°) for the latitude. Assume L is equal to Rmp at the subsolar point.
14. **Make a scatter plot of the magnetopause distance (Rmp) versus auroral latitude** obtained in item-13. Use x-axis as Rmp and vertical axis as the latitude (Lambda).
15. **Interpret your plot made in item-14.**
16. **Make a scatter plot of the Pdyn versus auroral latitude.** Use x-axis as Pdyn and vertical axis as the auroral latitude.
17. **Interpret your plot made in item-16.**
18. **Statistics: Make a Table** as you see below.

Title of your table					
	Mean	Median	Max	Min	Standard Deviation
Bz ≥ 0 (nT)					
Bz < 0 (nT)					
Pdyn (nPa)					
Rmp (Re)					
Λ (degree)					

19. **Summary and Conclusions:** Give a summary on what you have done and list your conclusions that include what you found.
20. **Learning outcomes:** List what you have learned from this labwork. Do not list your results here.
21. **Write a LAB report covering your results. In your LabReport you are expected to give the steps in RED in order seen in this sheet.** Appearance of the Lab Work report is important in the evaluation. Be neat. DO not use a separate page for the title. Write your name and student ID or any other info you want to give as header on your report. Use the attached document for your first page. Reports should be **maximum FIVE pages** in length, **not more**.
22. **Return** your report in **PDF document** by 23:59 on **Dec. 29, 2023.** You will upload your report to **Ninova**. Late returns will not be evaluated.

Please pay attention that the scanned homework or photocopied homework or homework sent by email are NOT acceptable.
