SPACE ENVIRONMENT, 2022-2023 Given: Oct. 26, 2023
Instructor: ZKaymaZ Event Date →Due: Oct. 26, 2023
LAB WORK-1 Report Date→Due: Nov. 13, 2023

PURPOSE OF THE LAB WORK-1: This Lab Work aims to introduce you the interplanetary environment (solar wind) near the Earth (1 AU). You are expected to analyze spacecraft data located at L1 location using simple statistical methods.

ATTENTION POINTS BEFORE THE START:

- Use WIND spacecraft at L1 from 1994 to 2022.
- You can use your favorite software to carry out the statistical analysis for your work such as MATLAB, python, Fortran, C etc. Do not use excel.
- In your work, use data in GSM (Geocentric Solar Magnetospheric) coordinate system to plot vector data (Bx, By, Bz, Vx, Vy, Vz). But, you must use GSE coordinates to plot the orbit in xy-, yz, xz and xR planes.
- Related web sites to obtain data:
  - Link-1: http://cdaweb.gsfc.nasa.gov
    CDAWEB-NASA→for magnetic field vector (*B), velocity vector (V), density (n), temperature (T)* data
  - Link-2: http://sscweb.gsfc.nasa.gov
    SSCWEB-NASA → for spacecraft position (x, y, z) data.
- Use unit of (electron-volt(eV)) for temperature data in Table-1 and for plotting. 1eV= 11600 Kelvin.
- Make sure there are data measurements for density, velocity, temperature. Do not use the time interval where any one of these are not available.
- **You will register your event to a google sheet prepared for Lab Work-1 and it will be checked by the assistant for any overlapping of the event dates.**
- Communicate as often as you need with the assistant until you find the correct time interval for your event.
- Below it is described how you will prepare your report **using the parts** given in **RED**.

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1. **Give the name** of the instruments you use data from. Learn about the instrument **names** and their acronyms on CDAWEb page for
   a. Magnetic field
   b. Density
   c. Velocity
   d. Temperature
2. **Select** any "**12 hours**" time interval during the operational time (1994-2022) of the spacecraft. The data that correspond to 12-hour time interval is your **EVENT** defined by the start and the end times.
3. **Screen Plotting the data:** Login to CDAWEb (link-1) and make 12-hours plot of solar wind data on your computer screen. These plots should include magnetic field (Btot, Bx, By, Bz), density, Velocity (Vx, Vy, Vz), and temperature. Horizontal axis will be Time (UT) and vertical axis will be the solar wind variables listed above. Once you make plots on screen, you will then copy-and-paste these plots on your Lab Work sheet for your report. You can get help from documents prepared on "How to use Cdaweb or SSCWeb" attached or may want to ask assistant.
4. **Register your EVENT on the google sheet.** Before you register your event, you need to make sure that anybodyelse has taken the same time interval by looking thtough the list in the google sheet. Google sheet registration sheet is given on the last page of this LabWork.
5. **Make ONE orbit plot** of WIND spacecraft in XY- and YZ-planes using link-2 (sscweb). Explore the sscweb tool. Use Manual Scaling for the axes and choose ±100 Re for y and z coordinates as maximum/minimum.
6. **Download data corresponding to your 12-hour interval** that you made the plots in item (3). The variables you want to **download** are magnetic field (Btot, Bx, By, Bz), density, Velocity (Vx, Vy, Vz) and Vtot (you will calculate Vtot yourself), and temperature. If the data resolution for any of

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these variables is higher than 1 min, then you can use average quantities for your variables. You can contact with the assistant to determine the averaging interval.

7. **Remove** data gaps and flag data from your interval before plotting. Flag Data is usually an unexpected number such as $1x10^{-31}$ issued when the spacecraft did not measure anything.
8. Make a Table indicating the statistical properties belong to your event shown below in the Table-1: **Average, Median, Max, and Min**. Components of vector quantities such as magnetic field and velocity, should be calculated both for negative and positive values separately. Namely, for example for Bx, you should calculate the statistical properties for both Bx≥0, and Bx<0. Other vector quantities should be treated the same. For scalar quantities such as Btot, Vtot, density and temperature, follow the standard way. An example of Table-1 format is given below. Use two digits after comma. However, if you have a number starting with 0, then use 3 digits after comma. For example: 0.001. **The blue colored parts** in Table 1 indicate the solar wind variables that you will plot in item-8. "X-axis scale" and "Bin size" columns are given as examples and can be replaced with those in your data range. When you construct your Table-1, you will omit these two columns (x-axis scale and BinSize columns) because they are given to help with the plotting.

Table-1: Statistical properties of Solar wind at 1 AU						This column will be omitt your Table-1 for the repor	This column will be on in your Table-1 for the r
SPACECRAFT NAME: **Type the short name of the spacecraft you use for your analysis**						This column will be omitt your Table-1 for the repor	This column will be on in your Table-1 for the r
PERIOD FROM **Type the starting day and time** TO **Type the ending day and time of your event.**						This column will be omitte your Table-1 for the repor	This column will be omit in your Table-1 for the r
	Average	Median	Max	Min	Standard Deviation	x-axis scale (numbers here are examples. You should use own data ranges.) This column will be omitt your Table-1 for the repor	Bin Size (numbers here are examples. You should your own data ranges. column will be omitt your Table-1 for the rep
Density (#/cm^3)						**0-20**	**1**
Vtot km/sec						**200 to 700**	**50**
Vx≥0 km/sec						0 to -700	50
Vx<0 km/sec							
Vy≥0 km/sec						-60 to 60	5
Vy<0 (km/sec)							
Vz≥0 (km/sec)						-60 to 60	5
Vz<0 (km/sec)							
Temp (eV)						**0 to 10**	**1**
IMF Btot (nT)						**0 to 20**	**1**
IMF Bx≥0 (nT)						-20 to +20	1
IMF Bx<0 (nT)							
IMF By≥0 (nT)						-20 to +20	1
IMF By<0 (nT)							
IMF Bz≥0 (nT)						**0 to +20**	**1 or 2**
IMF Bz<0 (nT)						**-20 to 0**	**1 or 2**
Pdyn						**0-4**	**0.2**
Pgas						0 to (0.01)	0.001
Pmag						0 to (0.01)	0.001
Cs						**0 to 100**	**5**
Mach # (Ms)						**0 to 20**	**1**

9. Calculate Pdyn, Pgas and Pmag in nPa, sound speed and sound Mach number and fill in the averages for these in Table-1 above. **Explain** how you calculated these quantities in your Lab Work report. **Compare** the pressures.
10. Create and interpret bar plots (histogram) for the quantities indicated in **BLUE** color in Table-1. The axis (x axis) scales for this plot type is given in Table-1. Pay attention and make sure that the

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plot of (positive and negative) IMF Bz should be plotted on the same panel. Namely, do not make separate bar plots for IMF Bz≥0 and IMF Bz<0. **Calculate and Add** "Ave", "StDev", "Max" and "Min" numbers for each quantity on the left or right corner of the bar plots. See also the template for this plot in the document named "SampleSheetForReport-page 4".

11. **Summary:** Give a summary on what you have done.
12. **Learning outcomes:** Give a list of what you have learned.
13. **Write a LAB report covering your results.** Appearance of the Lab Work report is important in the evaluation. **Be neat**. DO not give 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 format for your first page. Reports should be **maximum five pages** in length (no cover page), **not more**. Do not forget to remove last two columns from Table-1 (highlighted in gray) while presenting.
14. **Return** your report by **17:00 on Nov. 13, 2023** to the class assistant. Electronic submissions will not be accepted. Talk to assistant about this.
15. **The earlier you register your event, the earlier you can finish analyzing your event data and submit your LabWork report.**

REGISTERING YOUR DATE:

Enter the starting and ending times of your event using the following link by **23:59 of Nov 13, 2023.** The example of the date format is:
2021/month/day hr:min:sec, Month, Day, Hr, Min and Sec.
Example: 2022/10/18 10:00:00

Link to register.
https://docs.google.com/forms/d/e/1FAIpQLSdxaTazFBcqoMLwyP5rwFJ4PxRBhnvSSqLTpawKJuu3ge9GZw/viewform?usp=sharing

Link to check the list of registered events:
https://docs.google.com/spreadsheets/d/1BPJwTW2WGYGJ_Js-OlK-9zFMlT7EfJ4g4-R-ABYjCto/edit?usp=sharing

THESE LINKS WILL BE CLOSED BY 23:59 of Nov. 5, 2023 (SUNDAY).

IMPORTANT NOTE ON REGISTERING YOUR EVENT DATE:

a. Each student has to have her/his own event date. Make sure that the event data you register is not taken by anybody else. Otherwise your event will not be accepted and your Lab Work will be **INVALID**. It is your responsibility to make sure that the event dates are unique to you and not used by somebody else. Overlapped event dates are NOT acceptable. In case of overlapping, the "Time Stamp" in the list will be taken as a basis to resolve the conflicted dates.
b. Register your events by **23:59 of Nov. 5, 2023 (SUNDAY).**
c. **Communicate with the assistant when you have any questions or problems as you progress on your Lab Work.**

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