SPACE ENVIRONMENT | HOMEWORK-I♣
UZB411E, CRN: 12015 | **NOT COMPULSORY** | Given : Oct. 12, 2023
Instructor: Z. KaymaZ | Due : Oct. 26, 2023

Q.1. SOLAR WIND AND SOLAR ACTIVITY

(5) (a) Calculate the required time for each of the following to travel the Sun-Earth distance and compare.

(i) visible light produced in the photosphere (give your answer in minutes)
(ii) x-rays from a flare (give your answer in minutes)
(iii) Solar wind particles traveling at 400 km/s (give your answer in days)
(iv) A CME moving with a velocity of 1500 km/sec (give your answer in days)
(iv) A jet aircraft traveling at 220 m/s (give your answer in years)

(5) (b) It takes a photon produced at the center of the Sun to reach the surface in about $2x10^5$ years. How long does it take this photon to travel the same distance in free space? Explain why these two differ by such a large factor.

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(40) Q.2. SOLAR WIND

The mean distance from the Sun to Mercury, Venus, Earth, Mars and Jupiter are 0.39, 0.72, 1.0, 1.5, and 5.2 AU. Assume that the density, solar wind speed, and temperature **at the base of the corona** are **$28x10^4$ #/cc**, **400 km/sec**, and **$3x10^6$ °K.** Assume that the total magnetic field is given by the radial component of the magnetic field, i.e. (*Br*) and is given as 5 Gauss. Ignore Bϕ. Using these values,

(a) **Calculate** the solar wind parameters shown in the Table below for each of these planets. Show your calculations and also fill in the Table. **Assume the base of corona is the surface of the Sun**.

(b) **Make a plot** of total magnetic field (B_{tot}), number density (n) and temperature (*T*) with distance (in AU) and evaluate how these parameters change with distance in space.

	Mercury	Venus	Earth	Mars	Jupiter
Speed (V_{sw}) (km/s)					
Density (n) (#/cm^3)					
B_{tot} (nT)					
T (°K)					

(15, 5, 10) Q.3. SOLAR WIND

(a) Under the conditions given in previous question (Q2), calculate the dynamic pressure, gas pressure, and magnetic pressure at the Earth's distance.

(b) Calculate the force that the solar wind will apply on a satellite at Earth's distance that has an area of 10 m^2 facing the wind perpendicularly? Assume that upon impact, the protons reflect specularly after hitting the surface of the satellite. (modified from H.C. Ohanian "Physics").

(c) Calculate the sound speed and Mach number at the Earth's distance and decide if the solar wind supersonic or not at this distance.

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(10) Q.4. HELIOPAUSE

The heliopause is the boundary between the heliosphere (solar system) and the stellar system. This boundary is determined by the balance between the solar wind dynamic pressure and the dynamic pressure of the stellar wind. Use the initial values at the solar surface given/found in Q-2 above. Assume that the stellar wind has density of **0.5 #/cm^3**, velocity of **50 km/sec**, determine where the heliosphere ends, i.e. at what distance heliopause occurs. Give your answer in AU.

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(10) Q.5. Search Question/Brain Storm: This part tests your ability of independent research.

Do not copy from internet. Use your own words. Be concise with your answer.

a. What are Lagrangian points? Make a definition.

b. How many Lagrangian Points are there in the Sun-Earth system? Use a figure to show their locations.

c. Why should a scientist place a spacecraft at "L1" location? What is the use of it?

d. Give names of at least 3 spacecraft located at L1 point.

e. Explore ACE and CLUSTER spacecraft. Make a Table that includes their orbital characteristics including orbit (elliptical, circular, polar, equatorial etc.), their location (apogee, perigee, or altitude/distance), orbital period (in days), whether they are magnetospheric or interplanetary mission, and their scientific tasks to study the space environment. Give distances in units of Re, periods in days. **Note:** Be careful, Ace has its orbit around L1 point, not around Earth. Give your answer accordingly.

♣ *Note:*
1. *Homework returned after due date will not be accepted.*
2. *Electronic submission of Homework is not accepted. Return your homework in paper work with your handwriting.*
3. *Photocopied or Scanned homework is not accepted.*
4. ***Do not** use **COMPUTER PRINTER OUTPUTS** for your homework. Use **your handwriting**.*