國立中央大學105學年度碩士班考試入學試題

所別： 太空科學研究所 碩士班 不分組(一般生)
太空科學研究所 碩士班 不分組(在職生)

科目： 太空物理學

本科考試禁用計算器

＊請在答案卷(卡)內作答

Space Physics: Magnetosphere (50 points)

1.(a) Please explain the existence of equilibrium plasma sheet based on the particle drift motion and MHD momentum equation, respectively. (b) If a particle initially locates at 9 R_E on the equatorial plane with pitch angle of 90° and 2 keV energy, please determine a particle's energy when it moves earthward to 5 R_E on the equatorial plane by assuming that the Earth's magnetic field is a dipole field and using the adiabatic invariants. (25 points)

2.Under the ideal MHD condition, please (a) illustrate the properties in the low-beta and high-beta plasma, (b) write down the Ohm's law and explain the physical meanings. (25 points)

注意:背面有試題

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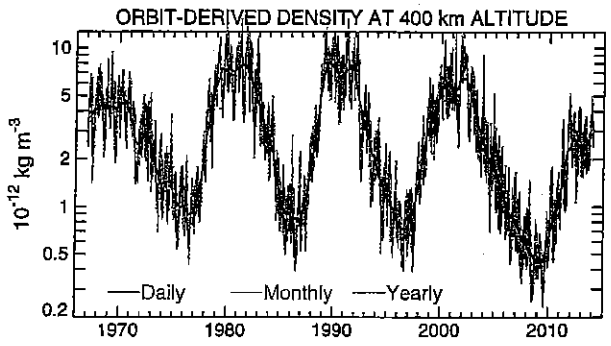
Graduate School Entrance Exam: Space Physics (Ionosphere)
50 points total. Show all calculations and explain your answers. Answers in English or Chinese are both acceptable.

Useful Hints:
Vector Triple Product: $\vec{A}\times(\vec{B}\times\vec{C}) = \vec{B}(\vec{A}\cdot\vec{C}) - \vec{C}(\vec{A}\cdot\vec{B})$

3. (25 points, Neutral Density / Solar Cycle) The following figure shows global average neutral atmospheric density measured at 400 km altitude by satellites in Low Earth Orbit from 1967 – 2013.



Answer the following questions:

a) (7 points) How does the neutral density at 400 km vary interannually? Explain the physical mechanism driving this variation.

b) (10 points) In addition to the neutral density at 400 km (ρ_{400}), the neutral density is also measured at 450 km (ρ_{450}). Derive a mathematical model for the average temperature between 400 and 450 km ($\bar{T}$), making use of ρ_{400} and ρ_{450}. What assumptions does this model make?

c) (8 points) Using the neutral density data in the figure, do you expect the ionospheric total electron content (TEC) to be higher in 2000 or 2010? Why? Name at least two reasons.

4. (25 points) Answer the following questions regarding particle motion:

a) (7 points) Assume a single particle with charge q in the presence of an electric field $\vec{E}$, magnetic field $\vec{B}$, and gravitational acceleration $\vec{g}$. The particle velocity is $\vec{v}$. Write the vector equation of motion (Newton's 2nd Law) for this particle.

b) (8 points) Assume a Cartesian coordinate system where the z-axis points upwards, while the x and y axes are in the horizontal directions. From part a), let the magnetic field be $\vec{B} = B\hat{k}$, and the gravitational acceleration be $\vec{g} = -g\hat{k}$. Would this situation correspond to the Earth's polar regions, mid-latitudes, or equatorial region? Is this the northern or southern hemisphere? Why?

c) (10 points) Solve for the steady-state velocity $\vec{v} = v_x\hat{\imath} + v_y\hat{\jmath} + v_z\hat{k}$ of this charged particle using the magnetic and gravitational field directions from Part b). Let the electric field $\vec{E} = E_x\hat{\imath} + E_y\hat{\jmath}$. What are the values of v_x, v_y, and v_z?

注意：背面有試題