國立中央大學八十五學年度碩士班研究生入學試題卷

A. 太空物理 簡答題（每題5分）

1. 試述太空物理研究的 (a) 空間範圍爲何？ (b) 介質的物理特性爲何？

2. 試分別就形成激震波 (Shock Wave) 之氣體的 (a) 壓縮性 (b) 上、下游速度變化與特性 (c) 上、下游溫度變化 (d) 上、下游亂度 (entropy) 變化，來說明激震波的一般物理特性。

3. 什麼是 the first adiabatic invarient ？ 什麼條件下 the first adiabatic invarient 才成立？

4. 什麼是太陽風 (Solar Wind) ？ 較快速的太陽風來自太陽表面的那一區域？ 試述該區域的物理特性。

B. 太空物理 證明、計算、繪圖題（每題10分）

1. Using Maxwell's equations and the Ohm's Law in magnetohydrodynamic limit (i.e., $\mathbf{E} + \frac{\mathbf{V} \times \mathbf{B}}{c} = 0$), show that MHD (magnetohydrodynamic) plasma satisfies the frozen-in-flux condition, i.e.,

$$\frac{d\Phi_B}{dt} = \frac{d}{dt}\int_s \mathbf{B} \cdot d\mathbf{a} = 0$$

where **E**, **B**, **V**, and c are the electric field, magnetic field, plasma flow velocity, and speed of light, respectively. The Ohm's Law is written in Gaussian units.

2. (a) Consider a nonuniform magnetized plasma with a large density gradient at x=0. i.e., plasma density is lower at $x < 0$, but higher at $x > 0$. If the background magnetic field is along the z-direction, please qualitatively determine the direction of electric current at $x = 0$.

(b) Apply your result to determine the electric current direction at dayside magnetopause, nightside magnetopause, plasma sheet boundary layer, and at plasmapause.

3. 簡單繪出子午面上地球磁層的結構，並標明

1. 艏 震 波 (bow shock)
2. 磁 鞘 (magnetosheath)
3. 磁 層 頂 (magnetopause) （以虛線表示之）
4. 電 漿 蓬 (plasma mantle)
5. 磁 尾 瓣 (magnetotail lobe)
6. 電 漿 片 (plasma sheet)
7. 電 漿 片 邊 界 層 (plasma sheet boundary layer)
8. 極 尖 區 (polar cusp)
9. 電 漿 層 (plasmasphere)
10. 電 漿 層 頂 (plasmapause)

C. Please state the following terminology (20%)

(i) Chapman theory
(ii) diffusive equilibrium
(iii) transition level
(iv) deviate and non-deviate absorptions
(v) ionospheric slab thickness
(vi) true height analysis
(vii) TEC (the Doppler Shift technique)
(viii) PCA
(ix) ionospheric conductivities σ_0, σ_p, and σ_c
(x) equatorial anomaly

D. (i) Use an equation to express the rate of change electron concentration in the ionosphere and derive the relationship between plasma frequency f_N and zenith angle χ in the α and β-type Chapman layers during photochemical equilibrium.
(ii) The total solar eclipse path on October 24, 1995 was near the geomagnetic equator and the maximum occurring at Taiwan was 75% and around the midday, what kind of responses could be observed in the ionospheric E, F1, and F2 regions at Chung-Li? and why?
(15%)

E. The Appleton formula can be expressed as

$$n^2 = 1 - \frac{X}{1 - iZ - \frac{Y_T^2}{2(1-X-iZ)} \pm \left[\frac{Y_T^4}{4(1-X-iZ)^2} + Y_L^2 \right]^{1/2}}$$

In the collisionless ionosphere, (i) please derive the relationship between X and Y for the reflection condition of vertical sounding; (ii) for the geomagnetic filed 0.5 gauss and a sounding frequency 4 MHz with an incident angle 30°, please calculate the refractive index and electron concentration at reflection point of the O-wave.
(15%)