

# CSI 662 / PHYS 660 Fall 2009

## Introduction to Space Weather

### Review Sheet

December 04, 2009

This is to provide a list of topics covered by the space weather class. The final exam will be based on these topics. Many topics in the list require only conceptual understanding, while the others require analytic solutions. To prepare for the final exam, you are advised to study (1) the relevant sections in the textbook (Kallenrode), (2) your class notes, (3) my lecture notes, and (4) the homework.

#### Part 1: the Sun

- The Interior Structure of the Sun
- The Atmosphere of the Sun: Photosphere, Chromospheres, Transition Region, and Corona; Temperature, Density and Structural Properties
- Sunspot; Magnetic Pressure; Plasma Beta
- Maxwell Equations
- Generalized Ohm's law
- Magnetic Induction Equation
- Frozen-in Effect
- Zeeman Effect
- Hale's Polarity Law
- Solar Cycle; Solar Magnetic Cycle; Butterfly Diagram
- Solar Differential Rotation; Tachocline
- Solar dynamo;  $\Omega$ -effect;  $\alpha$ -effect
- Magnetic Energy; Magnetic Pressure and Magnetic Tension
- Potential Magnetic Field; Force Free Field
- Coronal Heating
- Flares; Temporal Evolution; Spectrum
- Magnetic Reconnection
- Magnetic Diffusion Time
- Conceptual Flare Model
- CMEs; Halo CMEs; Streamers; Coronagraph
- Conceptual CME Model

#### Part 2: the Heliosphere

- Solar Wind; Slow Wind; Fast Wind
- Hydrostatic Atmosphere Solution; Chapman's Atmosphere Solution
- Parker's Hydrodynamic Solar Wind Solution
- IMF (Interplanetary Magnetic Structure); IMF solutions
- Archimedean Spiral or Parker Spiral; Jetlines versus Streamlines
- Heliospheric Current Sheet
- Alfvén Wave

- Corotating Interaction Regions
- ICMEs (Interplanetary CMEs); Magnetic Clouds
- Shocks
- SEPs (Solar Energetic Particles)

### **Part 3: the Magnetosphere**

- Geomagnetic Field
- Dipole Model; L-shell Parameter
- SAA (South Atlantic Anomaly)
- Magnetopause; Stand-off Distance; Chapman-Ferraro Current
- Polar Cusp
- Polar Cap
- Magnetotail
- Bow Shock
- Magnetosheath
- Plasmasphere
- Plasma Sheet or Neutral Sheet
- Neutral Sheet Current; Cross-tail Current
- Ring Current
- Gyration Motion of Charged Particles
- Drift Motion of Charged Particles: EXB Drift; Gravitational Drift; Magnetic Gradient Drift; Magnetic Curvature Drift; Drift Current
- Magnetic Mirroring; Bounding Motion; Loss Cone Angle
- Solar Wind Dynamo
- Open Magnetosphere Reconnection Model
- Geomagnetic Substorm
- Geomagnetic Indexes: Dst, AE, AA and K
- Aurora; Aurora Oval
- (Van Allen) Radiation Belt; Inner Belt, Outer Belt
- Sources and Losses of Particles of Radiation Belts

### **Part 4: the Ionosphere**

- Layered Earth's Atmosphere: Troposphere; Stratosphere; Mesosphere; Thermosphere
- Barospheric Density Distribution; Pressure Scale Height
- Ionospheric Structure: D Region; E Region; F Region (F1 and F2)
- Chapman Profile
- Radiation Intensity Profile; Optical Depth
- Ionization Production: Photoionization; Charge Exchange; Particle Precipitation
- Ionization Loss: Dissociative Recombination; Radiative Recombination; Charge Exchange
- Radio Waves in the Ionosphere; Refraction and Reflection
- Ionosonde
- Ionospheric E (Electric Field): Polar Cap E; Polar Oval E
- Ionospheric Convection: Polar Cap Convection; Polar Oval Convection

- Source of Polar Cap Electric Field
- Ionosphere Current: Pederson Current; Hall Current: Burkeland Current
- Region 1 Current; Region 2 Current

#### **Part 5: Space Weather Effects**

- Effects on Spacecraft
- Surface Electric Charging; Deep Dielectric Charging
- Single Event Effect: Single Event Upset; Single Event Latchup
- Spacecraft Dragging
- Radiation Health Hazard; Shields
- (GIC) Geomagnetically Induced Current; Effect on Power System
- Effects on Communication; Sudden Ionospheric Disturbance (SID); Polar Cap Absorption (PCA)
- Effects on Navigation; GNSS (Global Navigation Satellite System); TEC (Total Electron Content); WAAS (Wide Area Augmentation System)