Purpose and Content:

The goal of this course is to provide an introduction to the physics of the near Earth space environment. The on-line course description is:


Since the region is predominantly filled with plasma, energetic particles, and electromagnetic energy, I will devote a substantial amount of time to a quantitative description of the behavior of single particles in the presence of electric and magnetic fields and to their collective behavior as a plasma. There will also be a focus on the topic of space weather that has received a great deal of attention lately as we move through the solar cycle maximum after an extended solar minimum.

Text:


Assessment and Grades:

Grades will be based on a combination of problem sets, two mid term and a final exam. Approximately 25% of the grade will be based on the problems sets, 20% on each of the two mid-terms, and 35% on the final exam. There will be at least one problem set that I will ask that it be your work exclusively. For a majority of the problem sets I encourage discussion but the material that you turn in should be your work and should reflect your understanding of the individual problem.

Mid-Term Exam #1 will be March 6th in class room 502

Mid-Term Exam #2 will be April 10th in class room 502

Final Exam TBD
Course Outline (not necessarily in this sequence)

Introduction: What is space physics?
1. The Role of Space Observations
2. The New concept of Space
3. An Introduction to Heliophysics

Topic 1: Plasma Physics
1. What is a plasma?
   a. Concept of number density
   b. Concept of temperature
2. Maxwell Equations
3. Phase Space Density and Differential Flux

Topic 2: The Sun
1. The Quiet Solar Atmosphere
2. The Convection Region, driver of solar activity
3. Solar Active Regions and Sunspots
4. The 11 year sunspot cycle and the role of magnetic fields
5. Coronal heating and the solar wind
6. Flares and Coronal Mass Ejections (CME)

Topic 3: The Solar Wind
1. The steady-state Solar Wind
2. Solar Wind Structure and the Heliospheric Current Sheet
3. CMEs and Interplanetary Shocks
4. The Heliosphere and Solar Wind interactions with planets

Topic 4: The Magnetosphere
1. The dipole field vs. the geomagnetic field
2. Particle motions and the trapped radiation belt fluxes
3. Single Particle Motion
   a. Motion is a static uniform magnetic field
      i. Guiding center motion
      ii. Magnetic Moment
   b. Motion is Perpendicular Electric and Magnetic Fields $[E \times B]$
   c. Drift due to a force perpendicular to the magnetic field vector $B$
   d. Gradient and Curvature Drifts
   e. Bounce Motion/Mirror Geometries
   f. Adiabatic Invariants
      i. First = Magnetic Moment
      ii. Second = Integral invariant
      iii. Third = Flux invariant
   g. The McIlwain L-shell
   h. Violation of the Adiabatic Invariants
4. Coordinates and the L parameter
5. Magnetospheric structure and nomenclature
6. The Magnetopause, Bow Shock,
7. Plasma Populations
8. Magnetospheric Convection and Magnetic Reconnection at Earth
9. Magnetospheric Substorms, Magnetic Storms, and Aurora

Topic 5. *Insitu* Measurement Techniques
1. Satellites, what they can and cannot do
2. Particle Detectors
3. Detection of Electric and Magnetic Fields

Topic 6: Selected topics (as time permits)
1. Space Weather and Satellite Operations
2. Ionospheric/Atmospheric Physics
3. Present Controversies