

AA 478/678: Space Weather

(Autumn Semester 2021)

Instructors:

Dr. Bhargav Vaidya

Dr. Rajkumar Hajra (coordinator)

Time: to be updated

Google Meet Link: to be updated

Distribution of Marks: MSE (20%), ESE (40%) Class Evaluation (40%)

TEXTS:

1. ***Physics of Space Storms*** by Hannu E. J. Koskinen

Link: <https://www.springer.com/gp/book/9783642003103>

2. ***Physics of Earth's Space Environment*** by G. W. Proelss

Link: <https://link.springer.com/book/10.1007/978-3-642-97123-5>

3. ***Physics of the Space Environment*** by Tamas I. Gombosi

Link:

<https://www.cambridge.org/core/books/physics-of-the-space-environment/CB472874EC2AB2A0937FB556355948C3>

4. ***Plasma Physics for Astrophysics*** by Russel Kulsurd

Link:

https://books.google.co.in/books/about/Plasma_Physics_for_Astrophysics.html?id=uZdwQgAACAAJ&redir_esc=y

5. ***Physics of Fluids and Plasmas*** by Arnab Ray Choudhari Link:

<https://www.cambridge.org/core/books/physics-of-fluids-and-plasmas/8A235D6F1D9DA51F05237D42BDFEFD06>

Projects: (1) Space weather probes (2) Data analysis and/or review of space weather events

COURSE STRUCTURE (Each week is 2 lectures + 1 tutorial):

- **Introduction to Space Weather (Week 1):** An overview to space weather, Size Parameters of Our Sun, Different layers of Sun, Observatories to study Sun, Solar Magnetic Structure (Maxwell's Equation), Solar Spectrum.
- **Fundamentals of Space Plasma (Week 2):** Plasma Orbit Theory, Plasma Waves, Vlasov Theory, Concepts of Ideal and Resistive Magneto-Hydrodynamics.
- **Sun-Earth Connection (Weeks 3-4):** Standard Models for Flares and CMEs, Coronal Loops, Solar Energetic Particles: Shock Accelerations, Solar Wind, Heliospheric structure
- **Introductory concepts of magnetosphere (Weeks 5-6):** Dynamo theory, Planetary magnetism, dayside magnetopause, different types of magnetospheres and mechanism, basic electromagnetism for magnetosphere, and consequences

Mid Semester Examination (MSE)

- **Earth's magnetosphere (Weeks 7-8):** Magnetospheric structure, plasma regions, current systems, concepts of ring current belts, Van Allen Radiation belts
- **Solar wind-magnetosphere ionosphere coupling (Weeks 9-10):** Physics of magnetic reconnection, MHD induction equation, concepts of frozen-in and magnetic reconnection, Magnetic Reynolds number, Dungey cycle, magnetic storms, substorms, high-intensity long-duration continuous auroral activity, geomagnetic indices
- **Ionosphere and Earth's Atmosphere (Week 11):** Properties of Neutral Atmosphere and Ionosphere, Chapman Theory, Layer Formation and Properties
- **Space Weather Measurement (Week 12):** Ionospheric Sounding Systems, Radar, Trans-ionospheric Propagation Systems, GPS.
- **Space Weather Effects on Telecommunication Systems (Week 13):** Outline of ionospheric effects, integrated propagation effects – refraction, phase and group path variation, Doppler shift, Faraday rotation, absorption, differential effects – scintillations, mitigation scheme

End Semester Examination (ESE)