SYLLABUS

PTYS/ATMO 544 – SPRING 2023
Physics of the High Atmospheres

Course Description: The study of the high atmosphere is critical to our understanding of the long-term evolution and chemistry of the atmospheres of the Earth and other planets. High atmosphere processes such as photochemistry, ionization, and atmospheric escape can shape the atmosphere as a whole and alter its evolution. A robust understanding of the physics and chemistry of high atmospheres is also important to remote sensing planetary atmospheres. The goal of this course is to develop a grasp of the key concepts and physical mechanisms underlying the thermal structure, composition and dynamics of middle and upper atmospheres of the Earth and other planets, required for further research in this area.

Time and location: Tuesday and Thursday, 12.30-1.45pm, Kuiper Space Sciences room 301

Instructor: Tommi Koskinen, Assistant professor
Office: Kuiper Space Sciences room 421
Tel: 621-6939; Email: tommi@lpl.arizona.edu
Office Hours: after class (or any time when I am in the office)
Administrative Assistant: Tabitha Rother (Room 415, tel. 621-9692)

Prerequisites: There are no formal pre-requisites for this course. I will assume familiarity with classical physics, including: mechanics, electricity and magnetism, and mathematical methods of calculus (vectors, tensors, differential equations and numerical methods).

Expected learning outcomes: At the conclusion of this course, the students will demonstrate practical knowledge required to investigate high atmosphere phenomena in greater depth and start developing and running models of the middle and upper atmosphere.

Grading: Your final grade will be based on a cumulative performance on homework, in-class project presentation and participation. The weighting of the assignments is as follows:
50% Homework assignments
30% Project presentation
20% In-class participation
The grade will reflect your final overall average according to the following scale: (A) 90-100%, (B) 80-90%, (C) 65-80%, (D) 50-65%.

Assignments and participation: Homework will be assigned as necessary (roughly every other week) to support a practical understanding of the materials covered in class. Homework assignments will be announced in class and supporting materials will be made available by the instructor. Homework will focus on practical applications and/or derivations of key concepts related to in-class materials. Late homework will not be accepted without prior arrangement and a valid reason for extra time.

Each student is expected to choose a topic for intense study that they will present to the class during the final weeks of this class. The selected topic should fall within the scope of the course as confirmed by the instructor. In-class presentations are 60 minutes in length, followed by questions. The project can consist of a research problem and/or in-depth literature review. Literature reviews should aim to identify at least a few directions for future original research.

In-class participation will consist of class attendance and participation, presenting solutions to homework problems and discussing journal articles. Journal articles will be assigned for reading throughout the course based on a bibliography that I will maintain. You are encouraged to propose papers yourself.

Course website: D2L (TBD)

Textbooks: There is no required textbook for this course. Reading assignments will consist of journal articles. In preparing for this course, I have used the following textbooks, in addition to my personal notes:

- R. W. Schunk and A. F. Nagy, *Ionospheres: Physics, plasma physics and chemistry*, Cambridge University Press. A handbook-style book, which reviews many topics.
- M. H. Rees, *Physics and chemistry of the upper atmosphere,* Cambridge University Press. A detailed exploration of the theory of the terrestrial thermosphere and ionosphere.
- T. Gombosi, *Gaskinetic theory,* Cambridge University Press. Kinetic theory from first principles, one of the best textbooks that I have read.
- M. L. Salby, *Fundamentals of atmospheric physics*, Academic Press. A standard text for atmospheric physics, including the middle atmosphere.
- J. W. Chamberlain, D. M. Hunten, *Theory of planetary atmospheres: An introduction to their physics and chemistry,* Academic Press. A classic textbook that focuses on the high atmosphere and comparative planetology.

General Policies:

Academic Integrity: For general guidelines on this, please refer to the University's code of academic integrity: http://deanofstudents.arizona.edu/codeofacademicintegrity. With regards to homework for this class, you are encouraged to work with other students; however, the work that you turn in must be your own.

Attendance: This course will adhere to the University's policies, as found in the links below. The UA's policy concerning Class Attendance, Participation, and Administrative Drops is available at:

http://catalog.arizona.edu/policy/class-attendance-participation-and-administrative-drop

The UA policy regarding absences for any sincerely held religious belief, observance or practice will be accommodated where reasonable, http://policy.arizona.edu/human-resources/religious-accommodation-policy.

Absences pre-approved by the UA Dean of Students (or Dean Designee) will be honored. See:

https://deanofstudents.arizona.edu/absences

Note that success in this course will require that you attend and participate in each class.

Threatening Behavior Policy: This course will adhere to The UA Threatening Behavior by Students Policy, which prohibits threats of physical harm to any member of the University community, including to oneself. See http://policy.arizona.edu/education-and-student-affairs/threatening-behavior-students.

Accessibility and Accommodations: It is the University's goal that learning experiences be as accessible as possible. If you anticipate or experience physical or academic barriers based on disability or pregnancy, please let me know immediately so that we can discuss options. You are also welcome to contact Disability Resources (520-621-3268) to establish reasonable accommodations. Please be aware that the accessible table and chairs in this room should remain available for students who find that standard classroom seating is not usable.

Non-discrimination and anti-harassment policy: This course will adhere to the UA Nondiscrimination and anti-harassment Policy. The University is committed to creating and maintaining an environment free of discrimination; see http://policy.arizona.edu/human-resources/nondiscrimination-and-anti-harassment-policy.

All university policies are available at: https://academicaffairs.arizona.edu/syllabus-policies

Graduate student resources can be found at: http://basicneeds.arizona.edu/index.html

Information contained in the course syllabus, other than the grade and absence policies, may be subject to change with reasonable advance notice, as deemed appropriate by the instructor of this course.

LIST OF TOPICS

Terminology and scope
Upper and middle atmospheres in the solar system
Kinetic theory and equations of motion
Energy balance and electron transport
Diffusion and atmospheric escape
Photochemical models