SYLLABUS

PTYS/ATMO 544 – SPRING 2019
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, for example, can completely transform these atmospheres over time. A good 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 an understanding of the key concepts and physical mechanisms underlying the thermal structure, composition and dynamics of planetary middle and upper atmospheres. The general validity of the theory, originally developed for the Earth, will be investigated through a comparative study of different planets. A tentative schedule of topics is included at the end of this syllabus. At the conclusion of this course, the students should have gathered enough practical knowledge to start building their own models and investigating high atmosphere phenomena in greater depth.

Time and location: Tuesday and Thursday, 12.30-1.45pm, Kuiper Space Sciences room 301 (except January 17 in room 312)

Instructor: Tommi Koskinen, Assistant professor of Planetary Sciences
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: Viridian Robles de Serino (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).

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 an in-depth literature review and/or a research problem. 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 but this is not a requirement.

Course website: TBA

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 in superficial detail.
- 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 work that focuses on the high atmosphere and comparative planetology, showing its age by now.

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.

Note that the workload and course requirements are subject to change at the discretion of the instructor with proper notice to the students.

TENTATIVE SCHEDULE OF TOPICS

Weeks 1, 2: Review of planetary middle and upper atmospheres
Week 3: Equations of motion from kinetic theory
Week 4: Ionosphere formation (non-auroral)
Week 5: Electron transport, heating and secondary ionization
Week 6: Energy balance in the thermosphere
Week 7: Principles of photochemistry
Week 8: Energy balance in the middle atmosphere
Week 9: Spring recess
Week 10: Numerical methods and models
Week 11: Airglow and aurora
Week 12: General circulation models
Week 13: Comparative aeronomy
Week 14: High atmospheres of extrasolar planets
Week 15: Student presentations
Week 16: Student presentations