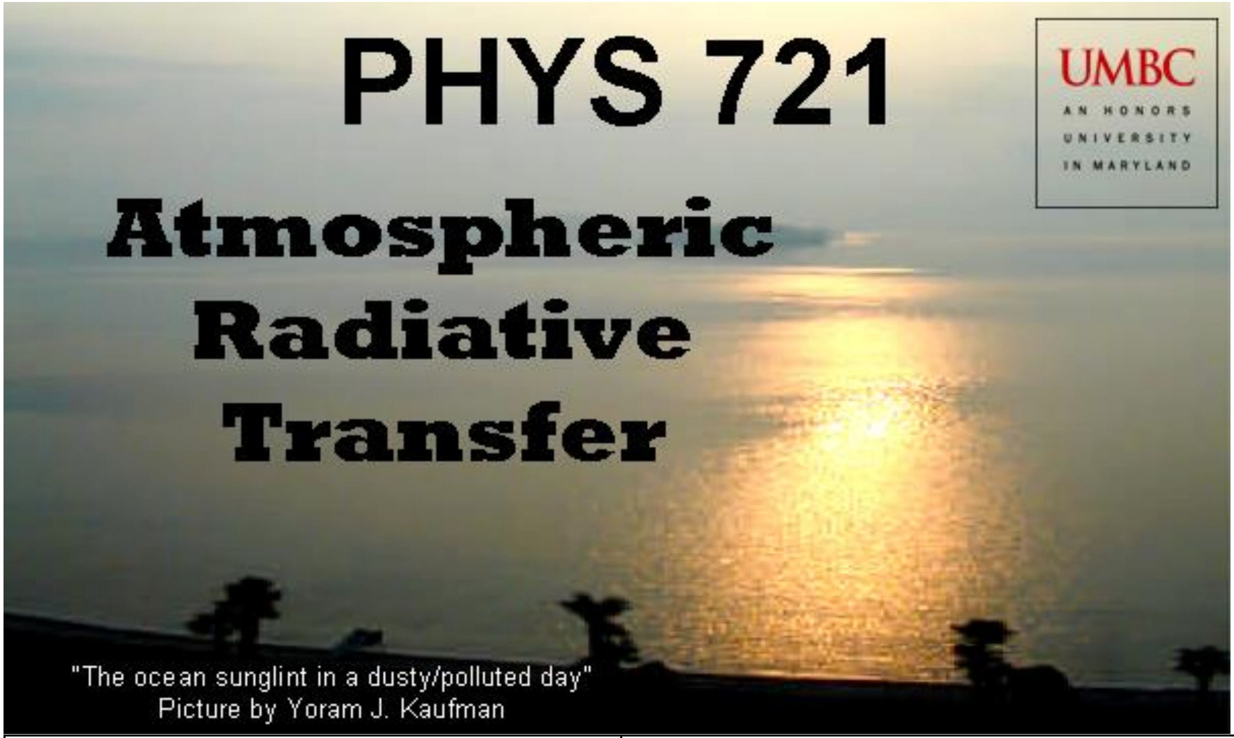

Instructor: Dr. Jose Vanderlei Martins **Office Hours: Tue/Thu: 16:00–17:30** **Physics Building – room 429** **Phone: 410-455 2764** martins@umbc.edu	Lectures Time/Place: **Tue/Thu: 14:30-15:45** **Sherman Hall O11**
Grading Method: Final Exam (25%), Mid-Term Exam (25%), Project (25%), Homework (25%)	**Required Textbook:** G. E. Thomas and K. Stamnes, 1999: *Radiative Transfer in the Atmosphere and Ocean*, Cambridge University Press, 517pp.
Suggested Textbooks: (not required) -R. M. Goody and Y. L. Yung, 1989: *Atmospheric Radiation, Theoretical Basis*, Oxford, 519pp. - John R. Schott, 2009: Fundamentals of Polarimetric Remote Sensing,	**Additional Textbooks: (not required)** -K. N. Liou, 2002: *An Introduction to Atmospheric Radiation, 2nd edition*, Academic Press, 583 pp. -G. W. Petty, 2004: *A First Course in Atmospheric Radiation*, Sundog Publishing, 446 pp. -*3D Radiative Transfer in Cloudy Atmospheres.* Springer Berlin Heidelberg, New York, edited by: Marshak, A. and Davis, A., ©2005, 686, 2005.

Obs: A number of www-based aides, summary notes, etc. will be available but the students are always encouraged to take their own notes.

Course Syllabus

- **PHYS 721** *Atmospheric Radiation* [3 credits] **[ATM Phys-Program]**

(from Catalog) This course introduces the student to formal radiative transfer theory, which is quickly simplified for application to Earth's atmosphere. The physical processes, which contribute to absorption and scattering in Earth's atmosphere, are examined. Topics include molecular absorption via vibration-rotation transitions and spectral line formation in homogeneous atmospheres. Rayleigh and Mie scattering theory are covered, as well as their application to radiative transfer in clouds and aerosol-laden atmospheres. The importance of radiative transfer to the heat balance of Earth and implications for weather and climate will be examined. If time permits, various parameterizations and approximation schemes for atmospheric radiative transfer will be developed.

Prerequisites:

PHYS602, PHYS605 or PHYS705, PHYS607, PHYS621, PHYS622.

Course Description and Objectives:

The physical processes which contribute to absorption and scattering in the Earth's atmosphere will be explained with the ultimate goal to appreciate the importance of radiative transfer to the heat balance of the Earth and its implications for weather and climate. By the end of the course, students should be equipped with enough knowledge to not be intimidated by research projects that require radiative transfer calculations, derivation and interpretation of radiation budgets, analysis of atmospheric optical properties, and understanding of passive remote sensing algorithms physical principles and limitations. Finally, the course is designed to provide a solid background for those planning to take PHYS 722 (Remote Sensing).

The main topics covered by this course include (not necessarily in this order):

- Role of radiation in climate. Concept of extinction. Radiative quantities: optical path, extinction coefficients, intensity, flux.
- Classical viewpoint of light-matter interactions. Thermodynamic equilibrium. Planck's law. Wien's law. Stefan-Boltzmann law.
- Scattering by spherical particles. Rayleigh scattering. Mie scattering.
- Phase functions. Legendre expansion. δ-scaling. Optical properties of clouds and aerosols.
- Publicly available RT tools. Class demonstrations.
- Development of RT equation with scattering and emission. Solution of RT equation with no scattering. Atmospheric heating and cooling rates. Atmospheric sounding.

- Solutions of the RT equation with scattering (1). Two-stream. δ-Eddington.
- Solutions of the RT equation with scattering (2). Accurate methods (1D).
- 3D radiative transfer. Monte Carlo.
- Vibration-rotation spectra. Link to QM interpretation.
- Line shape. Broadening of spectral lines. Spectral absorption by the Earth's atmospheric constituents.
- Transmission by single line. Band absorption. Band models.
- Broadband RT. Line-by-line. Transmission in homogeneous media. k-distribution method.
- Transmission in inhomogeneous media. Scaling approximations. Correlated k-distribution method.
- Cloud heating and cooling profiles.
- Role of radiation in climate revisited. Role of gases. Role of clouds. Role of aerosols. Forcings. Feedbacks. Models for climate studies. Recent observations.

Note: *The emphasis on a given topic or the course content may vary according to specific interests of the class and links with special events on Atmospheric Radiation.*

Course Work:

- ***Homework*** assignments will be given periodically covering subjects discussed or related to topics discussed in class or related to the class project.
- A ***Project*** topic will be selected at the beginning of the course and the students will develop it along the whole semester. Individual students will make oral presentations on their results and turn in a final report with no more than 10 pages. The report must be well organized, well written, and present references following an AGU publication-like standard.
- The ***mid-term*** and ***final exams*** will be cumulative, covering the entire subject discussed up to their dates. At the instructor's discretion, these exams could be given as take home exams.

Policies & Expectations

Policy on Attendance

Attendance at most lectures is **optional** - the only **exceptions** being for Quizzes, Exams and Project Presentations (*see below*). Despite being optional, it should be stressed that you are **strongly encouraged to attend** the lectures. They are an integral part of the course.

A note on **Classroom Etiquette**: You are expected to show the professor and your fellow students respect. You are expected to arrive prior to the start of the lecture, and not to leave until after the end of the lecture. You are expected to pay attention to the lecture, and usually to take notes. Behavior such as reading non-course related material, wearing headphones, disrupting fellow students, etc. are unacceptable. If you need to clarify a point with your neighbor, please do so in a "hushed manner". You are encouraged to ask questions, but to do so you are expected to raise your hand & wait to be called upon.

Please turn cell-phones OFF prior to entering the lecture hall.
Laptops are allowed and even encouraged in this class as they can be used for real time calculations, simulations and data analysis but they must be used only for class work.

Policy on Exams & Quizzes:

Make sure you **read & understand the "rules" and consequences of academic misconduct** (see below).

Policy on Grading *etc*

Dr Martins will determine all final grades. Your final grade is based on your actual total score. Grade Distribution: Final Exam (25%), Mid-Terms (25%), Project (25%), Homework (25%)

You have one week from receiving a grade to appeal.

Academic (Mis)Conduct

Cheating will not be tolerated. We all know what that means, so I am not going to list all the possible "dos & donts". However here are a few pointers:

Quizzes & Exams are to be completed **alone** (*not with the help of your neighbors and classmates*)

A note on academic integrity:

By enrolling in this course, each student assumes the responsibilities of an active participant in UMBC's scholarly community in which everyone's academic work and behavior are held to the highest standards of honesty. Cheating, fabrication, plagiarism, and helping others to commit these acts are all forms of academic dishonesty, and they are wrong. Academic misconduct could result in disciplinary action that may include, but is not limited to, suspension or dismissal.

The consequences of misconduct will be severe, and may be reported to the Academic Conduct Committee. See also the UMBC Graduate School website references on Academic Integrity (http://gradschool.umbc.edu/students/integrity/).

If you are uncertain as to whether something is allowed: ASK FIRST!!

Phys 721 Calendar - Fall 2017

Aug. 31	**First Day of Classes**
Sept. 13	**Last day to Change/Drop Classes**
TBD	**Mid-Term Exam**
Nov. 23-26	**Thanksgiving Break**
TBD	**Invited Lecture**
Dec. 4-7	**Project Presentations**
Dec. 12	**Last Day of Classes (will be rescheduled to the previous week due to AGU meeting)**
Dec. 14-20	**Final Exam**

Students are expected to be familiar with the Policies & Expectations of this course, and all UMBC regulations.