ASTRONOMY 355:
Introduction to Radio Astronomy
Fall Semester 2007
Syllabus (Experimental Course)

Professor:	Dr. H. Paul Shuch
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Academic website	http://shuch.net
Lecture:	MWF 2:00 – 3:05 PM, Room D-301
Laboratory:	Tuesday, 1:00 – 3:50 PM, Room C-302
Office Hours:	MWF, 1:00 – 2:00 PM, Room D-304

Text: Radio Astronomy, 2nd Ed., John D. Kraus, Cygnus-Quasar Books

Catalog description:

The human eye is blind to most electromagnetic emissions, including those waves providing important clues into the history, composition, and workings of the Universe. Radio astronomy uses new tools to study the sky in ways not possible with optical telescopes. In this course, physics and astronomy students will be introduced to the techniques of radiometry, spectroscopy, and interferometry, and will apply them to studying the sky at radio frequencies, to detect the most powerful, distant, and exotic objects in space. *Four hours of lecture and three hours of laboratory per week. Prerequisites: Astr 101 or 111; Phys 226.*

Learning outcomes:

Upon successful completion of this course, students will:

1. compare and contrast the radio and optical skies.
2. discuss the distribution and characteristics of continuum radio sources.
3. identify the most common stellar and interstellar spectral emission lines.
4. describe the operation of a basic microwave radiometer.
5. explain the techniques of microwave spectroscopy.
6. correlate baseline to angular resolution for an aperture synthesis interferometer.
7. relate cosmic, galactic, stellar, and planetary evolution to the radio emissions associated with each.
8. calculate flux density from observed signal amplitude.

Core competencies:

1. **Information processing:** the ability to gather, organize, analyze, and apply information.
2. **Problem solving:** sensing that a problem exists; defining the problem; analyzing problem/solution interactions; determining and assessing possible solutions.
3. **Critical thinking**: using reflective thinking to decide on a course of action or belief; supporting ideas with facts and logic; explaining relationships.
4. **Communication:** learning to plan, create, and present verbal, visual, and written information; sharing thoughts and ideas with others in a clear, concise manner.
5. **Leadership skills:** working productively and independently as an individual; being an active, positive and productive group member; demonstrating positive leadership skills.

Lecture Topics:

1. Review of astronomy fundamentals
2. History of radio astronomy
3. Power, brightness, temperature, and noise
4. Wave propagation
5. Wave polarization
6. Radio telescope antennas
7. Aperture synthesis and interferometers
8. Radio telescope receivers
9. Preamplifiers and sensitivity
10. Calibration and stabilization
11. Solar emissions
12. Planetary emissions
13. Galactic emissions
14. Cosmic background radiation
15. Pulsars, Quasars, Supernovae, and exotica

Laboratory exercises:

1. The Sun’s thermal signature
2. Lunar radiometry
3. Antenna beamwidth and gain
4. Meridian transit measurements
5. Basic interferometry
6. Hydrogen line spectroscopy
7. Aperture synthesis
8. Jupiter’s decametric emissions
9. Mapping the Milky Way
10. SETI all-sky survey

Grading scheme:

Laboratory Activities	20%
Weekly Quizzes	20%
Research Project	20%
Midterm Exam	20%
Final Exam	20%
Total	100%

Laboratory component:

Working in small groups, you will gain experience operating, calibrating, and servicing a variety of small radio telescopes and related instruments, and documenting your efforts in technical reports. Laboratory projects should be considered cooperative, not competitive. Lab grades will be shared by the group, rather than assigned to the individual student. You and your lab partners will trade off duties weekly, so that by the end of the course, you will have gained experience as a supervisor, technician, and technical writer.

Quiz component:

Brief weekly quizzes will give you an opportunity to demonstrate your ability to qualitatively and quantitatively apply the principles studied in class. They will also permit you to gauge your own progress and understanding.

Practice problems appear at the end of each chapter in your textbook. As we go over the material in that chapter, you should work progressively on those problems. I do *not* collect and grade your homework. It is expected that you will work through the problems, and seek assistance with those that you do not fully understand. You *will* see some of these problems again in weekly quizzes, as well as on exams, so it behooves you to at least read all of the end-of-chapter problems! Extra credit will be given for any unusual or elegant solutions you may choose to present to the class, so be creative.

Research component:

During this semester, you will be assigned a relevant research topic for which not all the answers are known, and asked to delve into the literature, in order to prepare a summary report of current thinking and findings. Your report will be prepared at a level suitable for publication in *Acta Astronautica* or a similar peer-reviewed scholarly journal. An oral report will be presented to the entire class. Journal submission is encouraged, with significant extra credit accruing to those students whose papers are accepted for publication.

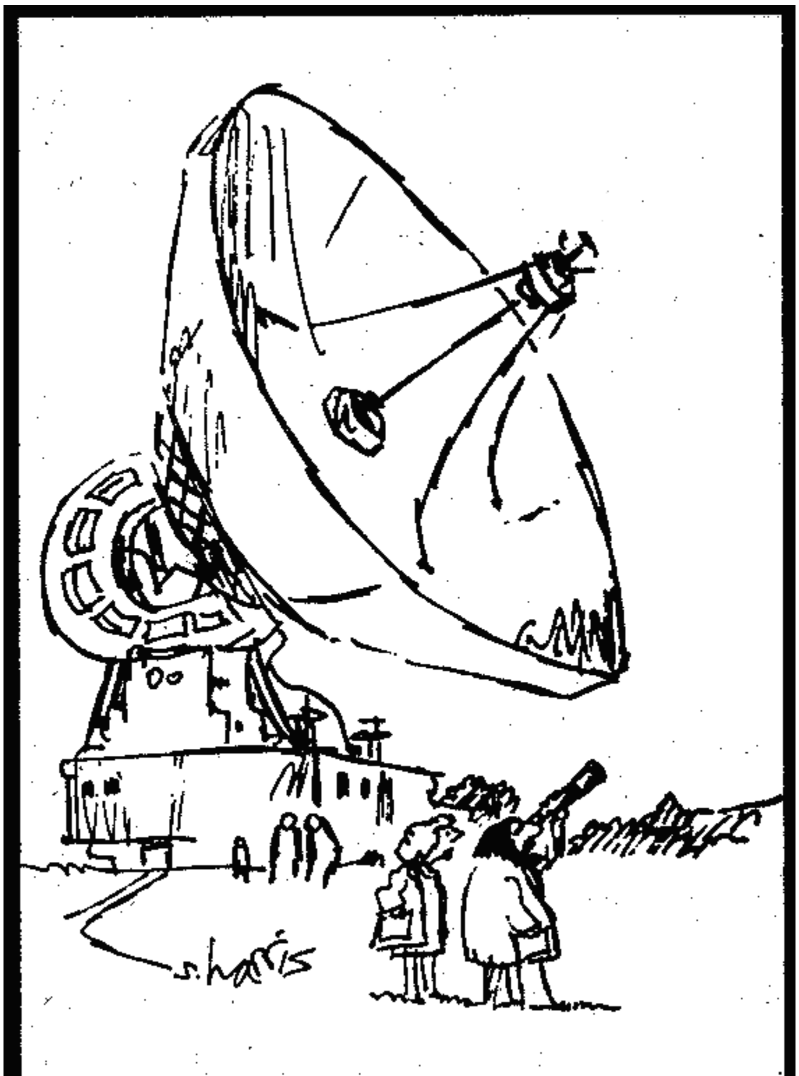
Examination components:

A single midterm exam, and a comprehensive final exam, will be comprised of problems similar to those in the homework sets, plus questions similar to those found at the end of chapters. These require a short answer, and test your qualitative knowledge of the physical theory discussed in that chapter. Examinations will be devoted equally to quantitative problem solving and qualitative short answer questions.

The final exam will be of the take-home variety. The final exam problems will be handed out during the last week of classes, and solutions turned in on the day designated by the Registrar as the final examination period for this class.

Academic integrity:

Although much of your work in this class will be collaborative in nature, and you are encouraged to demonstrate cooperation and teamwork in laboratory experiments and problem solving, Lycoming College has strict policies regarding plagiarism. You are expected to work *independently* on quizzes and examinations. Written assignments are to be completed in your own words. The work of others may be incorporated, either by paraphrasing or direct quotation, but all sources must be cited, and complete, properly formatted references provided. A brief tutorial on the issue of plagiarism, which all students are expected to complete during the first week of the semester, is linked from the professor's academic website. Any violations of the College's plagiarism policy will subject a student to strict disciplinary measures.



"Just checking."

Professor's comments:

A favorite cartoon drawn by the ever-popular Sidney Harris (reproduced here) shows a giant radio telescope pointing at the sky. Beside it stands a stereotypical scientist wearing a white lab coat. He is staring at the sky through a small refractor telescope, and saying to his colleague, "Just checking." When you duplicate this crude experiment, you will discover that the radio sky and the optical sky look nothing alike, providing two entirely different windows into the workings of the universe. Upon successful completion of this course, you will appreciate the elegance of a host of new tools, which will reveal to you a universe unlike any you have encountered before.

Syllabus revised:
14 February 2007