

Astro 4300/7440: Radio Astronomy

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Office Hours: Mondays & Wednesdays 1:00-2:00 pm (or by appointment)

Class Hours: 13:00-14:15 pm Tue and Thu

Location (Lectures): 319 Allen Physics Lab

Course Website: <http://www2.physics.umanitoba.ca/u/odea/radioastronomy/>

Synopsis:

Radio Astronomy is a growing field supported by state of the art ground-based instrumentation, e.g., the Jansky Very Large Array (JVLA) and the Atacama Large Millimeter Array (ALMA). The next generation radio telescope, the Square Kilometer Array (SKA), is currently planned and Canada is a key participant. This course will provide an introduction to observational radio astronomy and processes in radio astrophysics. Topics will include: an introduction to radio astronomy; Basic radiative transfer; blackbody radiation and radiation from an accelerated charge; radio telescopes, receivers, and interferometers; thermal continuum sources (e.g., HII regions); nonthermal continuum sources (e.g., radio galaxies); Pulsars; and spectral-line sources (e.g., the 21 cm line, radio recombination lines, and rotational energy transitions in simple molecules).

Prerequisites: PHYS 2380 (Quantum 1), PHYS 2600 (E&M Theory), and PHYS 3670 (Thermodynamics). ASTRO 2XXX (Introduction to Astrophysics) recommended.

Lecture: 3 cr hr

Textbook: The text book is Essential Radio Astronomy by Condon & Ransom (Princeton University Press). The content of the text book is available on the web
<https://science.nrao.edu/opportunities/courses/era>

Grading:

5 problem sets 14% each for a total of 70%.

A written paper and in-class presentation discussing a topic relevant to the course material worth 30%.

Topics must be approved by the instructor.

4300 students - paper is at least 5 pages and talk is 15 min.

7440 students - paper is at least 10 pages and talk is 30 min.

There is no Final Exam.

Grading Scale:

A+ 90%

A 80%

B+ 75%

B 70%

C+ 65%

C	60%
D	50%
F	Below 50%

Syllabus:

- I. Introduction
 - Atmospheric Windows
 - Astronomy in the Radio Window
 - What is special about long wavelengths?
 - Radio Telescopes and Aperture-Synthesis Interferometers
 - The Discovery of Cosmic Radio Noise
 - A Tour of the Radio Universe
- II. Radiation Fundamentals
 - Brightness and Flux Density
 - Radiative Transfer
 - Polarization
 - Black Body Radiation
 - Noise Generated by a Warm Resistor
 - Cosmic Background Radiation
 - Radiation from an Accelerated Charge
 - Dust Emission at Radio Wavelengths
- III. Radio Telescopes and Radiometers
 - Antenna Fundamentals
 - Reflector Antennas
 - Two-dimensional Aperture Antennas
 - Waveguides
 - Radio Telescopes
 - Radiometers
 - Interferometers
- IV. Free-Free Radiation
 - Thermal and Non-thermal Emission
 - HII Regions
 - Free-Free Radio Emission from HII Regions
- V. Synchrotron Radiation
 - Magnetobremssstrahlung
 - Synchrotron Power
 - Synchrotron Spectra
 - Synchrotron Sources
 - Inverse-Compton Scattering
 - Extragalactic Radio Sources
- VI. Pulsars
 - Pulsar Properties

Pulsars and the Interstellar Medium
Pulsar Timing

- VII. Spectral Lines
 - Recombination Lines
 - Line Radiative Transfer
 - Excitation Temperature
 - Masers
 - Recombination Line Sources
 - Molecular Line Spectra
 - The HI 21-cm Line

Academic Policies:

The Faculty of Science asks us to inform you that academic dishonesty has serious consequences.

The Faculty of Science and The University of Manitoba regard acts of academic dishonesty in quizzes, tests, examinations, laboratory reports or assignments as serious offences and may assess a variety of penalties depending on the nature of the offence.

Acts of academic dishonesty include, but are not limited to bringing unauthorized materials into a test or exam, copying from another individual, using answers provided by tutors, plagiarism, and examination personation.

Penalties that may apply, as provided for under the University of Manitoba's Student Discipline ByLaw, range from a grade of zero for the assignment or examination, failure in the course, to expulsion from the University. The Student Discipline ByLaw may be accessed at:

http://umanitoba.ca/admin/governance/governing_documents/students/student_discipline.html

The Students' Discipline Document is available from the Faculty of Science:

<http://umanitoba.ca/faculties/science/resources/ScienceDisciplineProcedures-June2013.pdf>

All Faculty members (and their teaching assistants) have been instructed to be vigilant and report all incidents of academic dishonesty to the Head of the Department.

Some other links:

The Faculty of Science Template Statement on Academic Dishonesty:

http://umanitoba.ca/faculties/science/resources/Science_StatementOnAcademicDishonesty2013.pdf

How to avoid cheating and plagiarism -- take the Academic Honesty Quiz:

http://umanitoba.ca/student/resource/student_advocacy/academic_honesty_quiz.html