ASTR 240: Radio Astronomy

VVO 110 / Spring 2013 / MW 2:40-4:00 PM

http://amhughes.web.wesleyan.edu/astr-240.html

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COURSE DESCRIPTION

This course will introduce students to the origins, theory, and practice of radio astronomy. It will cover basic radiative transfer and emission mechanisms relevant for radio astronomy, theory of antennas and interferometers, as well as signal detection and measurement techniques. Particular emphasis will be placed on the theory and applications of Fourier transforms. A practical laboratory component will provide experience working with single-dish and interferometric data.

Since this is the first time radio astronomy will have been taught at Wesleyan (at least for a very long time), we also have the unique opportunity to devote some class time to assembling a radio telescope, the Small Radio Telescope (SRT) designed by Haystack, which has been effectively used for education and outreach at many universities across the country and will be the newest addition to Wes's telescopic arsenal (http://www.haystack.mit.edu/edu/undergrad/srt/index.html). If all goes well, we may even be able to observe with it by the end of the semester.

TEXTS AND READINGS

Readings will be drawn from the sources listed below. The primary text is *An Introduction to Radio Astronomy*, by Burke & Graham-Smith. This text provides overviews of all the topics covered in the course, but is less pedagogically satisfying than some other sources; hence the supplementary readings. The reading assignments for each class are listed in the course outline at the end of this document. The expectation is that all readings will be completed **before** each class session, so that class time may be used more effectively. We will not have time to cover all the reading material in detail in class, but it may appear on homework and exams. **At least two hours before each class,** send me an email with 1-2 sentences each about (1) what you found most interesting and (2) what you found most confusing about the assigned reading. This will count towards your participation grade.

Required: *An Introduction to Radio Astronomy*, Burke & Graham-Smith, 3rd Ed.,
ISBN: 978-0521878081

Readings from: *Radio Astronomy*, J. D. Kraus, 2nd Ed., ISBN: 1882484002
Radiative Processes in Astrophysics, Rybicki & Lightman, ISBN: 978-0471827597
A Student's Guide to Fourier Transforms, James, ISBN: 978-0521176835
Tools of Radio Astronomy, Rohlfs & Wilson, ISBN: 978-3540851219

Also Recommended: *Interferometry and Synthesis in Radio Astronomy*, Thompson, Moran, & Swenson, ISBN: 978-0471254928

NOTE: All supplementary readings (i.e., other than Burke & Graham-Smith) should be available online through E-Res. Paper copies of all relevant texts are also on hold in the library.

GRADING

Homework (including technical justification): 30%. Labs: 20%. Midterm: 15%. Final: 25%. Discussion/participation (including telescope work): 10%. Your lowest homework grade will be dropped when calculating your final grade.

ATTENDANCE

Attendance is expected, and will be critical for completing all aspects of this course.

HOMEWORK

There will be homework assigned every 1-2 weeks throughout the semester. Homework is due at the beginning of class. A full letter grade will be deducted for every day – including weekends – that a homework assignment is late. (0-24 hours after the start of class counts as one day late, etc.) You are encouraged to work collaboratively on homework assignments, but each person must turn in their own, unique work. Tests and labs will be based on concepts covered in the homework, so you should be able to solve each problem without the aid of colleagues or notes.

EXAMS

There will be an in-class written midterm on March 6, and a take-home written final exam due at 5pm on May 14, 2013. As always, the honor code is in effect, and an exam may not be discussed until all class members have turned it in.

DISCUSSION/PARTICIPATION

The discussion/participation grade will be based partly on participation in lecture/activities, but primarily on work on the SRT. Students will divide into teams to work on different components of the system. Since we may encounter unexpected obstacles beyond our ability to overcome during the semester, this aspect of the course will NOT be graded on the basis of telescope functionality, but rather on each individual's contribution to the project as determined by a combination of peer- and self-assessment at the end of the semester. These criteria are similar to the ones that we will use:
http://www.uky.edu/SocialWork/crp/files/Samplepeerevaluationform.pdf

STUDENTS WITH DISABILITIES

It is the policy of Wesleyan University to provide reasonable accommodations to students with documented disabilities. Students, however, are responsible for registering with Disabilities Services, in addition to making requests known to me in a timely manner. If you require accommodations in this class, please make an appointment with me as soon as possible (before February 22nd), so that appropriate arrangements can be made. The procedures for registering with Disabilities Services can be found at:
http://www.wesleyan.edu/deans/disability-students.html.

Course Outline

Date	Topic	Assignment	Reading
1/28	Overview, History, Units		(BGS 1, 2.1-2.2, A3)
1/30	Thermal Emission, Radiative Transfer		RL 1-1.7
2/4	Spectral lines: kinematics, excitation		BGS 7.6, 9-9.3,10-10.1
2/6	Molecules, Synchrotron emission	HW1 Due	BGS 7.2-7.5,7.7 WRH15
2/11	Radio Sky: Quasars, Pulsars, CMB		Skim BGS 12, 13, 14
2/13	Guest Lecture: Jon Wallace (SARA)	HW2 Due	
2/18	Fourier Transforms		James 1, BGS A1
2/20	Two-Element Interferometer I		BGS 5.1-5.3
2/25	Two-Element Interferometer II		BGS 5.4-5.10
2/27	Lab 1: Two-Element Interferometer	HW3 Due	
3/4	Aperture Synthesis I		BGS 6.1-6.4, 6.7
3/6	Midterm		
3/11	NO CLASS – SPRING BREAK		
3/13	NO CLASS – SPRING BREAK		
3/18	NO CLASS – SPRING BREAK		
3/20	NO CLASS – SPRING BREAK		
3/25	Aperture Synthesis II (VRI)		Welch 1988
3/27	Deconvolution + Imaging I	Lab 1 due	BGS 6.5-6.6, 6.8
4/1	Deconvolution + Imaging II (SMA)		
4/3	VLBI, mosaicking, dynamic range	HW4 Due	BGS 6.9-6.13
4/8T	Noise, Detection		BGS 3.1-3.3, WRH4
4/10T	Radiometers	TJ Due	BGS3.4-3.7,WRH5-5.4.1
4/15	Prep for Lab II		TBD
4/17	Lab II: TBD		
4/22	Spectrometry		BGS3.8,WRH5.4.2-5.4.3
4/24	Antennas I – Dipoles and Horns, Arrays	HW5 Due	BGS 4.1-4.2
4/29	Antennas II – Feeds, Beam Pattern		BGS4.3-4.7,WRH7.1-7.3
5/1	Antennas III – Mapping, Design	Lab 2 Due	BSG 4.9-4.11, WRH7.4
5/6	SETI		Kraus 12
5/8	Review	HW6 Due	

Notes: BGS = Burke & Graham Smith (A=Appendix); WRH=Wilson, Rohlfs, Huttemeister (on reserve), RL = Rybicki & Lightman (on reserve), Welch 1988 is available through E-Res only. TJ=Technical Justification. Possible travel dates are marked with a "T."

* I am hoping to arrange a field trip TBA. The most likely dates are April 13 or May 4.