Syllabus
ASTR 414: Astronomical Techniques
Fall 2014

(v1.1)

Instructors

Instructor	Prof. Athol Kemball	**Office**	Astronomy 203
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Office hours	Tue 2h45-3h45pm; Thu 3-4pm; or by appt.		
TA	Celeste Lu	**Office**	Astronomy 133
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Office hours	Mon 3h30-4h30pm; Wed 3h30-4h30pm.		

Course description

Credit: 4 hours.

Introduction to techniques used in modern optical and radio astronomy with emphasis on the physical and mathematical understanding of the detection of electromagnetic radiation; includes such topics as fundamental properties of radio and optical telescopes and the detectors that are used with telescopes. Lectures and laboratory.

Prerequisite: MATH 241 or equivalent; PHYS 212; or consent of instructor.
Recommended: ASTR 210, PHYS 213, PHYS 214

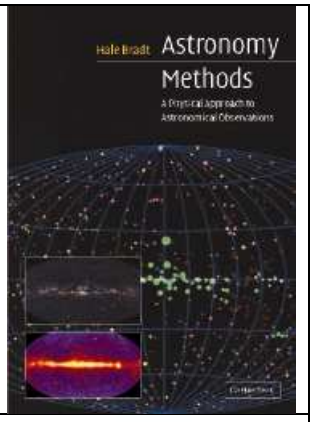
Learning objectives

On completing ASTR 414, you should be better able to:

1. Understand the common, unifying foundation principles of multi-wavelength observational astronomy, particularly concerning radiation properties, propagation effects, and instrument and detector design.
2. Analyze the impact of cutting-edge science challenges on modern observational astronomy.
3. Recognize the interdisciplinary nature of observational astronomy across the physical sciences and engineering.
4. Reduce and analyze actual observational data.
5. Apply statistical principles and modern computation techniques to problems in observational astronomy.

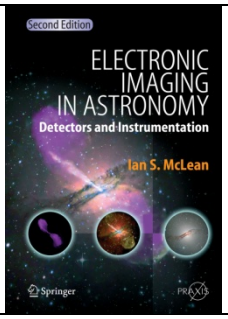
Required textbook and i>clicker

The required text for the course is *Astronomy Methods*. In addition, an i>clicker 2 response system is required. Both are described in the table below.

Astronomy Methods: A Physical Approach to Astronomical Observations, Hale Bradt (Cambridge University Press), Third Printing 2007. Paperback: ISBN 978-0-521-53551-9	
An i-clicker 2. Please register your i-clicker at: **http://iclicker.com/support/registeryourclicker/** Use your UIUC netid as Student ID on this web page. *Please note that the older i-clicker v1 does not provide the full capabilities required for this class.*	

Recommended textbook

The following text is recommended, and is available at the UIUC library.

Electronic Imaging in Astronomy: Detectors and Instrumentation, Ian S. McLean (Springer Praxis), 2nd edition 2008. Hardcover: ISBN 978-3-540-76582-0	

Course requirements

The course contains the following required elements and associated grade contributions.

Requirement	Points	Grade %
Class participation	50	5
Problem sets	7 x 50	35
Laboratory assignments	200	20
Mid-term exam	150	15
Final exam	250	25
Total	1000	100

Extra-credit problems will be be made available during the semester. These optional extra-credit problem sets will allow students to explore material covered in the class in greater detail, and simultaneously to improve their overall grade.

- **Class participation:** The participation grade will be determined from i>clicker scores during class; participation in class is a key element of success in the course.
- **Problem sets:** Seven problem sets will be assigned as homework assessments during the course. They will cover the essential elements of the class and are an important element of the overall grade. These problem sets will be due (in class) approximately every second Wednesday during the semester – due dates are posted in the class schedule. In order to be fair to all students, no credit can be given for late submissions.
- **Laboratory assignments:** Several laboratory projects will be assigned over the course of the semester, illustrating key principles in astronomical techniques.
- **Mid-term examination:** A one-hour mid-term examination will take place on Friday, 4th April 2014 in the regular classroom.
- **Final examination:** The three-hour final examination will take place on May 12th 2014 from 8h00am to 11h00am in the regular classroom, ASTR 134.

Grading

The grading scale used in the course is shown below.

Grade	*Range*
A+	990-1000
A	910-989
A-	900-909
B+	890-899
B	810-889
B-	800-809
C+	790-799
C	710-789
C-	700-709
D+	690-699
D	610-689
D-	600-609
F	0-599

Grades may be curved in the event that an exam proves to be at the incorrect level, but grade curves are not routinely used in this class.

Academic integrity and collaborative work

Violations of academic honesty and integrity, as defined in the University of Illinois student code (http://admin.illinois.edu/policy/code/article1_part4_1-401.html) will be enforced in this course following UIUC rules and procedures. Example violations described in the Student Code include cheating, fabrication, enabling breaches of academic integrity by others, representing the words or ideas of another as your own (plagiarism), academic tampering or interference, and unauthorized use of University resources or computing facilities. Penalties will be applied in accord with University rules concerning academic integrity.

Collaborative discussion of course material with fellow students is encouraged, but each student is required to do their own work. The issues behind homework questions may be discussed with classmates but the submitted answers and work must be your own. For examinations, all answers and work must be your own.

Accessibility statement

To insure that disability-related concerns are properly addressed from the beginning, students with disabilities who require assistance to participate in this class are asked to see me as soon as possible.

Illness, family emergencies, and related events

Please contact the Emergency Dean if you miss class or assignments due to illness or emergencies (http://www.odos.uiuc.edu/emergency/) and notify me as soon thereafter as possible by email. The Office of the Emergency Dean will issue a letter for valid absences that I can use in adjusting grades accordingly, but will keep the underlying reason for the absence confidential between the student and the Emergency Dean.

Course schedule

The course schedule is listed below. It will be kept up to date throughout the semester if there are any changes.

WEEK	DATE	LECTURE	TOPIC	READING
Week 1	Wed, 1/22	Lecture 1	Introduction to observational astronomy	Bradt, Ch 1, McLean, Ch 1
	Fri, 1/24	Lecture 2	Discovery power of observational astronomy	McLean, p.119-159
Week 2	Mon, 1/27	Lecture 3	Writing an astronomy research paper	ASTR 401 material
	Wed 1/29	Lecture 4	Astronomical coordinates	Bradt, p.34-56
	Fri 1/31	Lecture 5	Celestial motions	Bradt, p.60-79
Week 3	Mon 2/3	Lecture 6	Time systems and standards	Bradt, p.80-97
PS#1	Wed 2/5	Lecture 7	Electromagnetic radiation	Bradt, p.22-33, p.218-224
	Fri 2/7	Lecture 8	Radiation properties in astronomy	Bradt, p.224-252, p.260-264
Week 4	Mon 2/10	Lecture 9	Continuum emission mechanisms	Bradt, p.333-354
	Wed 2/12	Lecture 10	Spectral-line emission mechanisms	Bradt, p.354-377
	Fri 2/14	Lecture 11	Propagation effects: interstellar medium	Bradt, p.298-332
Week 5	Mon 2/17	Lecture 12	Propagation effects: Earth's atmosphere	McLean, p.39-51
PS#2	Wed 2/19	Lecture 13	Telescopes: optics and configurations	McLean, p.77-97, Bradt, p.98-109
	Fri 2/21	Lecture 14	Telescopes: angular resolution	Bradt, p.112-119
Week 6	Mon 2/24	Lecture 15	Telescope: adaptive optics	Bradt,p.119-129, McLean,p.53-66
	Wed 2/26	Lecture 16	Telescopes: survey instruments and large apertures	McLean, p.97-111
	Fri 2/28	Lecture 17	Incoherent single-pixel detectors	McLean, p.15-17, p.184-195, p.32-34
Week 7	Mon 3/3	Lecture 18	Coherent single-pixel detectors	McLean, p.195, p.474-481
PS#3	Wed 3/5	Lecture 19	Imaging and array detectors	Bradt,p.137-145, McLean p.10-25
	Fri 3/7	Lecture 20	High-energy detectors	Bradt, p.133-136, p.145-151
Week 8	Mon 3/10	Lecture 21	Sampling and data acquisition	McLean,p.353-358
	Wed 3/12	Lecture 22	Statistics of measurements	Bradt, p.151-165
	Fri 3/14	Lecture 23	Inference and model fitting	Bradt, p.165-174

Week 9	Mon 3/17	Lecture 24	Image restoration and inverse problems	McLean,p.378-384
PS#4	Wed 3/19	Lecture 25	Computing: general tools and resources	McLean,p369-378
	Fri 3/21	Lecture 26	Mid-term review	
Week 10	3/22-3/30	***Spring break***		
Week 11	Mon 3/31		No class: exam review	
	Wed 4/2	Guest lecture	Computing: VO era and archives	McLean,p.25-29
	Fri 4/4		***Mid-term exam***	
Week 12	Mon 4/7	Lecture 27	Instruments: optical photometry and imaging	McLean,p.161-167
PS#5	Wed 4/9	Lecture 28	Data reduction: optical imaging	McLean,p.315-332
	Fri 4/11	Lecture 29	Data reduction: optical photometry	McLean, p.332-340
Week 13	Mon 4/14	Lecture 30	Instruments: optical spectroscopy	McLean,p.167-176
	Wed 4/16	Lecture 31	Data reduction: optical spectroscopy	McLean,p.340-343
	Fri 4/18	Lecture 32	Radio astronomy	McLean,p.467-474
Week 14	Mon 4/21	Lecture 33	Instruments: single-dish radio astronomy	
PS#6	Wed 4/23	Lecture 34	Interferometry: basic principles	Bradt,p.175-194
	Fri 4/25	Lecture 35	Interferometry: imaging	Bradt,p.194-217
Week 15	Mon 4/28	Lecture 36	Data reduction: radio-interferometric imaging	
	Wed 4/30	Lecture 37	Optical interferometry	McLean,p.66-71, p.181-184
	Fri 5/2	Lecture 38	Observing in practice: proposals, scheduling and quality assessment	
Week 16	Mon 5/5	Lecture 39	Future developments in observational astronomy	McLean,p.501-513
PS#7	Wed 5/7	Lecture 40	Final review	
	Mon 5/12	***Final exam***	8h00am-11h00am; classroom Astr. 134	