ASTR 4200: Observational Astronomy (winter)

Calendar description: The principles of modern ground-based and space-based observational astronomy will be discussed. Emphasis will be on data acquisition (from observations and archives) and analysis, and on the statistical treatment of data. As much as practical, the Burke-Gaffney Observatory will be used for student projects.

Classes 3 hrs. and lab/observatory 2 hrs. per week; 1 semester.

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Overview

This course introduces the student to instrumentation and techniques of observational astronomy, with equal emphasis placed on as many wavelengths as possible. A significant portion of the formal instruction is devoted to statistical methods and data analysis, as this course is the only place in the ASTR curriculum where this topic is discussed. Student projects should utilise archival data from major space-based and ground-based observatories and, weather permitting, should acquire new data from the Burke-Gaffney Observatory. This course is offered to students in their third and fourth year not so much because of the level of the material, but because it allows students to draw on as broad an astronomical background as possible for their projects.

This course is cycled with ASTR 4600 (High-Energy Astrophysics).

Prerequisites

ASTR 2100 Foundations of Astrophysics

Students coming into this course will be assumed to have a solid understanding of spherical geometry and astronomical coordinate systems at the level taught in ASTR 2100.

In addition, the survey of the cosmos provided in ASTR 1100 (Introduction to Astrophysics) and continued in ASTR 2100 will be essential to succeed in this course. The *physics* of astrophysics (*e.g.*, the material covered in the remaining upper-year ASTR courses) is not so essential for this course, though obviously the broader the background of the student, the better equipped he or she will be to pick an astronomically interesting project.

Dependent courses

none

Student Outcomes

The overall aim of ASTR 4200 is to provide students with an understanding of observational astronomy and data analysis techniques. The student completing ASTR 4200 should be able to:

1. independently operate the BGO;
2. describe the principles of CCD detectors and how they are used at different wavelengths;
3. access web-based tools and databases for modern astronomy;
4. fit data and test the quality of fits with appropriate techniques.

Curriculum

1. multi-wavelength telescope design
2. improving resolution
   - interferometry
   - adaptive optics
3. detectors
   - CCDs
   - photomultipliers
   - calorimeters
   - coded-masks
4. instruments
   - imagers

- spectrographs

5. Statistics

   - error analysis
   - expectations
   - correlations
   - hypothesis testing)

6. Data modelling

   - chi-square
   - least squares
   - maximum-likelihood
   - Monte Carlo methods
   - bootstrap

7. Astronomy data analysis software

   - IRAF
   - ds9

8. Surveys

   - censored data
   - confusion limits

Suggested texts

It will be challenging to find one text book that is suitable for the course. Combinations of the following texts are useful. There are significant resources online so supplementing any one text book is possible. Most likely, a course pack will be created with time.

1. *Data Reduction and Error Analysis for the Physical Sciences* by Bevington and Robinson (ISBN 0-07-911243-9) is a great book for the statistics component of the course. It is also likely that the student will have this from previous physics courses (*e.g.*, PHYS 3600 Experimental Physics I).

2. *Practical Statistics for Astronomers* by Wall and Jenkins (ISBN 0-521-45616-9) has not been reviewed, but appears to cover the relevant statistics and with astronomical applications

(unlike Bevington).

3. *Handbook of CCD Astronomy* by Howell (ISBN 0-521-64834-3) covers CCDs very well.

4. *Observational Astrophysics* by Lena, Lebrun, and Mignard.

5. *Astrophysical Techniques* by Kitchin

Notes to the instructor

1. This course may benefit by being team-taught by several faculty in order to best utilize the expertise in the department.

2. There may be some overlap in the discussion of statistical methods with PHYS 3600 (Experimental Physics I), and the instructor(s) is/are encouraged to coordinate this material with the physics lab instructors.