

# ASTR 386 Theories and Instruments of the Astronomer

#### **Course Description**

This course will review various atlases, catalogs, ephemerides, and charts used in modern astronomy that address information about a variety of astronomical objects. The development of methods used to compute stellar positions, distances, temperatures, luminosities and chemical compositions will also be reviewed and applied. Discussions of astronomical instruments in the context of their use in observational astronomy will be discussed. The topics of astronomical astrometry, photometry, spectroscopy and photography along with image acquisition and processing of CCD images will be discussed. (3 credit hours)

Prerequisite: ASTR 332

## **Course Objectives**

This course is designed to introduce the student to research reference resources, telescopes, instruments and standard data systems used to determine the physical properties of planets, stars and other celestial objects. Methods for data acquisition, reduction and analysis will be presented and used to determine properties through the use of standard systems.

Discuss the wave and particle natures of electromagnetic spectrum and use the quantitative properties of these models to explain phenomena such as absorption, refraction, diffraction and dispersion appropriate to astronomical applications,

Describe the basic optical design parameters for telescopes and compute information required to plan an observing session,

Describe the basic components of such optical instruments as cameras, photometers, spectrographs and other optical instruments and use these instruments to collect astronomical data,

Collect astronomical data using CCD cameras and perform proper reductions to account for bias offsets, dark signal and flat fielding,

Identify catalogs used for the determination of celestial positions and be able to compute positions for stars from astronomical images and transform positions to account for coordinate system changes, physical effects and proper motions,

Describe the basic parameters of the UBV and RI photometric systems and use standards on these systems to calibrate data,

Discuss the Hipparchos satellite data sets and their value in determining stellar distances and luminosity,

Discuss the properties of the infrared Two Micron All Sky Survey (2MASS) and the Sloan Digital Sky Survey (SDSS) and their value for probing galactic structure and the large scale structure of the universe,

Describe the basic characteristics of the MKK spectral classification system and use it to classify stellar spectra,

Evaluate internal and external errors associated with observational data.

## **Course Rationale**

Astronomical research projects for students permit them to experience the technical details of planning and executing the full range of activities associated with observational astronomy.

These activities require students to master the use of astronomical instruments in order to gather and process information needed to determine the basic properties of celestial objects. The use of standard systems for positions, photometry and spectroscopy is standard for modern astronomy. This course prepares students to conduct independent research projects in observational astronomy.

## Course Content, Format, and Bibliography

Content

Sample of Course Topics	
1. Nature of Light & EM Radiation	6. Astronomical Distances
2. Properties of Light	7. Astronomical Photometry
3. Astronomical Telescopes	8. Astronomical Spectroscopy
4. Astronomical Instruments	9. Digital Image Reduction and Calibration
5. Astronomical Coordinate Systems	10. Data Reduction and Error Analysis

#### Format

The class will be conducted primarily in lecture/discussion format with homework and independent laboratory activities to be completed on an individual basis. Observing sessions in the Ball State University Observatory and perhaps the SARA facilities located at Kitt Peak National Observatory and Cerro Tololo Inter-American Observatory in Chile will be used to collect data for analysis.

This course is taught as a dual undergraduate/graduate course. Students will be required to complete activities appropriate for the level of the course in which they are enrolled. Student performance on homework, exams and/or labs will be evaluated using different standards for undergraduate and graduate students.

# Bibliography

**CCD Astronomy: Construction and Use of an Astronomical CCD Camera**, Buil, Christian, Willmann-Bell, Richmond, Va., 1991.

Observational Astrophysics, Smith, Robert C., Cambridge University Press, N.Y., 1995,

Astronomical Photometry, Henden, Arne A. and Kaitchuck, Ronald H., Willmann-Bell, Richmond, Va., 1990.

Astronomical CCD Observing and Reduction Techniques, Howell, Steve B., Astronomical Society of the Pacific Conference Series, Vol. 23, San Francisco, Ca., 1992.

The Observer's Guide to Astronomy, Vols. 1 and 2, Martinez, Patrick, Cambridge University Press, New York, 1992.

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