

OBSERVATIONS, DATA ANALYSIS AND STATISTICS

This model syllabus defines the core material for Observations, Data Analysis and Statistics. Instructors should use their discretion in deciding the ordering of topics, the depth to which each is covered, and additional material to include. It is anticipated that instructors will draw upon a range of examples from astrophysics and planetary science to illustrate the core material.

ASTRONOMICAL STATISTICS

Probability

Definition of probability and statistics
Conditional probability: Bayes' theorem
Random variables
Probability density functions
Expectation values and moments
Common probability distributions
Central limit theorem

Statistics

Construction of statistical estimators
Distributions of common statistics
Confidence intervals, error propagation, change of variables
Covariance and correlations
Hypothesis testing
Data modeling and parameter estimation: maximum likelihood, chi-squared minimization
Introduction to efficient parameter estimation methods (e.g. genetic algorithms)

SIGNAL PROCESSING AND NUMERICAL TECHNIQUES

Fourier transforms
Sampling theorem of information theory
Filtering
Digitization
Monte-Carlo methods

OBSERVATIONS AND DATA ANALYSIS

Imaging theory

Geometric optics
Diffraction theory
Image formation

Interferometry and aperture synthesis

Spectroscopy

Spectral resolution and bandwidth

Spectroscopic techniques: diffraction grating spectrometers, Fourier transform spectrometers, heterodyne receivers

Detectors and data analysis

Photometry with CCDs

Radio astronomy techniques (basic antenna theory, brightness temperature)

Techniques for in situ measurement of particles and fields

Sources and treatment of noise

Shot noise

Sky subtraction

Backgrounds as a function of wavelength