Astronomical Data Analysis

Introduction to the Course

Christoph U. Keller

Outline

Astronomical Data Analysis: NS-AP433M

Goal (7.5 ECTS)

Understand how to analyse
astronomical observations
to learn more about the universe

People

- Christoph Keller (Chair of Experimental Astrophysics)
- SIU Staff Members
- Catherine Fischer (PhD student in Solar Physics)

Communication

- everybody: through Blackboard
- C.U.Keller@uu.nl, C.E.Fischer@uu.nl

Course Web Page

Course URL

www.astro.uu.nl/~keller/Teaching/ADA_2011

Contents

- contact information
- course schedule, subscribe to iCal link
- lecture presentations, exercises, exercise materials
- presentation topics and assignments including links to papers (only from UU computers)

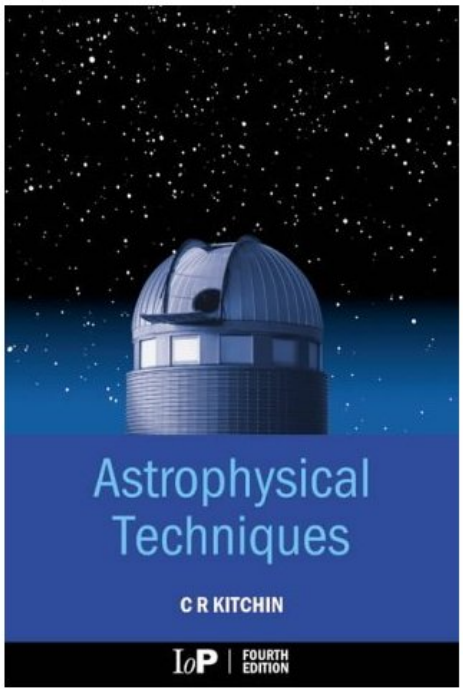
OSIRIS

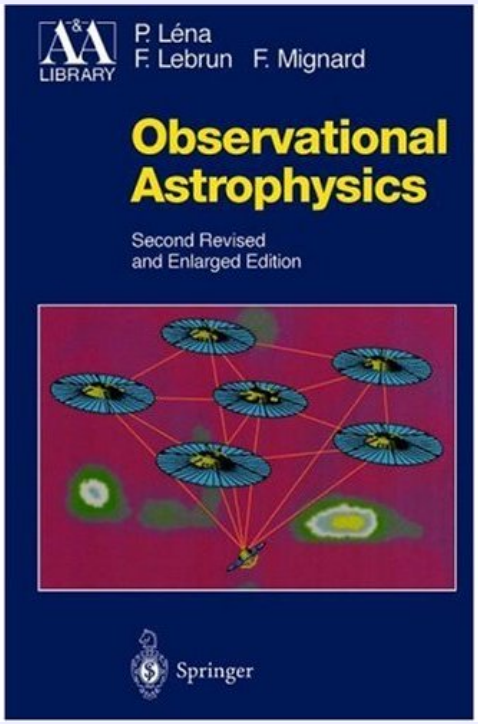
The course web page takes precedence over OSIRIS.

Lecture Notes and Books

Lecture Notes

- written by Johan Bleeker and Frank Verbunt for previous years
- will be distributed in the coming days
- updates as needed





Course Schedule and Requirements

Weekly Schedule

Day	Time	Location	Topic
Monday	13:15 – 15:00	BBL 077	Lectures
Tuesday	13:15 – 17:00	BBL 103	Computer Exercises
Thursday	9:00 – 10:45	BBL 077	Exercises/Presentations
Thursday	11:00 – 12:45	BBL 077	Lectures

Exercises

- exercises are integral part of course
- computer exercises and paper exercises (at home)
- home work has to be submitted by deadline
- will be checked, returned, and discussed
- solutions will not be made available in writing

Presentations

- select one original paper and present it to peers
- 20-minute presentation in English
- public and private discussion of presentation
- grade is for level of understanding of paper

Lectures

Title	Chapter	Instructor
Introduction to the course		Keller
Radiation Fields 1	1	Keller
Radiation Fields 2	1	Keller
Astronomical Measuring Process 1	2	
Astronomical Measuring Process 2	2	Keller
Fitting Observed Data 1	5	Keller
Fitting Observed Data 2	5	
Variability and Periodicity 1	6	Keller
Variability and Periodicity 2	6	Keller
Speckle Imaging		Keller
Deconvolution		Keller

Radiation Fields

- Astronomical measurements
- Stochastic processes
- Distribution functions
- Correlations and auto-correlations
- Convolution
- Fourier transforms
- Sampling and Nyquist theorem
- Filtering

Astronomical Measuring Process

- Power spectra
- Optimal filtering
- Discrete Convolution
- Noise removal
- Applications of filtering
- Moments of a stochastic process
- Stochastic description of radiation fields
- Fluctuations of radiation fields
- Thermal and quantum noise
- Poisson distribution
- Error propagation

Fitting Observed Data

- Comparing data with a model
- Least squares fitting
- Maximum likelihood method
- Gaussian data
- Poissonian data
- Monte Carlo simulations

Variability and Periodicity

- Variable and Periodic Signals in Astronomy
- Lomb-Scarle diagrams
- Phase dispersion minimisation
- Kolmogorov-Smirnov tests
- Fourier Analysis

Speckle Imaging

- Full-Aperture Interferometry
- Labeyrie Technique
- Knox-Thompson Technique
- Bispectrum Technique
- Differential Speckle Imaging
- Phase-Diverse Speckle Imaging

Deconvolution

- Convolutions in Astronomy
- Fourier Deconvolution
- Noise vs. Resolution
- Richardson-Lucy
- Maximum Entropy

Exams and Grades

Exams

- content
  - lectures
  - corresponding sections of lecture notes
  - exercises (computer and home work)
  - paper presentations and questions
- written exam after course ends
- oral exams after that

Grades

- 20% presentation
- 20% exerciseses
- 60% exam

Papers for Presentations

Topic	Paper with Link to ADS	Student Name	Date
CCD Spectroscopy	Horne 1986		10.3.2011
Doppler Imaging	Vogt et al. 1987		10.3.2011
Fringe Removal	Malumuth et al. 2003		24.3.2011
Rotating Modulation Imaging	Hurford et al. 2002		24.3.2011
Lucky Imaging	Law et al. 2006		31.3.2011
Crowded-field Photometry	Stetson 1987		31.3.2011
Radio Image CLEANing	Hogbom 1974		7.4.2011
Asteroseismology	Bruntt et al. 2007		7.4.2011