The Detection and Properties of (Exo)Planetary Systems

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TLS

Part I: Detection and properties ($\sim$observations)
 lectures by Dr. Veronika Schaffenroth

Part II: Formation and evolution ($\sim$theory)
  lectures by Prof. Dr. Alexander Krivov
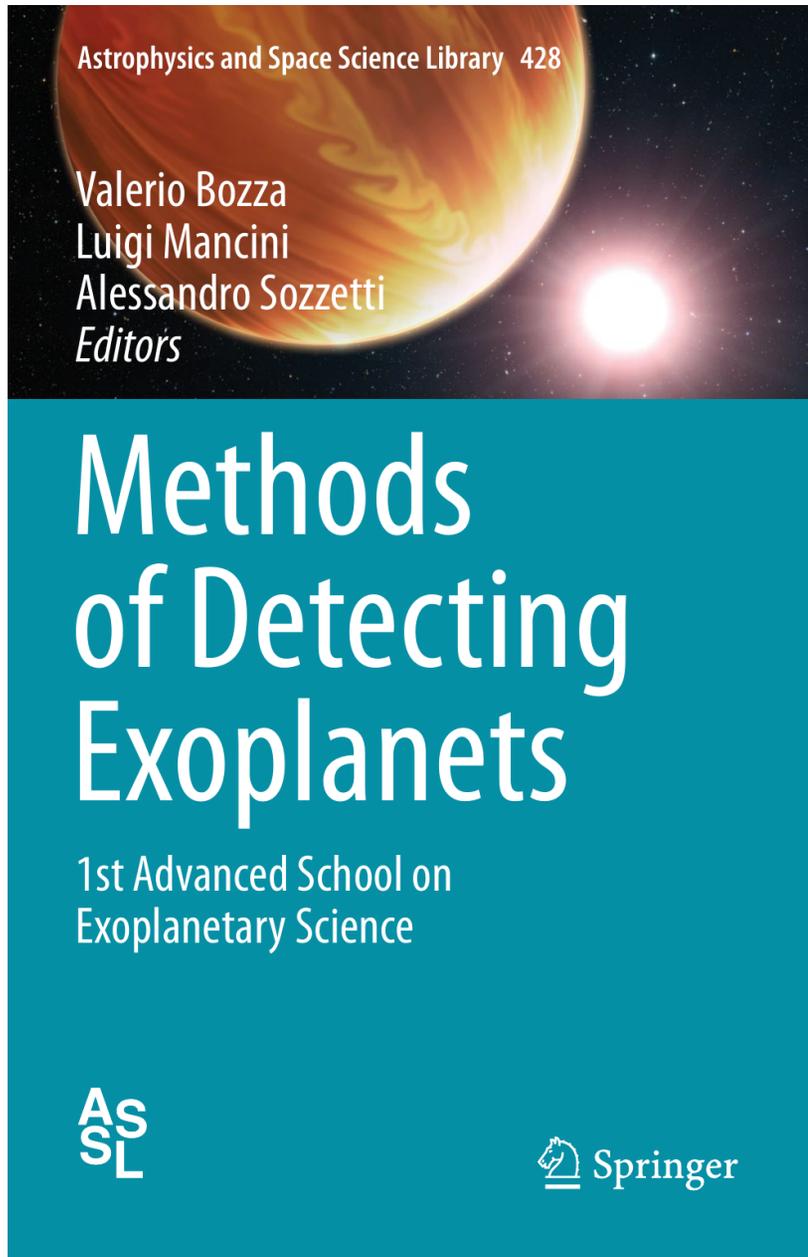
Exercises to both parts: by M.Sc. Tobias Stein

Schedule of Lectures

09. April: Introduction and Solar System
16. April: The Radial Velocity Method: Instruments and Techniques
23. April: The Radial Velocity Method
30. April: The Transit Method
07. May: The Transit Method: Ground-based and space-based results
14. May   **holiday**
21. May: The Astrometric Detection of Exoplanets
28. May: Direct Imaging
04. June: Microlensing
11. June: Pulsar planets and the properties of Exoplanets
18. June: Properties of Exoplanets
25. June: Atmospheres and Interiors
02. July: Host Stars
09. July: Host Stars and The Search for Habitable Planets
x. July: Excursion to Observatory in Tautenburg
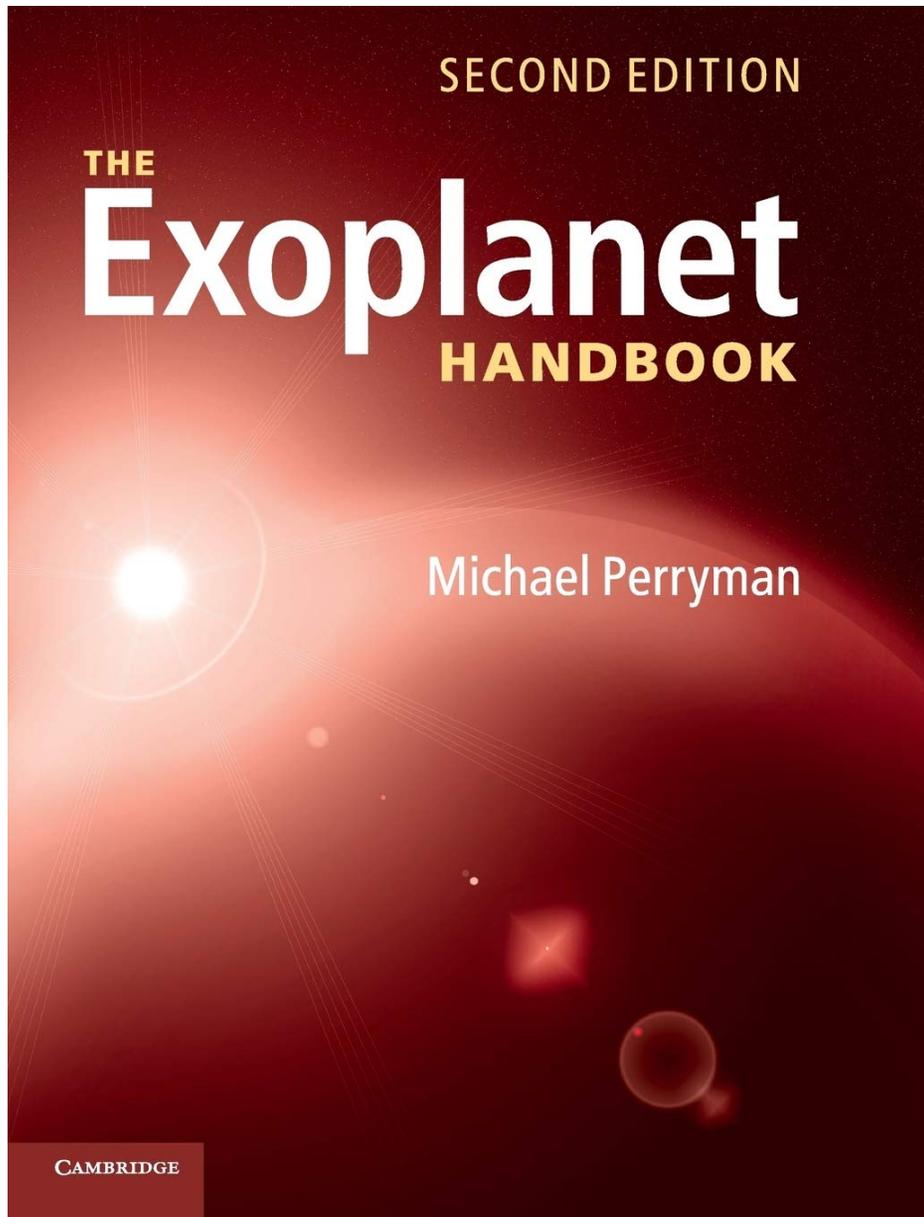
Contents:
- Radial Velocities
- Astrometry
- Microlensing
- Transits
- Imaging
- Host Stars
- Brown Dwarfs and Free floating Planets
- Formation and Evolution
- Interiors and Atmospheres
- The Solar System
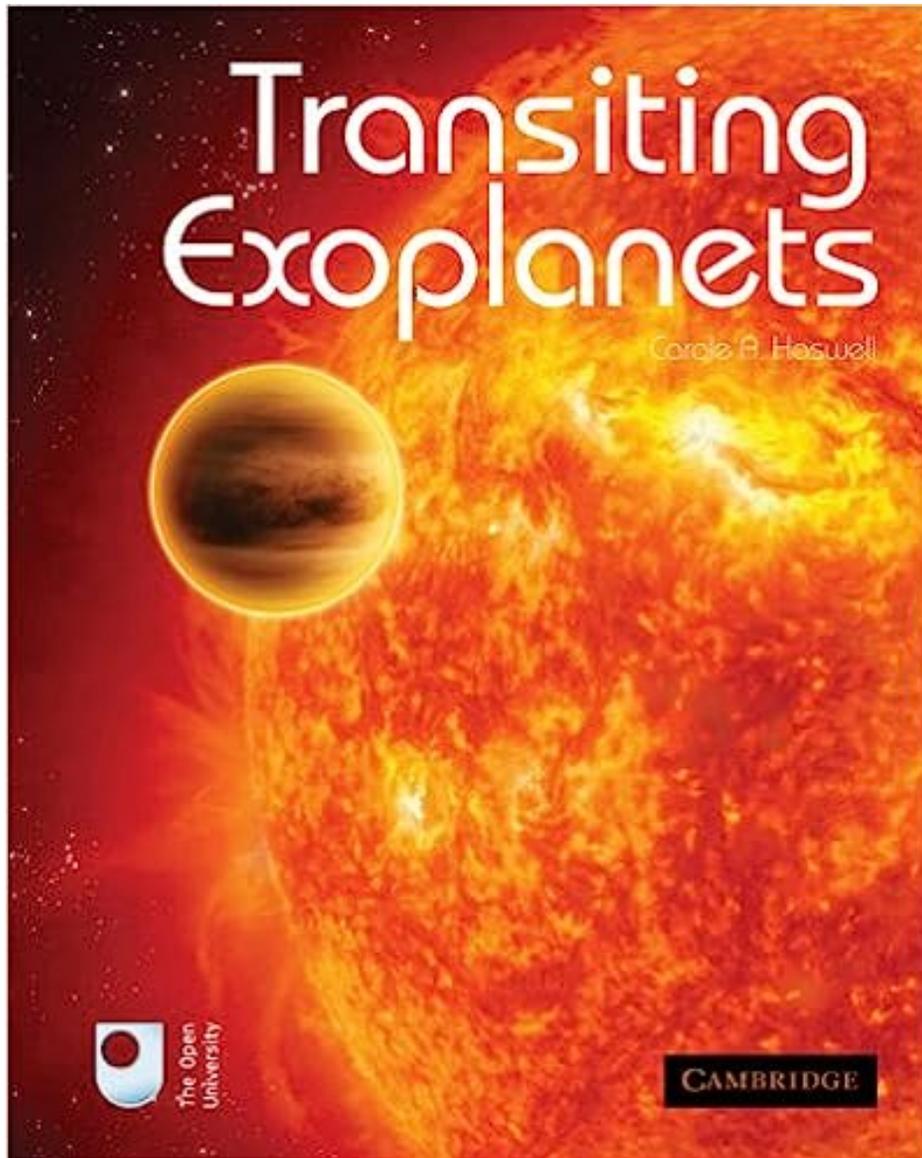
Contents:
- Our Solar System from Afar (overview of detection methods)
- Exoplanet discoveries by the transit method
- What the transit light curve tells us
- The Exoplanet population
- Transmission spectroscopy and the Rossiter-McLaughlin effect
- Host Stars
- Secondary Eclipses and phase variations
- Transit timing variations and orbital dynamics
- Brave new worlds

by Carole Haswell

Exoplanet data bases:

The first: Exoplanet Encyclopaedia
`www.exoplanet.eu` (Jean Schneider)

The best: NASA Exoplanet Archive:
`https://exoplanetarchive.ipac.caltech.edu/`
- Interactive catalog (radial velocity, transits, etc)
- On line histograms and correlation plots
- Download data

5,470
Confirmed Planets
07/11/2023

363
TESS Confirmed Planets
07/11/2023

6,687
TESS Project Candidates
07/08/2023

View more Planet and Candidate statistics

Explore the Archive

gamma cep   Search

Optional Radius (arcsec)   ❓ Advanced Search ➡

Exoplanet Mass vs. Period

Mass – Period Distribution

14 Jul 2023
exoplanetarchive.ipac.caltech.edu

○ Radial Velocity
□ Transits
▲ Microlensing
✴ Imaging
● Timing Variations
● Orbital Brightness Modulation
● Astrometry

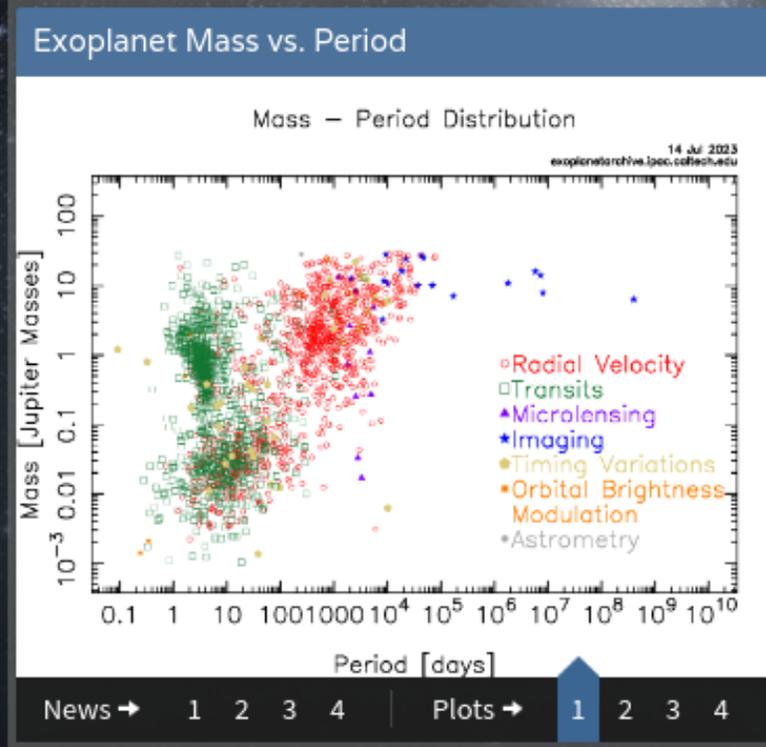Mass [Jupiter Masses]
Period [days]

Transit Surveys   130,041,578 Light Curves

Launched in April 2018, TESS is surveying the sky for two years to find transiting exoplanets around the brightest stars near Earth.

⊞ Confirmed Planets   ➡

⊞ ExoFOP-TESS   ➡

⊞ Project Candidates   ➡ | ⊞ Community Candidates   ➡

| TESS | Kepler | K2 | KELT | UKIRT |

News ➡   1 2 3 4   Plots ➡   **1** 2 3 4

Tools & Services

{Q} Build a Query (TAP)   ➡

{Q} Build a Query (API)   ➡

◐ Transit and Ephemeris Service   ➡ | ⋰ Periodogram   ➡

◐ EXOFAST: Transit and RV Fitting ➡ | ◐ Predicted Observables for Exoplanets (POE) ➡

Work with Data

⊞ Planetary Systems   ➡ | ⊞ Planetary Systems Composite Data ➡

⊞ Atmospheric Spectroscopy (BETA) ➡ | ⊞ HWO ExEP Precursor Science Stars ➡

⬇ Pre-generated Plots ➡ | 🗋 ExoFOP ➡

⊞ Microlensing Planets ➡ | ⊞ Direct Imaging ➡

gam Cep Ab

gam Cep b

gam Cep | 4.66 R⊕ | 4888.00 K

Overview   Notes   System Parameters   Ancillary   Nearby Data   Legend   **Expand All**

ARCHITECTURE
🪐 gam Cep
★ gam Cep Ab
★ gam Cep
  └ 🪐 gam Cep b

OTHER DATA
Bibliography 25
Exoplanet Archive Notes 2
gam Cep Ab Nearby Data 4 🗗
gam Cep Nearby Data 4 🗗

DISCOVERY DATA

Host	Planet	Method	Year	Reference	Disposition
gam Cep	🪐 gam Cep b	Radial Velocity	2003	Hatzes et al. 2003	Confirmed Planet

Exoplanet Archive Notes (2)   +

★ gam Cep Ab Stellar Parameters (0 Solutions) 🖼

★ gam Cep Stellar Parameters (13 Solutions) 🖼   +

🪐 gam Cep b Planetary Parameters (3 Solutions) 🖼   −

STATUS
Confirmed Planet
DETECTED BY
Imaging, Radial Velocity

TOOLS

Source	Endl et al. 2011 ★🔗	Benedict et al. 2018 ★🔗	Hatzes et al. 2003 ★🔗
T_p (days)	2453227±87	2453248.1	2453121.925±66.900
ω (deg)	94.6±34.6	86	49.6±25.6
$M_p \sin i$ ($M_\oplus$)	587.96±50.85	---	540.3±127.1
$M_p \sin i$ (M_{Jup})	1.85±0.16	---	1.7±0.4
e	0.049±0.034	0.08	0.12±0.05
P (days)	903.3±1.5	905.0	905.574±3.08
K (m/s)	31.1±0.97	32.4	27.50±1.5
a (au)	2.05±0.06	---	2.13±0.05
M_p ($M_\oplus$)	---	2988 $^{+222}_{-350}$	---
M_p (M_{Jup})	---	9.40 $^{+0.70}_{-1.10}$	---

The Nebraska Astronomy Applet:
An Online Laboratory for Astronomy

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http://astro.unl.edu/naap/
http://astro.unl.edu/animationsLinks.html
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The Nebraska Astronomy Applet Project

Online Labs for Introductory Level Astronomy

The Nebraska Astronomy Applet Project provides online laboratories targeting the undergraduate introductory astronomy audience. Each lab consists of background materials and one or more simulators that students use as they work through a student guide. Pretests and posttests can be used to gauge student learning.

NAAP materials are designed to be flexible to accommodate a variety of needs. Student guides are provided in MS Word format (in addition to PDF format) so that they can be edited if necessary. Demonstration guides and in-class worksheets are provided for some labs, helping instructors make use of NAAP simulations even if they don't assign the accompanying lab.

Please visit the instructor information page for more details on using the NAAP labs, or the lab descriptions page for a summary of the NAAP labs. You may also want to visit the simulations list page, which includes animations from the ClassAction project as well.

The NAAP Labs

Solar System Models
Basic Coordinates and Seasons
The Rotating Sky
Motions of the Sun
Planetary Orbit Simulator
Lunar Phase Simulator
Blackbody Curves & UBV Filters
Hydrogen Energy Levels
Hertzsprung-Russell Diagram
Eclipsing Binary Stars
Atmospheric Retention
Extrasolar Planets
Variable Star Photometry
Cosmic Distance Ladder
Habitable Zones

Stellar Properties

Distance Modulus Explorer
Stellar Velocity Calculator
Parallax Calculator
Spectroscopic Parallax Simulator
Stellar Luminosity Calculator
Flux Simulator
HR Explorer (NAAP)

Binary and Variable Stars

Eclipsing Binary Simulator
Aliasing in Wagon Wheels
Center of Mass Simulator
Lightcurve Simulator

Milky Way Galaxy

Milky Way Rotational Velocity
Traffic Density Analogy

Cosmology

Balloon Universe
Galactic Redshift Simulator

Solar System Characteristics

Planet Formation Temperatures Plot
Solar System Properties Explorer

ExtraSolar Planets

Influence of Planets on the Sun
Radial Velocity Graph
Transit Simulator (NAAP)
Extrasolar Planet Radial Velocity Demonstrator
Radial Velocity Simulator (NAAP)
Doppler Shift Demonstrator
Pulsar Period Simulator
Hammer Thrower Comparison

Solar System Debris

Driving Through Snow
Planetary Configurations Simulator (NAAP)
Planetary Orbit Simulator (NAAP)

You have some background in Astronomy from an introductory course

I assume that you:

1. Know what a star is
2. Know what a planet is
3. Know about Kepler's three laws
4. Know what a Hertzsprung-Russell Diagram is
5. Know what the Main Sequence is
6. Know what a Spectral Type is
7. Know what the magnitude scale is

If you don't, The Nebraska Astronomy Applet Project is a good place to learn