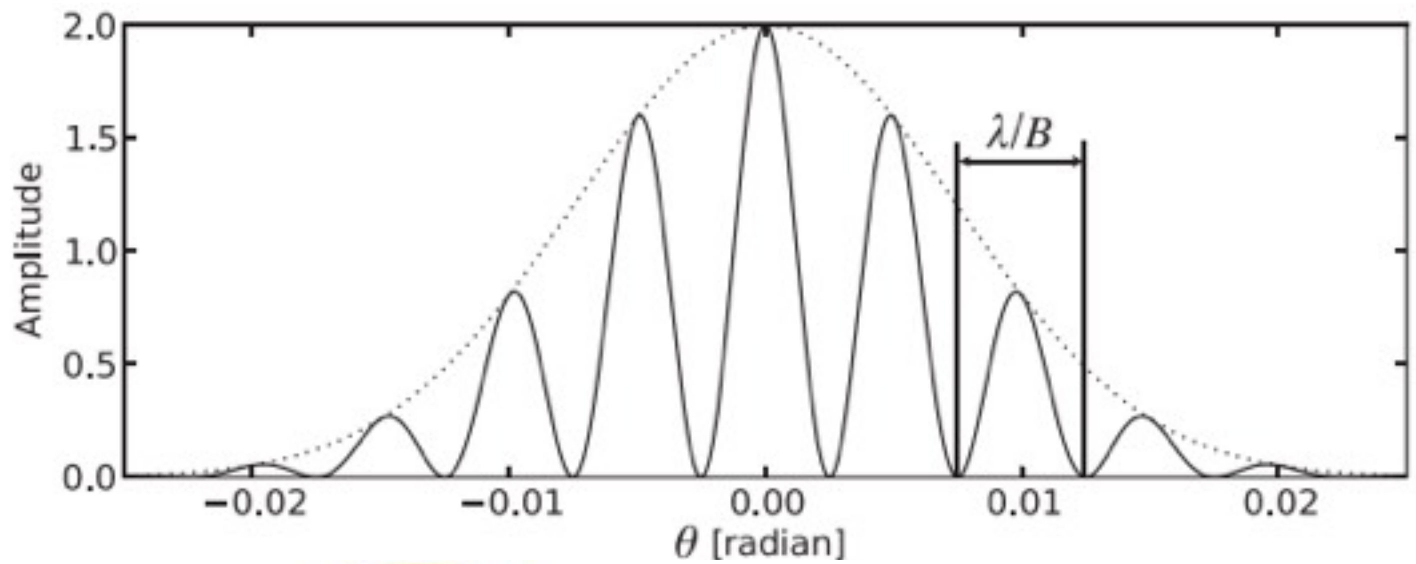
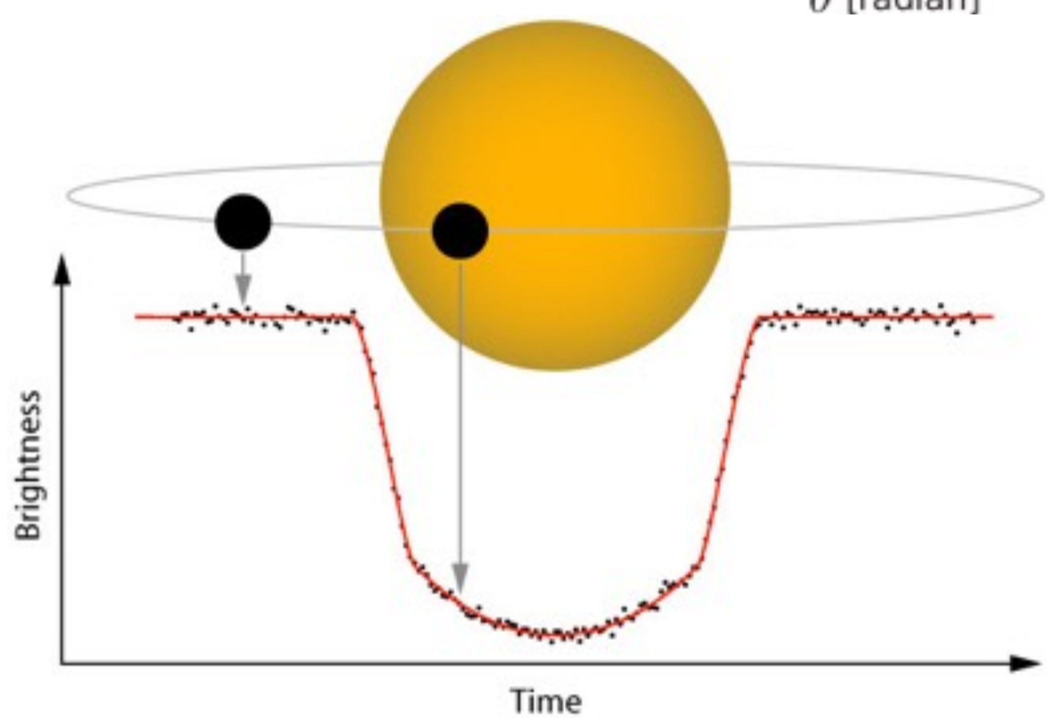
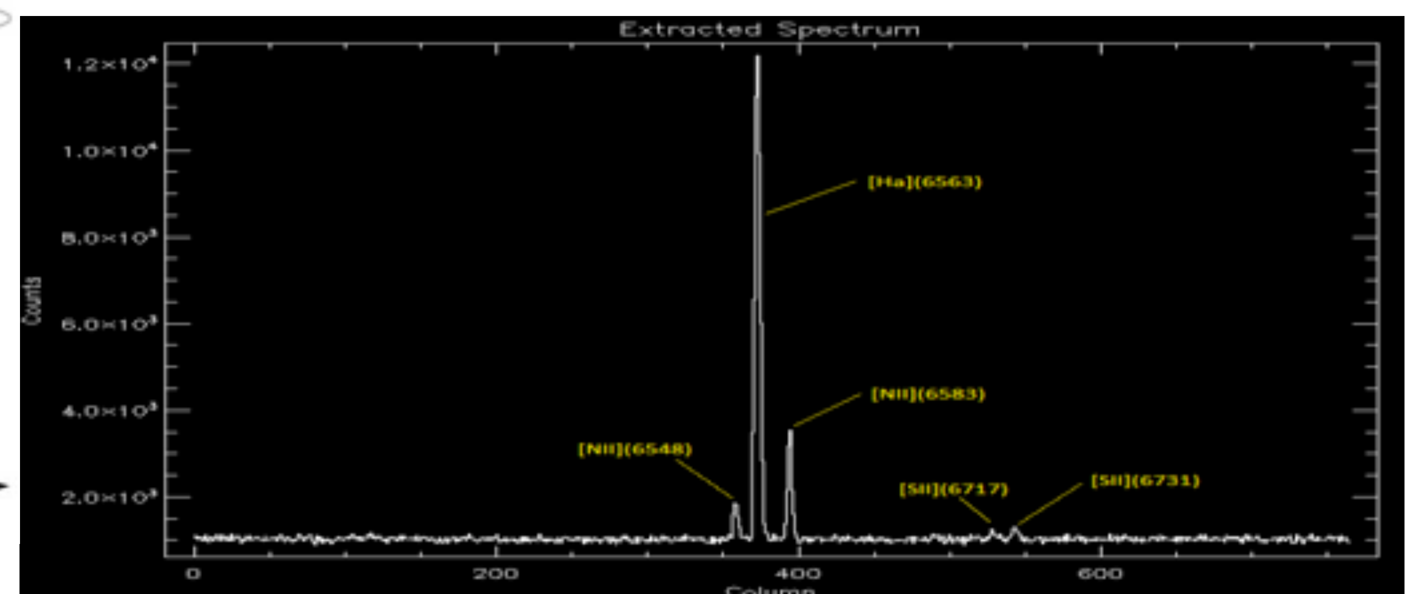
PHY 517 / AST 443: Observational Techniques in Astronomy

Fall 2018, Anja von der Linden

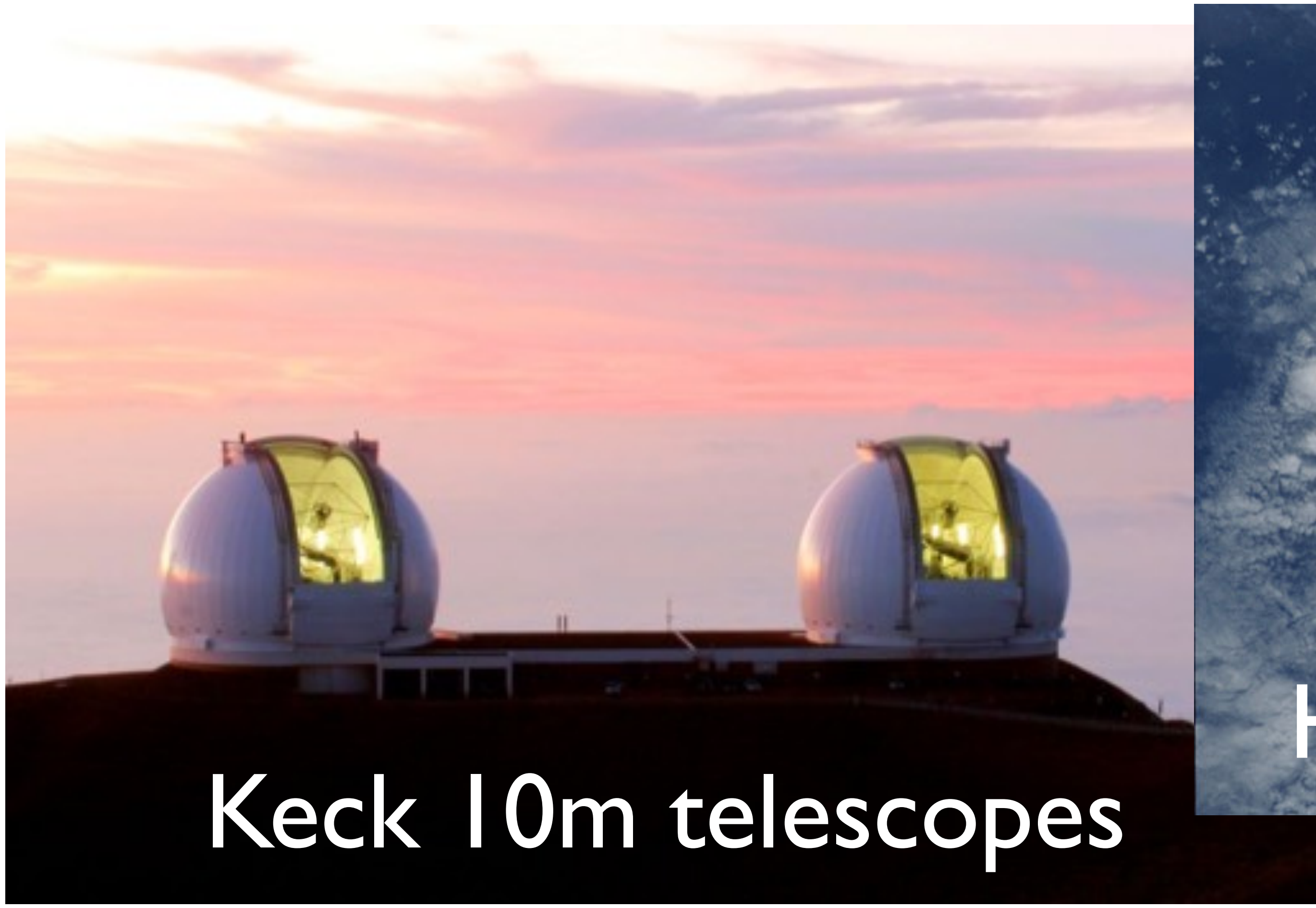






Course Objectives

- introduction to observational astronomy
- design, take, analyze and interpret astronomical observations
- report your work in a scientific paper
- same concepts as needed for these:



Keck 10m telescopes

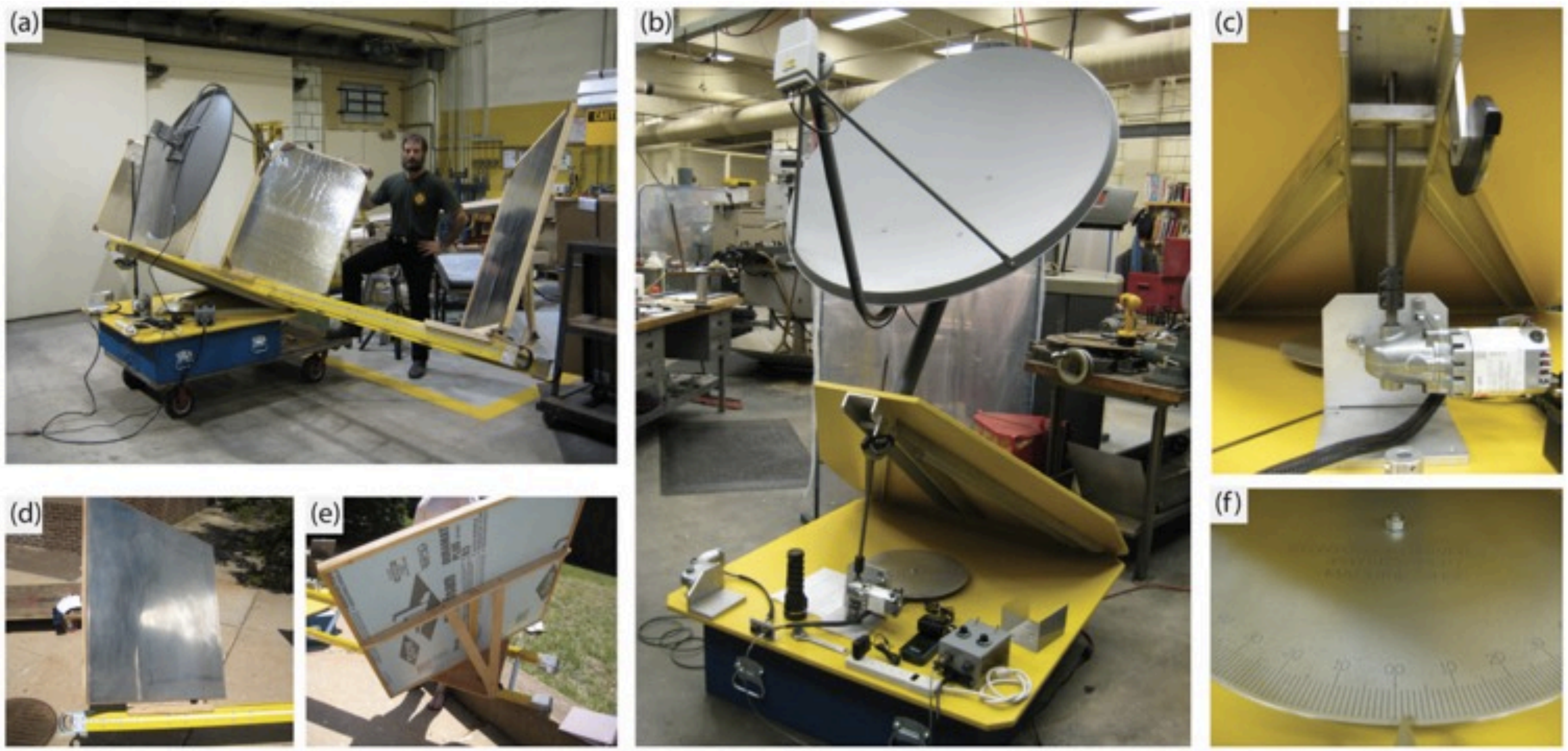
Hubble Space Telescope

Mt Stony Brook Observatory

- roof-top dome + telescope (14-inch) + CCD camera + spectrograph

Radio interferometer

- custom-built at Stony Brook



A Michelson-type radio interferometer for university education

Jin Koda, James Barrett, Gene Shafto, Jeff Slechta, Tetsuo Hasegawa, Masahiko Hayashi, and Stanimir Metchev

Citation: American Journal of Physics **84**, 249 (2016); doi: 10.1119/1.4940212

How to be an astronomer

1. come up with an interesting idea / hypothesis
2. search for and analyze archival observations
3. write a telescope proposal
4. plan and execute your observations
5. analyze your data
6. write a journal paper
7. present your work at conferences

We'll deviate a bit ...

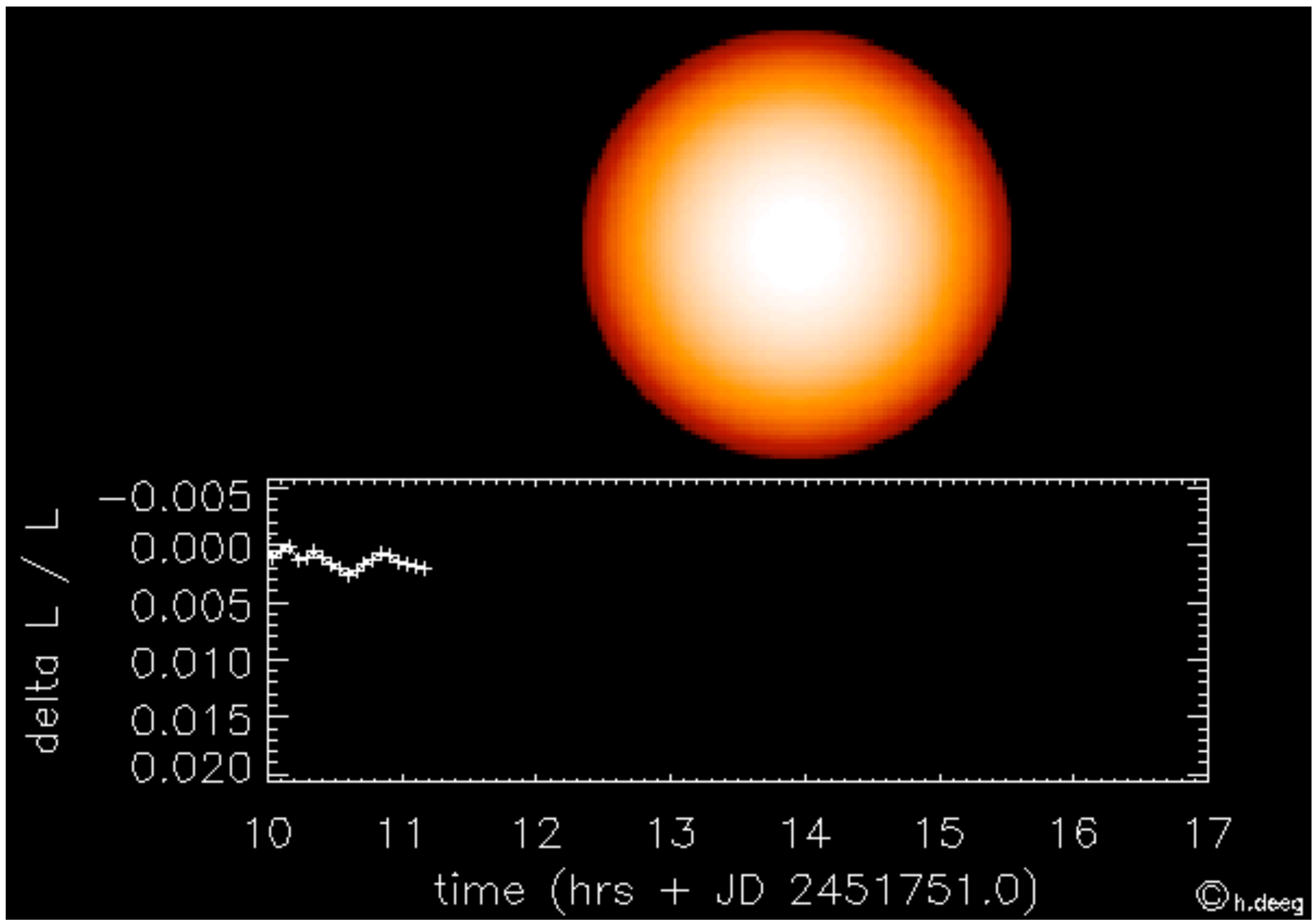
1. conduct and analyze observations
2. lab report → journal paper
3. write a telescope proposal
4. serve on a Time Allocation Committee (TAC)
5. present your work in class

Lab 0 - CCD cameras

- measure properties of our CCD cameras
- understand the role of calibration data
- familiarize yourself with the equipment

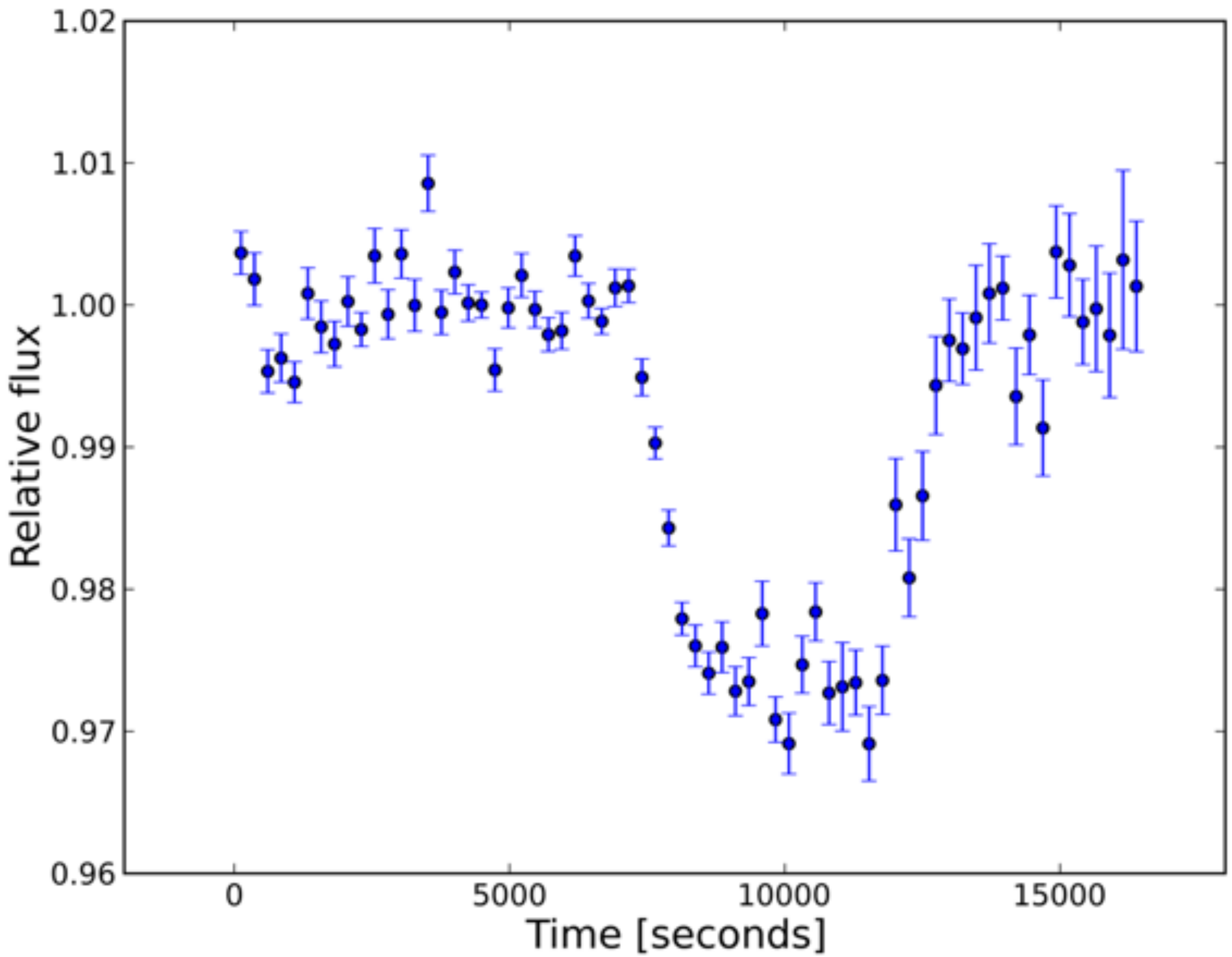
Lab 1 - optical imaging; time-series photometry

- detect an exoplanet transit



Lab 1 - optical imaging; time-series photometry

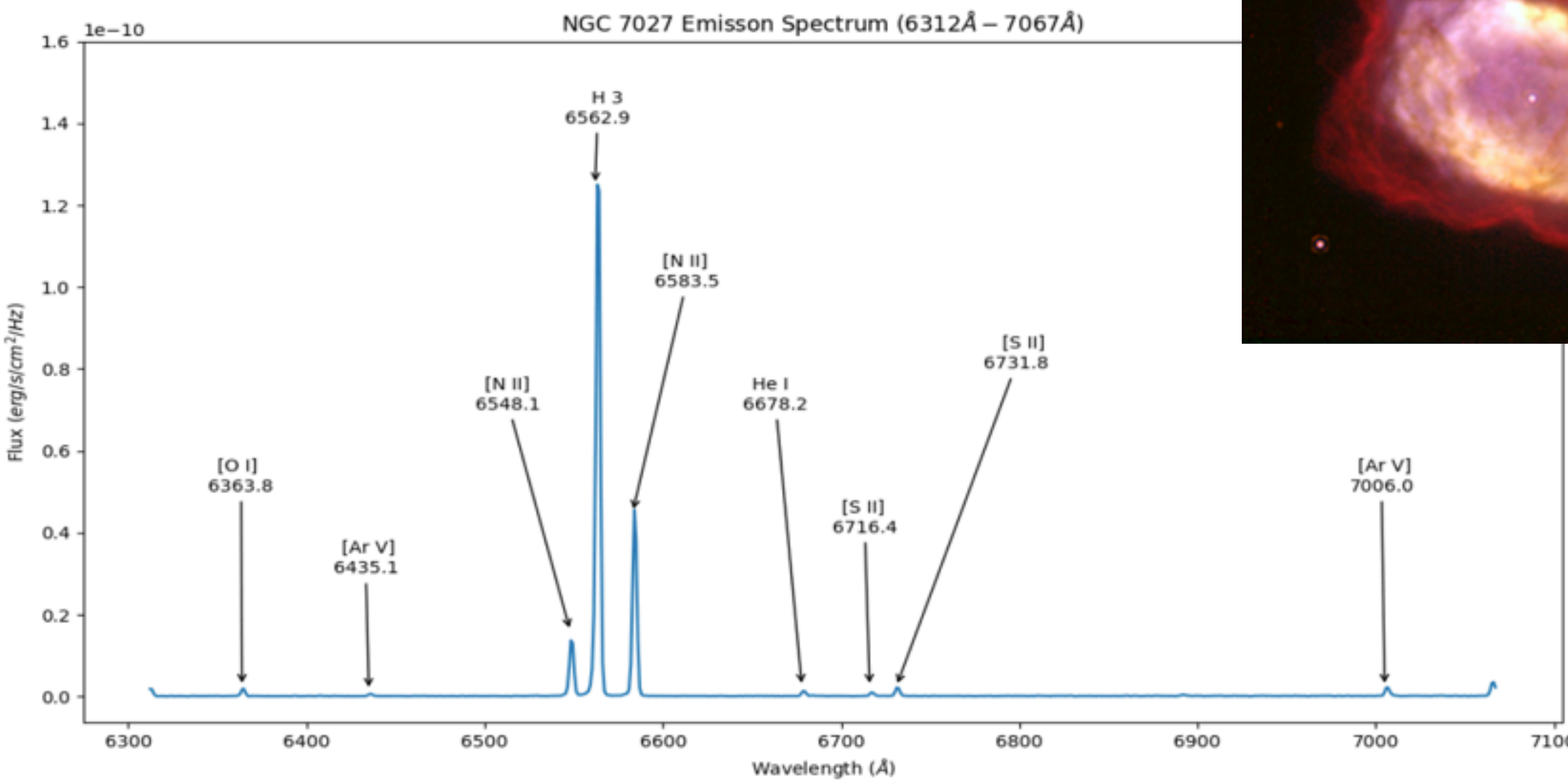
- detect an exoplanet transit



2016 lab

Lab 2 - optical spectroscopy

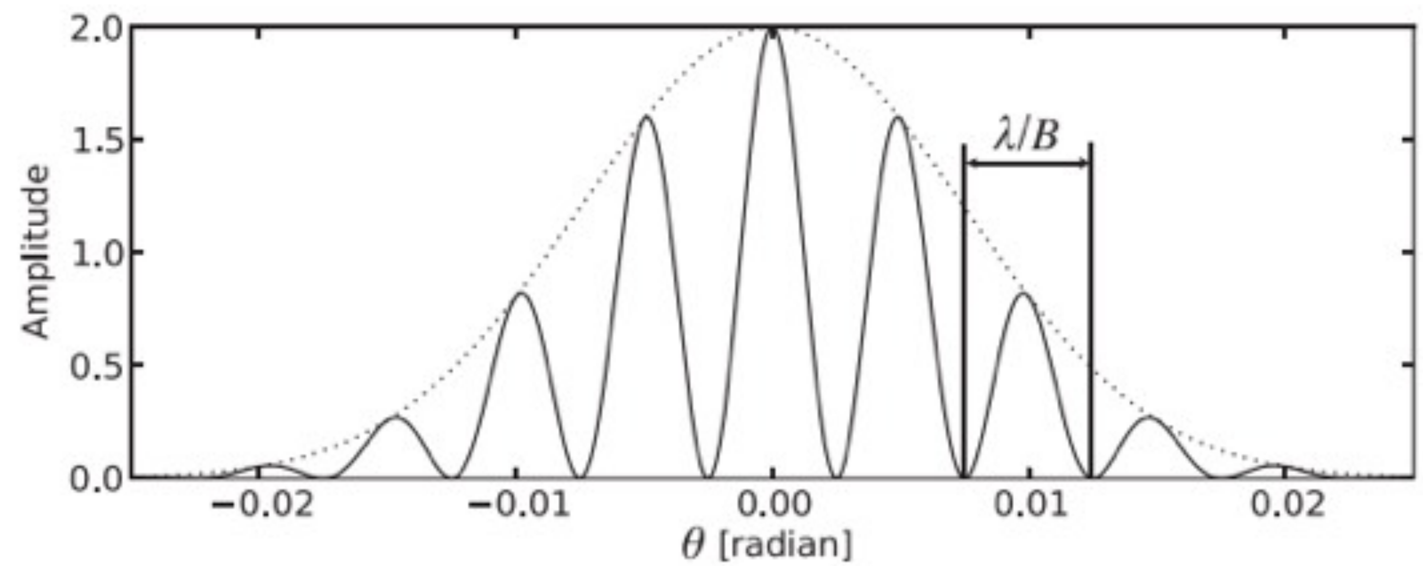
- measure the gas temperature of a gaseous nebula

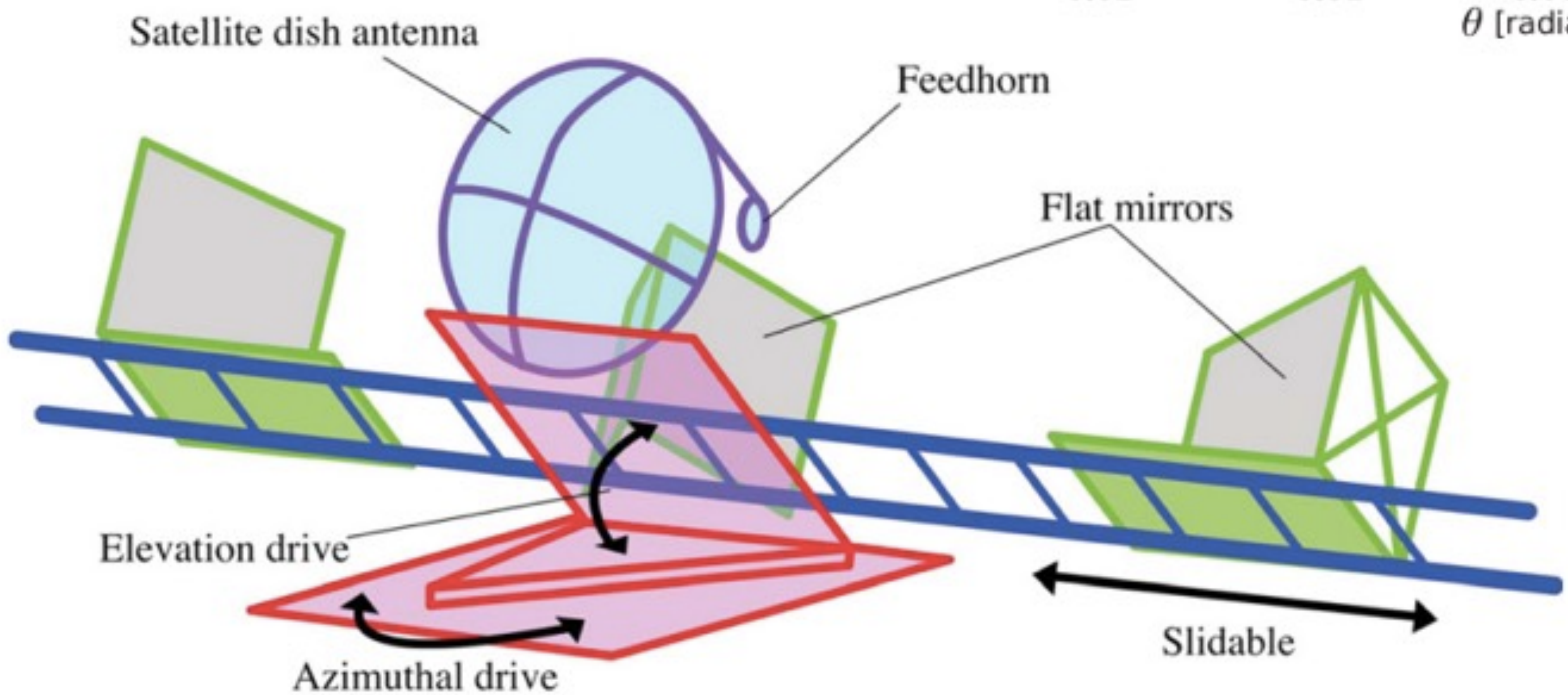


2017 lab

Lab 3 - radio interferometry

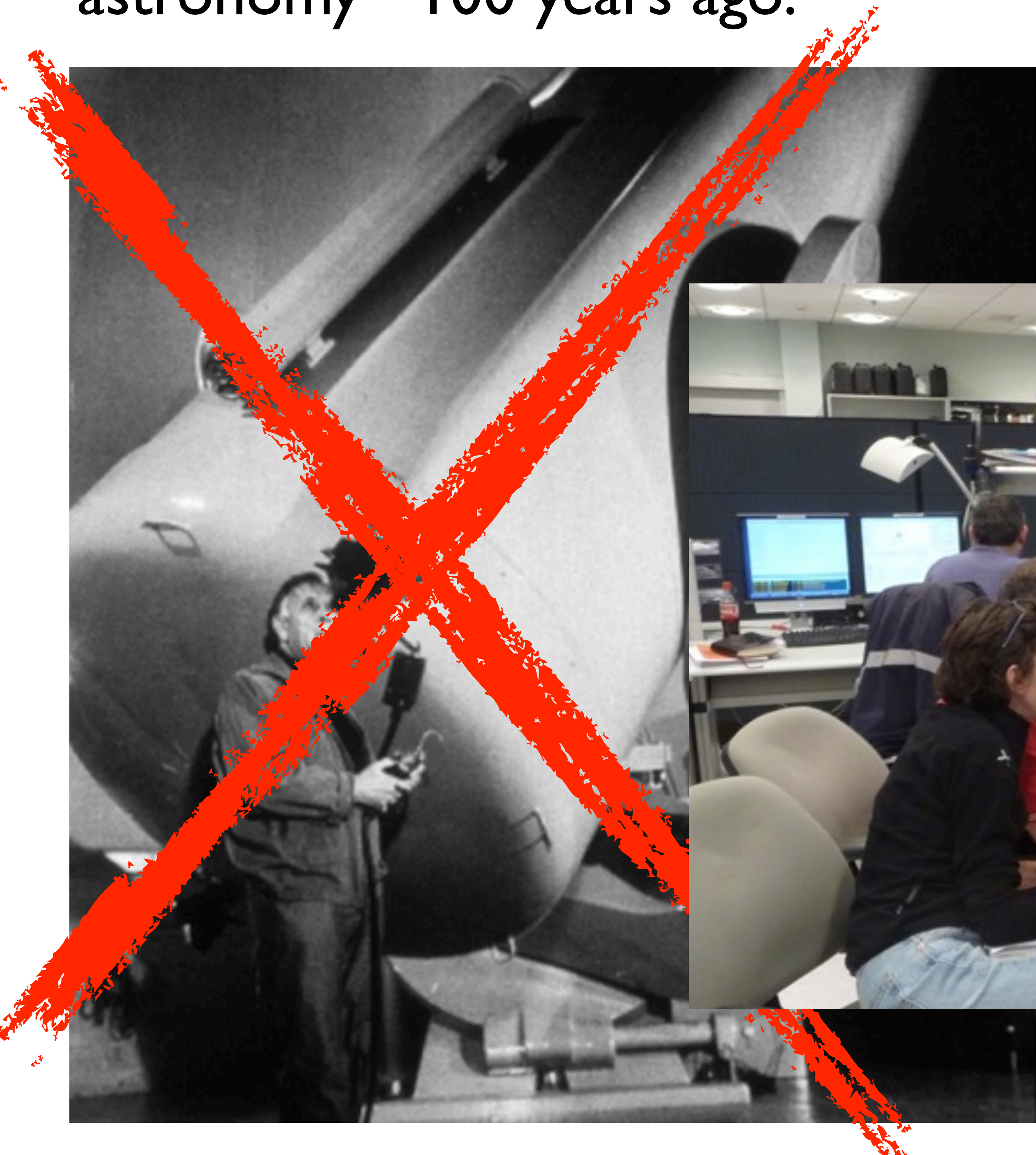
- measure the diameter of the Sun





Data analysis

astronomy ~100 years ago:



astronomy today:

Data analysis

- CCD cameras and digital image processing were revolutionary for astronomy
- first CCD cameras used on telescopes ~1980
- the Sloan Digital Sky Survey (SDSS), designed in the 90s, was one of the first "Big Data" projects; today we are preparing for the Large Synoptic Survey Telescope (LSST), ~20 TB per night, every night for 10 years

- *research in astronomy requires programming, and statistical analysis of large datasets*

- we will use several common astronomy software packages:
    - Source Extractor
    - ds9
    - pyraf / iraf
    - astrometry.net
    - FTOOLS
- most astronomy research is done on Unix / Linux. `bash` provides an integrated scripting language
- `python` is becoming ubiquitous in astronomy as higher-level programming language
- however, this is not a class on programming. we will provide basic instructions and help, but you will have to figure out many things on your own (google is your friend!)

Class structure

Class times:

- Mon + Wed 6-9pm

In practice:

- only ~6 lectures
- other sessions: tutorials / data analysis help, as needed
- most important scheduling constraint is that you get to take your observations
- you need good weather for the 3 observational labs
- for each optical lab: schedule target night + 2 back-up nights
- radio lab: schedule target day + 2 back-up days

Course webpage: https://github.com/anjavdl/PHY517_AST443

anjavdl / PHY517_AST443

Unwatch 15 | Star 3 | Fork 4

Code | Issues 8 | Pull requests 0 | Projects 0 | Wiki | Insights | Settings

Home

Edit | New Page

anjavdl edited this page 2 days ago · 14 revisions

General Information

Credits: 3 (PHY 517) or 4 (AST 443)

Instructor: Anja von der Linden (anja.vonderlinden 'at' stony brook.edu, ESS 453)

Office hours: TBD

TAs:

- Shuang Liang (Shuang.Liang 'at' stonybrook.edu)
- Will Tyndall (William.Tyndall 'at' stonybrook.edu)

Suggested texts:

- Measuring the Universe, G. Rieke (Cambridge University Press, 2012)
- Data Reduction and Error Analysis for the Physical Sciences, P.R. Bevington & D. K. Robinson (McGraw-Hill Higher Education, 2003)
- Practical Statistics for Astronomers, J.V. Wall & C.R. Jenkins (Cambridge University Press, 2008)

Prerequisites: AST203 (Astronomy). Highly encouraged: PHY277 (Computation for Physics and Astronomy), WRT102 (Intermediate Writing Workshop)

Pages 25

General Information

- Schedule
- Grading
- Academic Policies

Labs and Write-Ups

- Guidelines
- How to write a decent lab report
- Observing Equipment
- Observing Calendar
- Lab 0: CCDs
- Lab 1: Exoplanet transit
- Lab 2: Diffuse Nebula Spectroscopy
- Lab 3: Radio Interferometry
- Weather

Computing

- Computing Resources
- Astro Software Overview

anjavdl / PHY517_AST443

Unwatch 15 | Star 3 | Fork 4

Code | Issues 8 | Pull requests 0 | Projects 0 | Wiki | Insights | Settings

Home

Edit | New Page

anjavdl edited this page 2 days ago · 14 revisions

General Information

Credits: 3 (PHY 517) or 4 (AST 443)

Instructor: Anja von der Linden (anja.vonderlinden 'at' stony brook.edu, ESS 453)

Office hours: TBD

TAs:

- Shuang Liang (Shuang.Liang 'at' stonybrook.edu)
- Will Tyndall (William.Tyndall 'at' stonybrook.edu)

Suggested texts:

- Measuring the Universe, G. Rieke (Cambridge University Press, 2012)
- Data Reduction and Error Analysis for the Physical Sciences, P.R. Bevington & D. K. Robinson (McGraw-Hill Higher Education, 2003)
- Practical Statistics for Astronomers, J.V. Wall & C.R. Jenkins (Cambridge University Press, 2008)

Prerequisites: AST203 (Astronomy). Highly encouraged: PHY277 (Computation for Physics and Astronomy), WRT102 (Intermediate Writing Workshop)

Homework reading until Wednesday

Pages 25

General Information

- Schedule
- Grading
- Academic Policies

Labs and Write-Ups

- Guidelines
- How to write a decent lab report
- Observing Equipment
- Observing Calendar
- Lab 0: CCDs
- Lab 1: Exoplanet transit
- Lab 2: Diffuse Nebula Spectroscopy
- Lab 3: Radio Interferometry
- Weather

Computing

- Computing Resources
- Astro Software Overview

TAs

Shuang Liang <shuang.liang@stonybrook.edu>

office ESS-443C

Will Tyndall <william.tyndall@stonybrook.edu>

office B-128

Team work

- observational astronomy is done in teams
- for the labs, you will observe in teams of 2 or 3
- you are highly encouraged (and expected) to work together on the data analysis
- everybody has to submit individual lab reports (however, proof-reading each other's reports is highly encouraged)
- please form teams of 3 people by Wed this week
- please make sure that
  - at least one of you has some programming experience
  - at least one of you has a laptop with Linux
  - you are available on the same week-nights / days

(Night-time) observing

- a TA or instructor must be present (or in the building)
- please plan your observations to be done by ~ midnight
- familiarize yourself with the instructions: you will be quizzed at the beginning
- bring:
  - WARM clothes!
  - a red flash-light / rear bike-light
  - a USB key to take your data home
  - all materials needed for the lab: instructions, finding charts, your notebook etc.
  - cookies / chocolate

Grading

- 20% lab 1
- 20% lab 2
- 20% lab 3
- 10% lab 0
- 10% project proposal + evaluation of peer proposals
- 10% final presentation
- 10% homeworks + participation in discussions
- Attendance is mandatory!

Lab Reports

- 70% of your grade comes from your lab reports
- make sure you know how to write a scientific article!
- read scientific papers to see examples
- guidelines on wiki

Lab Reports

- every lab comes with weekly deadlines to show us your progress / hand in your report
- Lab 0: report due 3 weeks after observations
- others: report due 4 weeks after observations
- late penalty: for every day the data analysis check-in / the report is late, the final grade is multiplied by 0.95
- Example:
  - Initial grade of 80%
  - One day late: $0.80 \times 0.95 = 0.76$
  - Two days late: $0.80 \times (0.95)^2 = 0.72$
  - Three days late: $0.80 \times (0.95)^3 = 0.69$
  - One week late: $0.80 \times (0.95)^7 = 0.56$
  - Two weeks late: $0.80 \times (0.95)^{14} = 0.39$

Delay Days

- You all have other constraints (GREs, mid-terms) that will occasionally make meeting a deadline really hard...
- Everybody gets 7 "delay days" at the beginning of the course
- You can trade in delay days to avoid late penalties (for lab reports and data analysis check-ins, NOT proposals / presentations)
- For data analysis check-ins, delay days have to be used as a group (everybody "spends" a delay day)
- For lab reports, delay days can be used individually

Plagiarism

- Any incidence of plagiarism will automatically result in a final grade of "Q" (Academic Dishonesty).
- Examples of plagiarism specific to this course:
    - Copying parts of somebody else's lab report verbatim
    - Copying parts of somebody else's lab report, slightly modifying each sentence
    - Copying somebody else's observing proposal
    - ...

Final Grades / Curving

- Letter grades will be assigned according to the standard scheme:
  - >93%: A
  - 90% - 92.9%: A-
  - 87% - 89.9%: B+
  - ...
- If curving becomes necessary, there will be separate curves for undergraduate vs. graduate students (since the minimum passing grades are different)

“This class sounds tough...”

- This course was, by far, the best laboratory I have ever taken at Stony Brook. It is one of the best courses I have taken period. In only one semester, I was able to meaningfully participate in the scientific process in a way that was engaging, rigorous, educational, and purposeful. I learned about python, astronomical equipment, the astronomical bodies I studied, how to write research proposals, how to write scientific papers etc. The list goes on and on. I
- This course offers immense value to students with a desire to pursue academic research in the field of Astronomy. This course was difficult, time consuming, and the instructor has very high expectations of her students, which are merited. If we want to pursue research, fundamental skills must be developed. It was nice to be challenged, and I feel strongly that this course helped me improve as a student.
- It gave a sneak peek into the life of an astronomer.
- This is an extremely valuable class for astronomy students interested in going into research. It's really impressive that we were able to use legitimate equipment, targets, and techniques that real observers would use. It's rare that an undergraduate class would give this much real-world experience.
- I learned a lot in this course. The student is responsible to figure out how to do most everything in this class especially when analyzing data from lab experiments and this really prepares students to go into graduate school and into research as an astronomer. I improved my skills in coding, LaTeX, and writing scientific papers in this course. The TAs were very helpful during lab experiments.
- I appreciated that each report covered an area of astronomy very well. Putting in the effort, you can learn the relevant softwares/computing techniques used throughout the course associated to each topic. I also gained much deeper understandings of astronomy techniques, such as how an exoplanet light curve is constructed from just a series of images.
- I learned hands on observational astronomy techniques, I improved my writing skills and I also strengthened my coding skills. What makes this course so valuable is that the experiences I had in class will provide me will useful skills in my career.
- This course gave me a nice insight into the observational world of Astronomy. This was the first time i have been able to get hands on experience with observations.

Speaking of workload

- There's a lot of work to be done... 4 labs + reports, proposals + evaluations, final presentations
- It is unavoidable that you will be working on more than one assignment at a time
- The weekly analysis check-ins are meant to help you by dividing the work into manageable chunks
- Start scheduling your observations as early as possible to avoid too much work pile-up!

- By spacing out what needs to be done. At one point, we had to hand in a fully finished lab report, a data analysis check in of another lab, and had to observe for the third lab all in the same week. This class is extremely labor intensive and you will end up doing most of the things last minute because of other classwork.

Avoiding this situation is your responsibility!

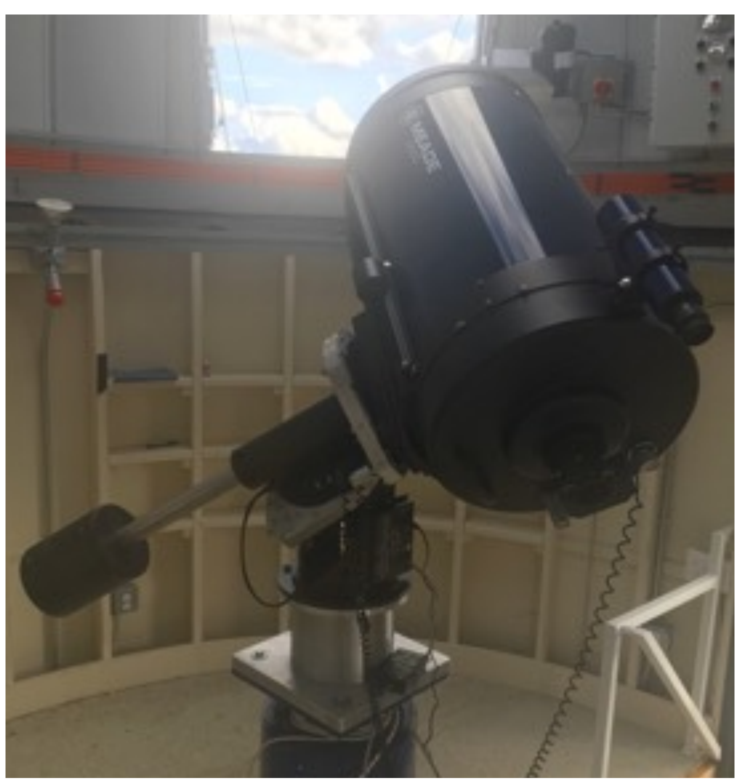
Note

- this is NOT an “easy” class!
- you will have to work hard
- you will have to figure out things on your own
- this class will challenge you

- ... for many of you, it will be the closest thing to actual research that you have encountered so far

New this year

- Old Mt. Stony Brook telescope mount:
  - pointing basically random
  - did not track reliably
  - significant time losses simply for finding targets



- 2018: we have a new telescope mount!
  - ... and it’s awesome!
  - I’m still setting it up
  - some documentation might be outdated

My Bio

undergrad:	University of Bonn
PhD:	Max-Planck-Institute for Astrophysics, Garching
post-docs:	Stanford University
	Tycho Brahe Fellow, Stanford + Copenhagen
since Dec. 2015:	faculty at SBU

How I got interested in astronomy

1990s:
Bayer moved my Dad+family to SE Texas

skies were dark, nights were warm, people were different

How I stayed interested in astronomy

International Astronomical Youth Camp:
spend 3 weeks with ~70 young people from all over the world

Me at big observatories