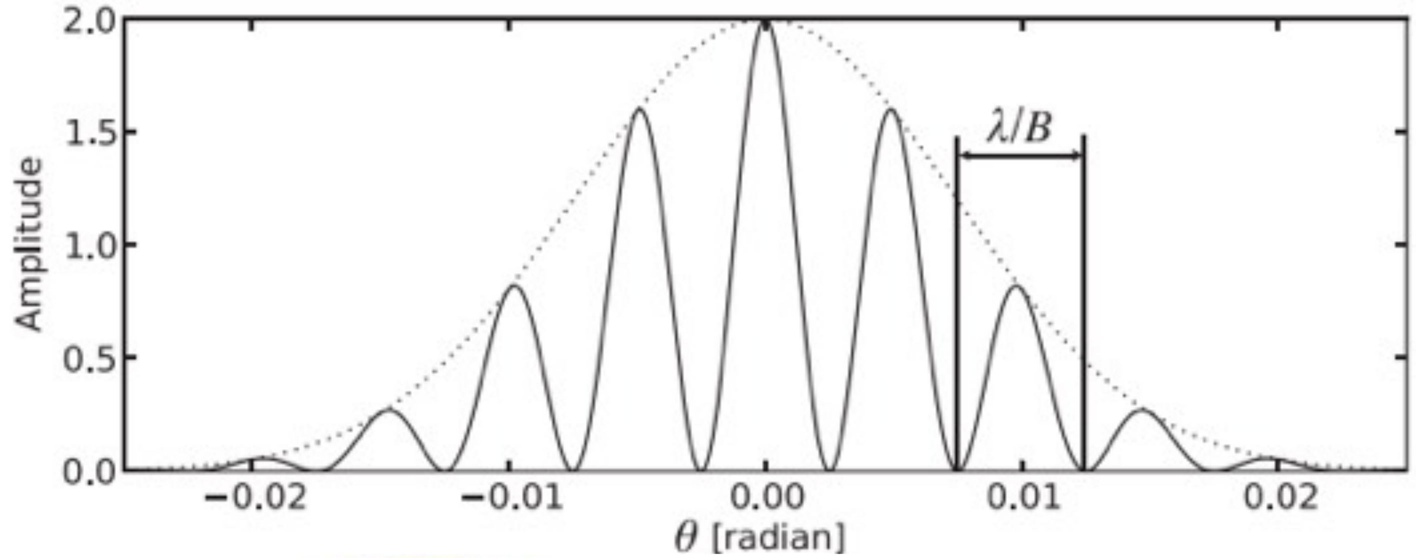
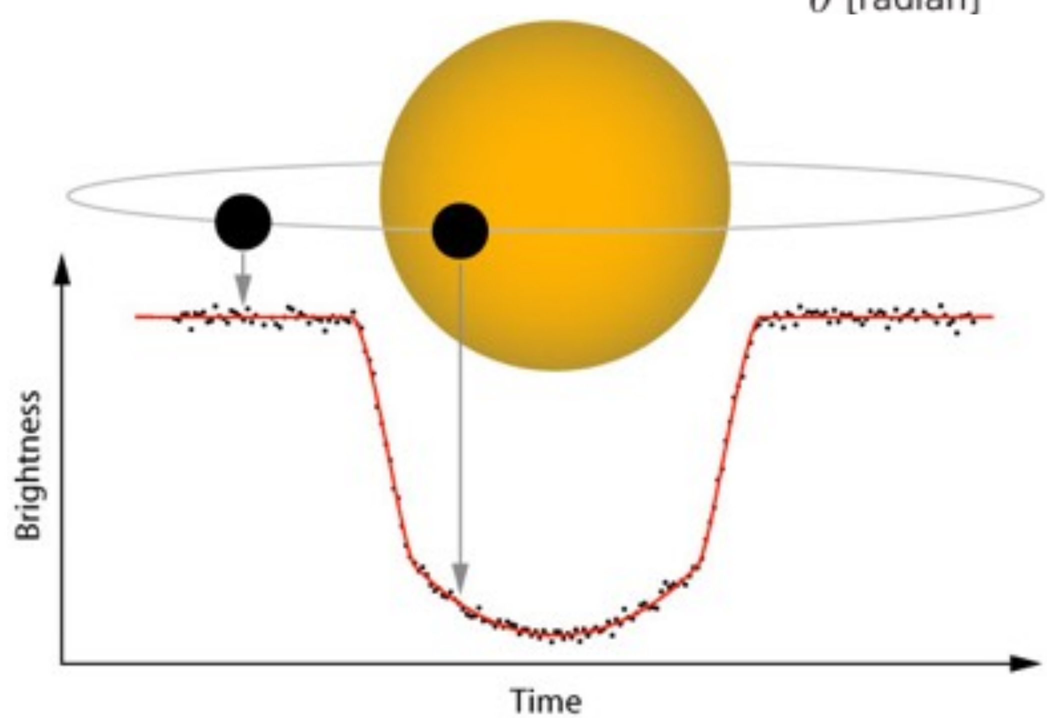
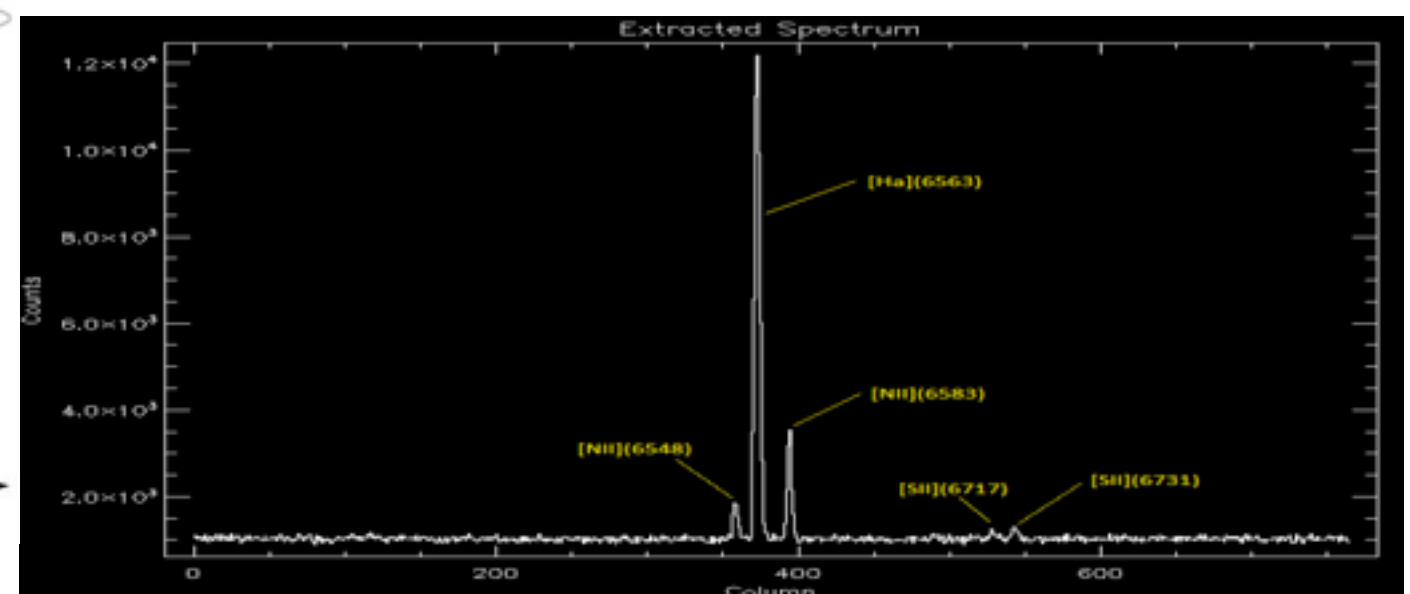
PHY 517 / AST 443: Observational Techniques in Astronomy

Fall 2017, Anja von der Linden

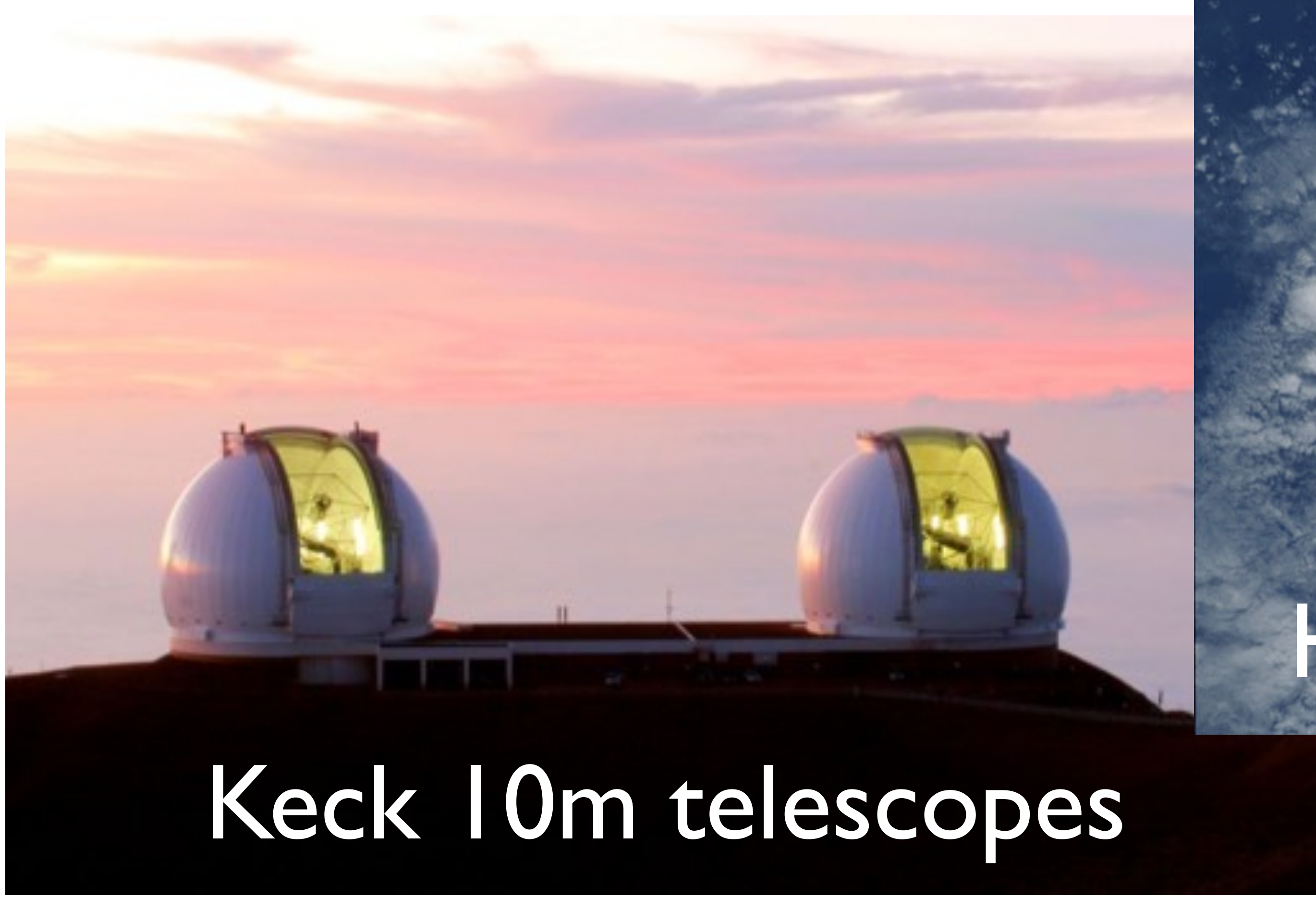


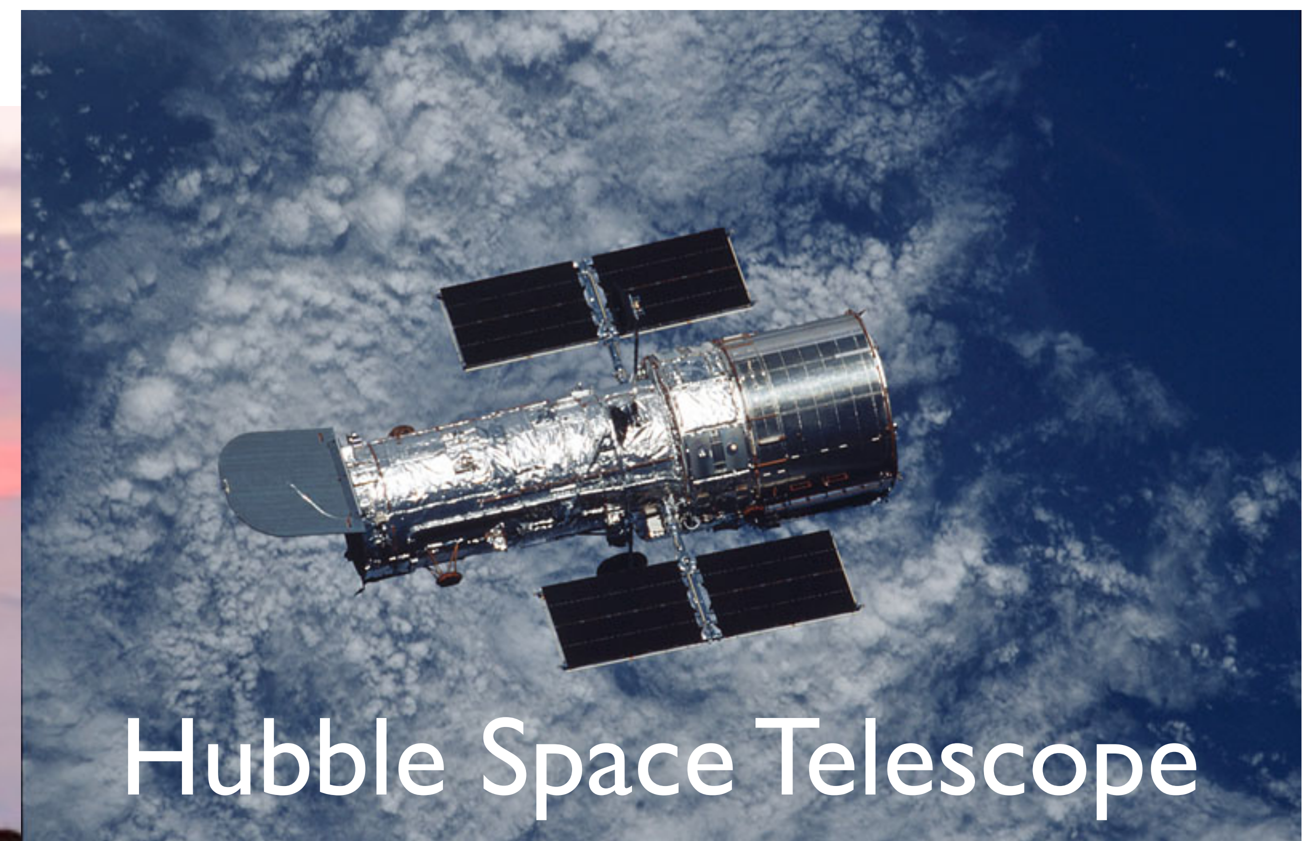




Course Objectives

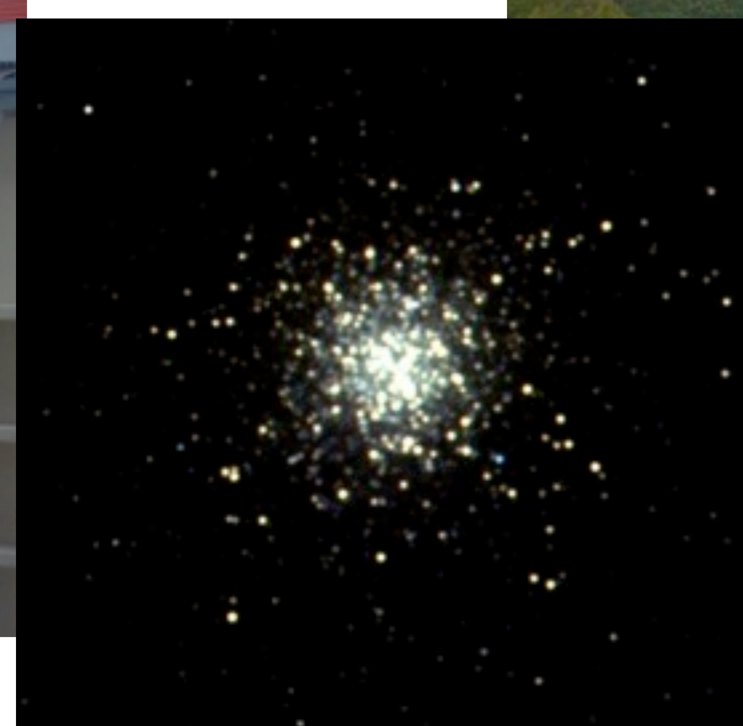
- introduction to observational astronomy
- design, take, analyze and interpret astronomical observations
- same concepts as needed for these:





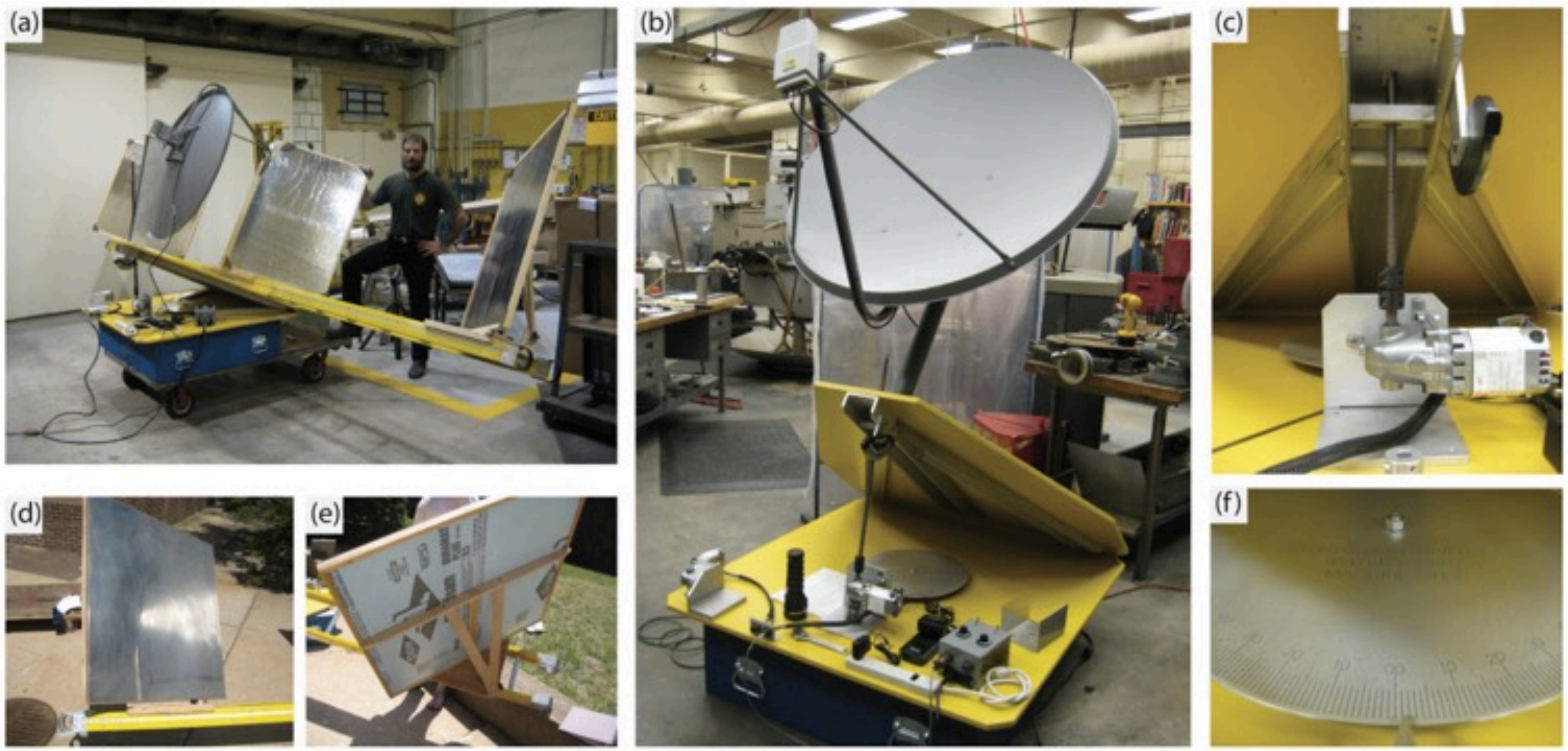
Mt Stony Brook Observatory

- 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 ...

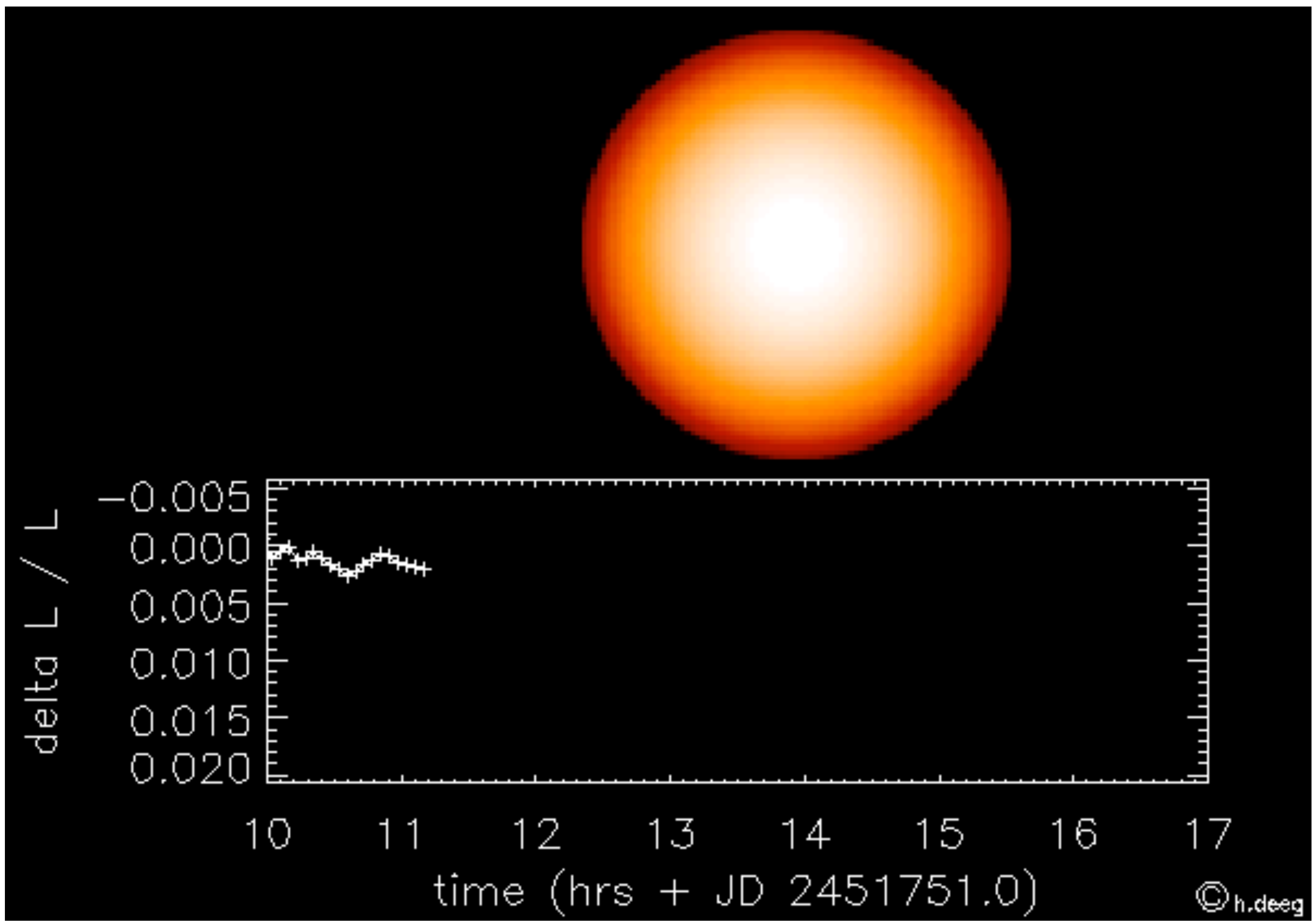
1. conduct and analyze observations
2. lab report → journal paper
3. write a telescope proposal
4. serve on a Time Allocation Committee (TAC)
5. present your work in class

Lab 0 - CCD cameras

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

Lab 1 - optical imaging; time-series photometry

- detect an exoplanet transit



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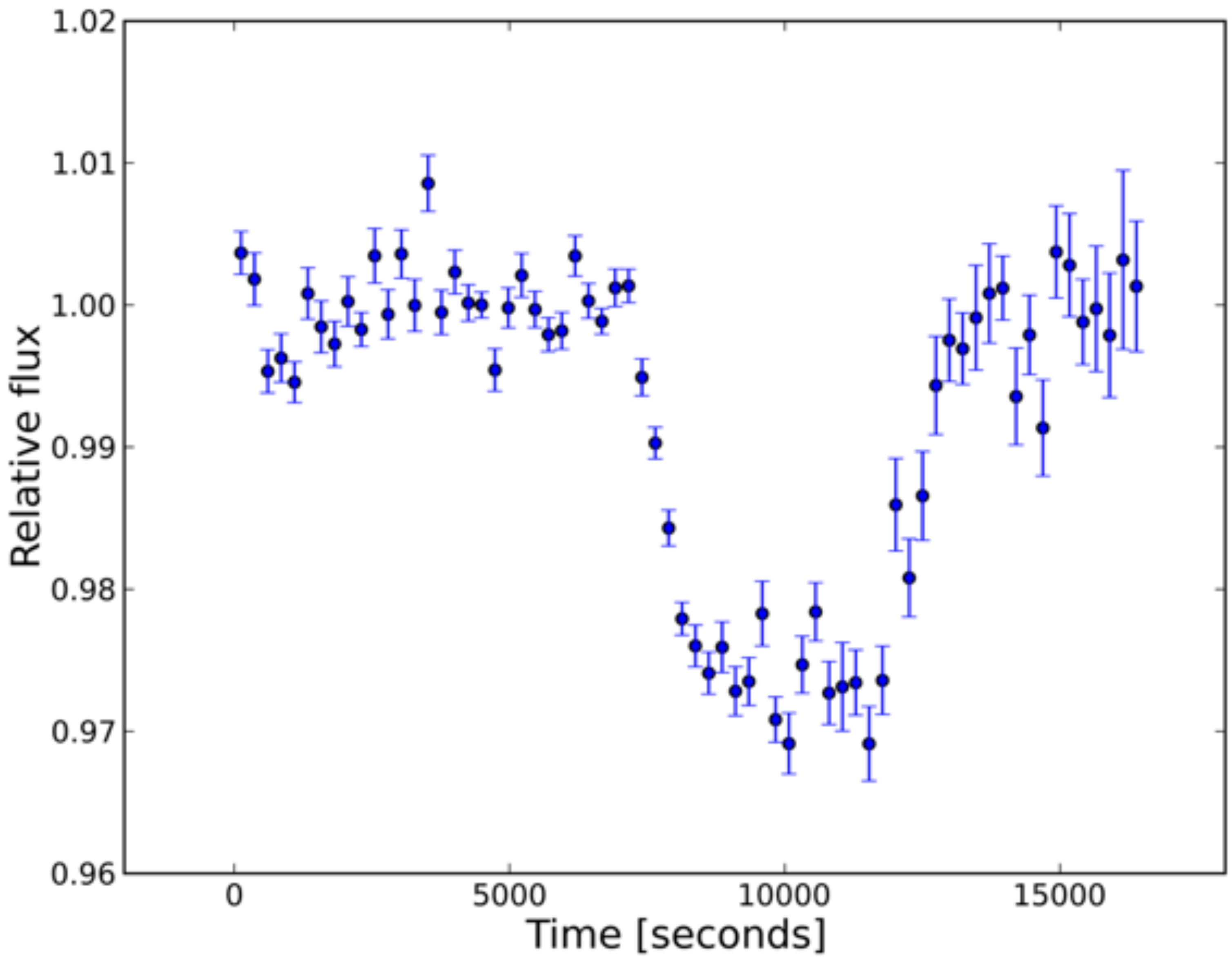
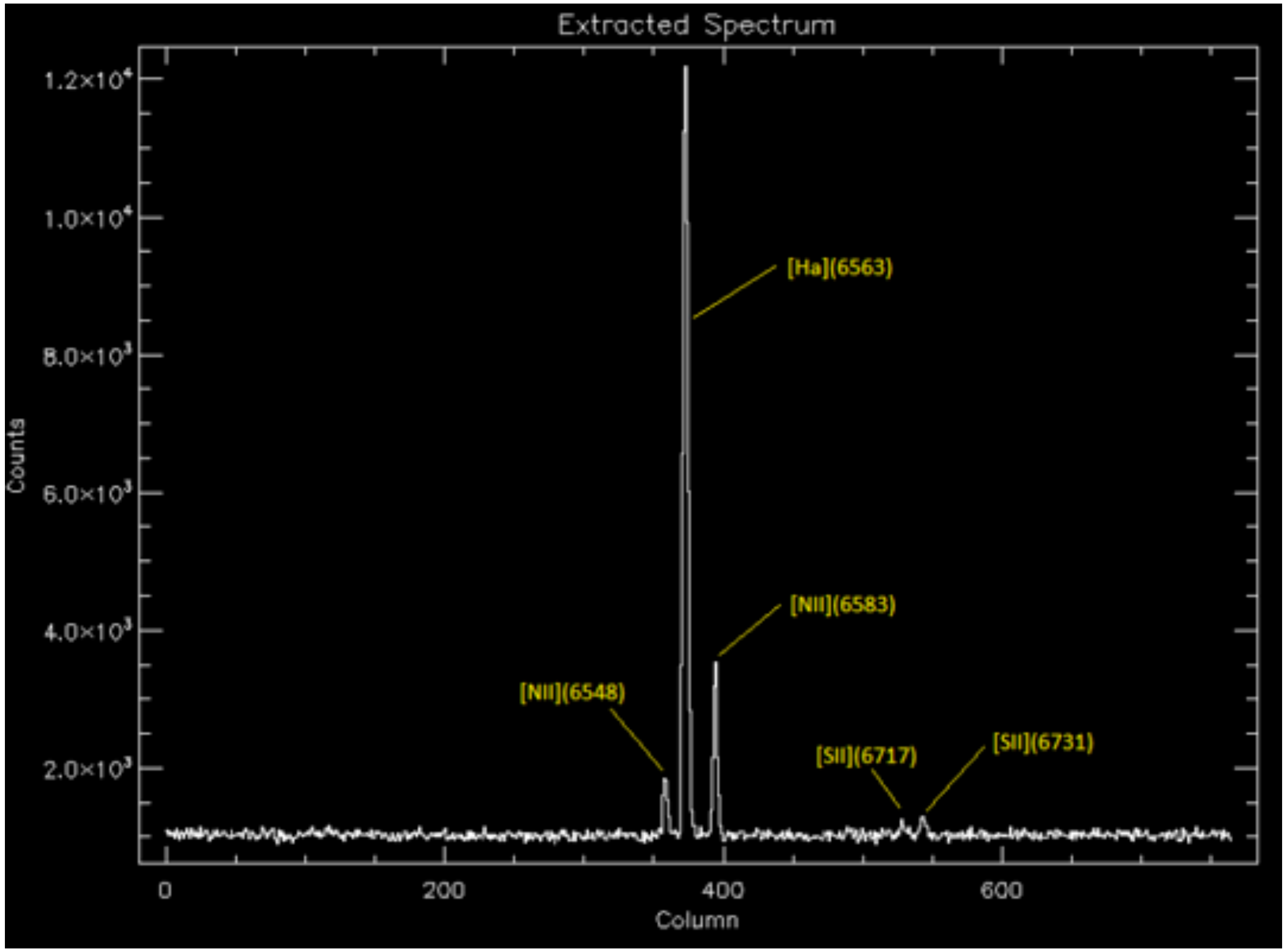


2016 lab

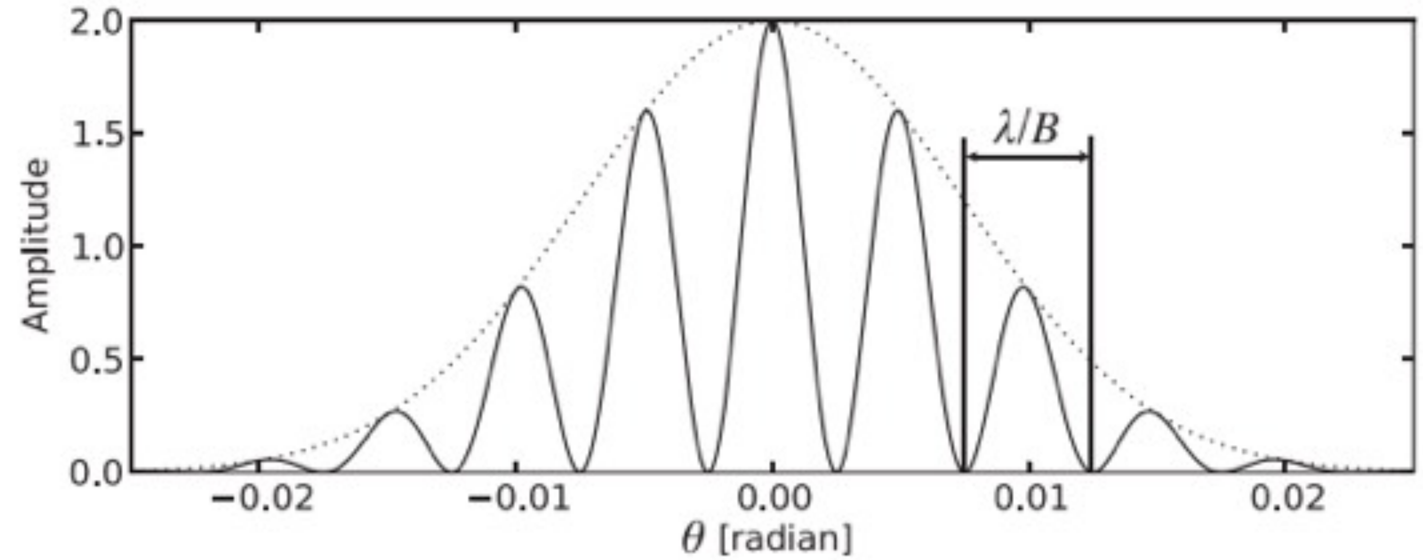
Lab 2 - optical spectroscopy

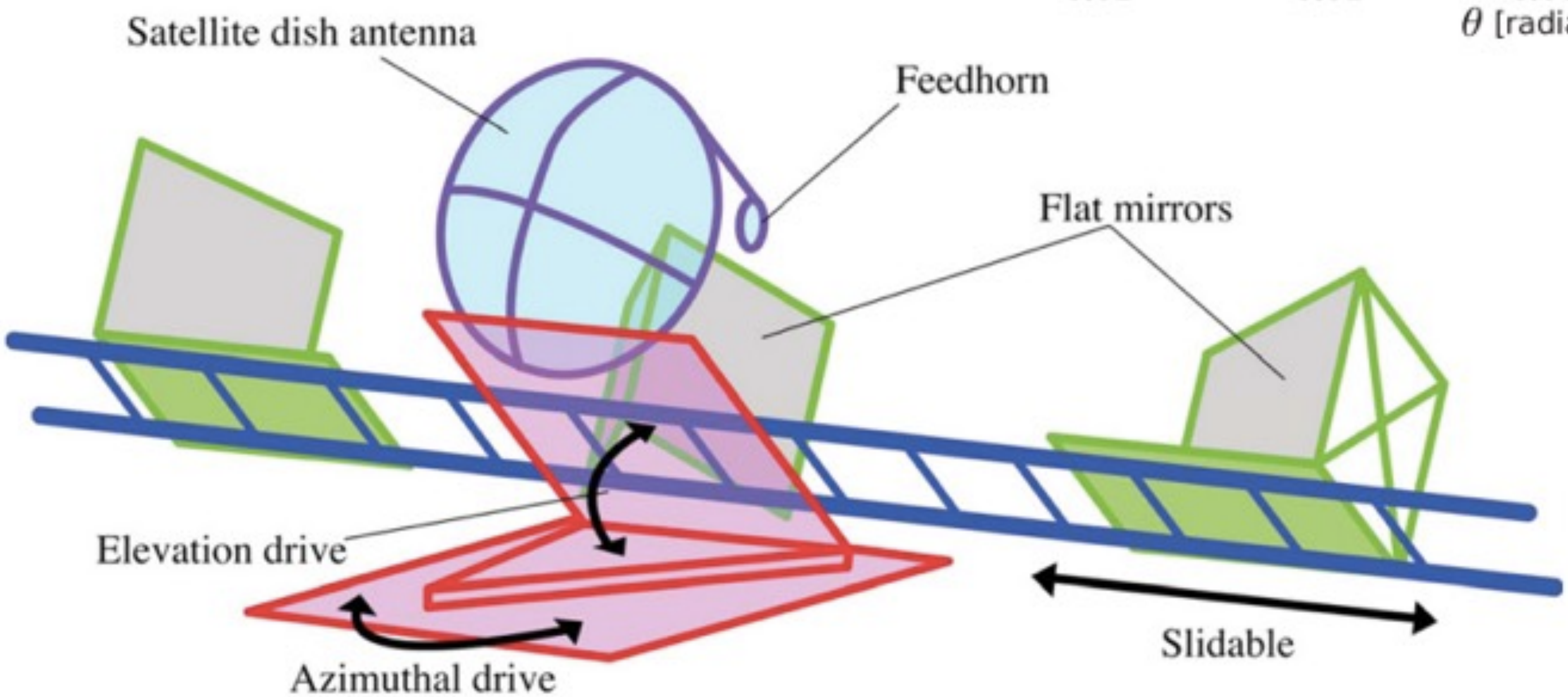
- measure the gas temperature of a gaseous nebula



Lab 3 - radio interferometry

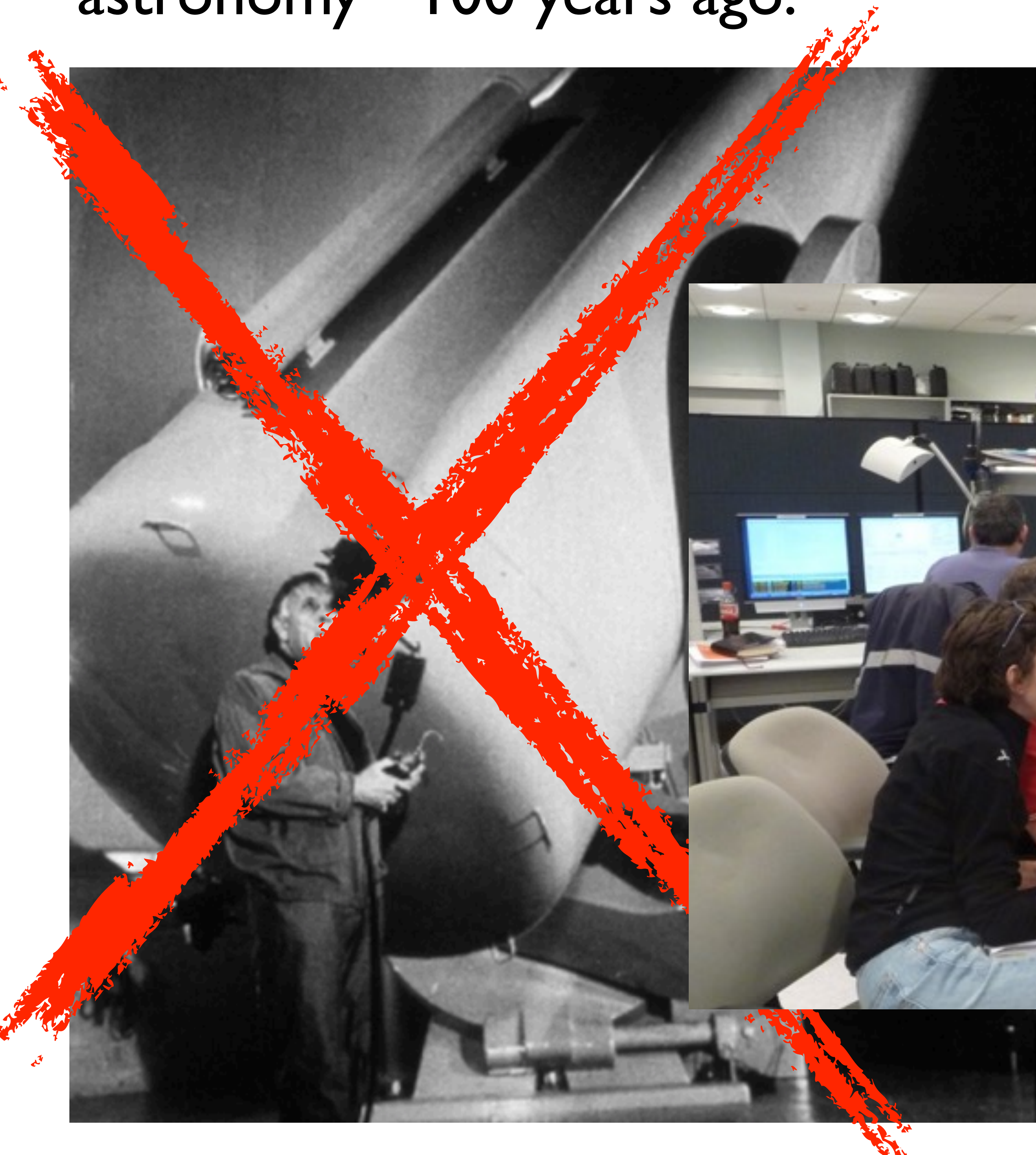
- measure the diameter of the Sun





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 : *change to 5-8pm?*

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

Team work

- observational astronomy is done in teams
- for the labs, you will observe in teams of 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

lecture attendance is mandatory

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

anjavdl / PHY517_AST443

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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:

- TBD

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: AST 203 ; some programming experience (at least PHY 277) is highly encouraged

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Class times are Mondays and Wednesdays, 6-9pm (TBC), in ESS 450, and will be scheduled either as lectures, tutorials, or computing lab time, i.e. the possibility to work on the data anjavdl / PHY517_AST443

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Homework reading until Wednesday

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General Information

Labs and Write-Ups

- Guidelines
- Observing Equipment
- Observing Calendar
- Lab 0: coming soon!
- Lab 1: Exoplanet transit
- Lab 2: Diffuse Nebula Spectroscopy
- Lab 3: Radio Interferometry

Computing

- Computing Resources
- Astro Software Overview
- Bash
- Python
- GitHub
- SExtractor
- Astrometry.net on uhura

Proposals

- Proposal Writing

TAs

Sydney Andrews <sydney.andrews@stonybrook.edu>

TBD

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 most of you, it will be the closest thing to actual research that you have encountered so far

This is me. Tell me who you are!