Short Overview of Observational Astrophysics

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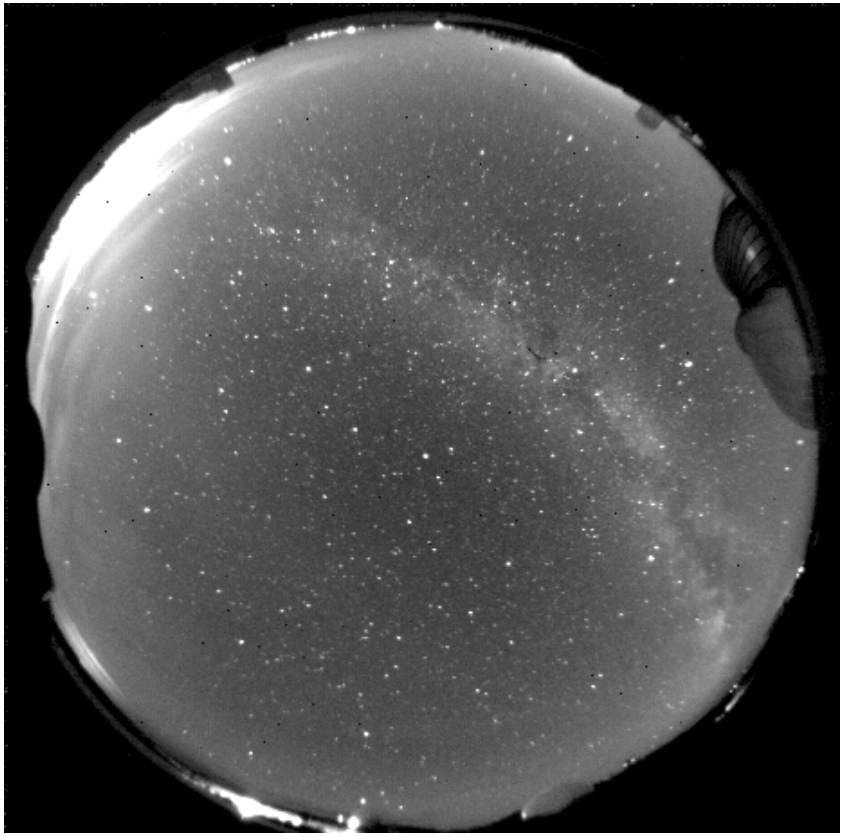
Overview

1. Syllabus
2. Observational Astrophysics Techniques
   - Programming
   - Statistics
   - Specific Example Data and Reduction

3. Help with install
4. Lia Talk about Exercises

What's in the Night Sky?

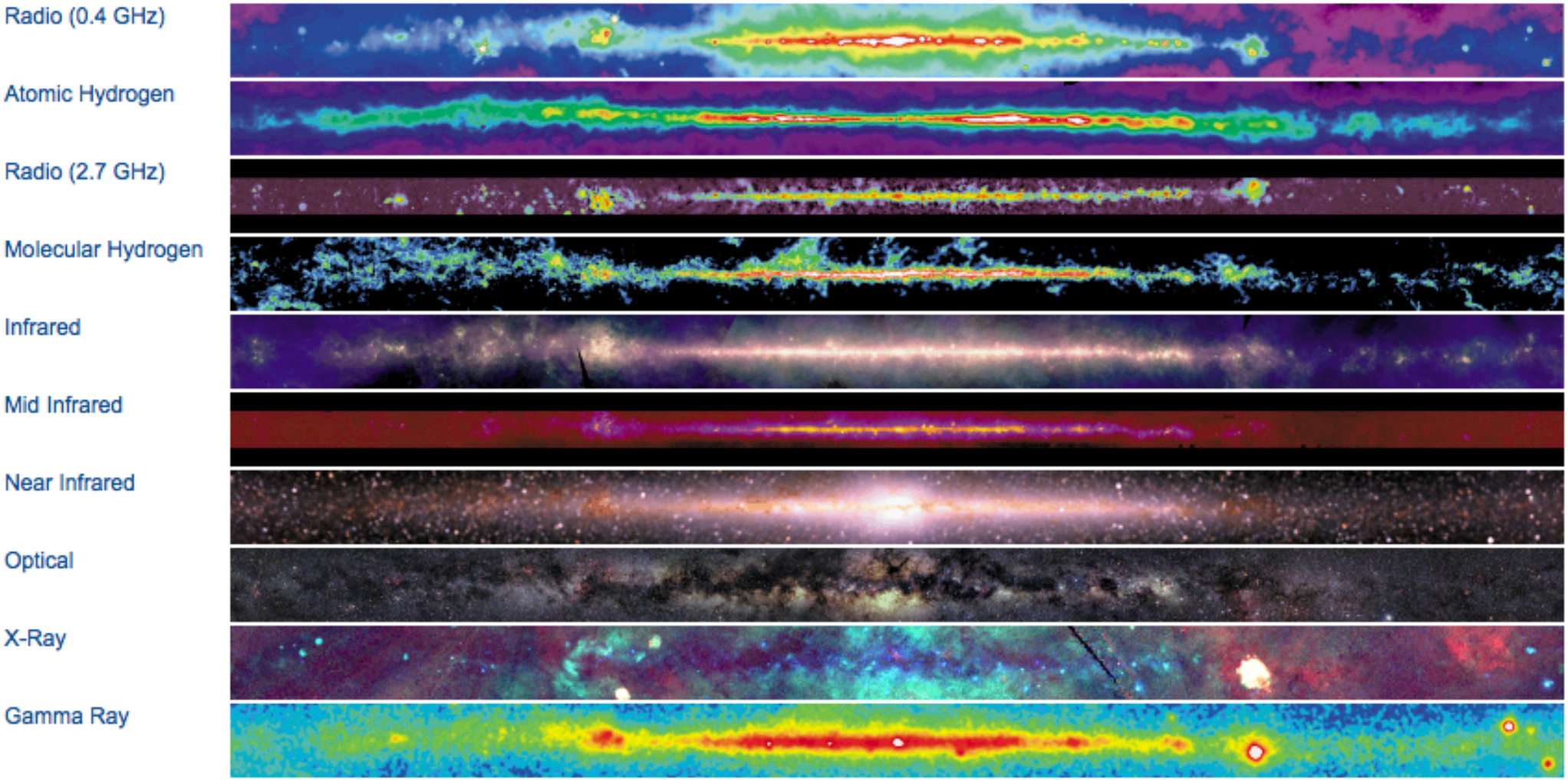


Fish Eye Lens-Whole sky from ground in Arizona

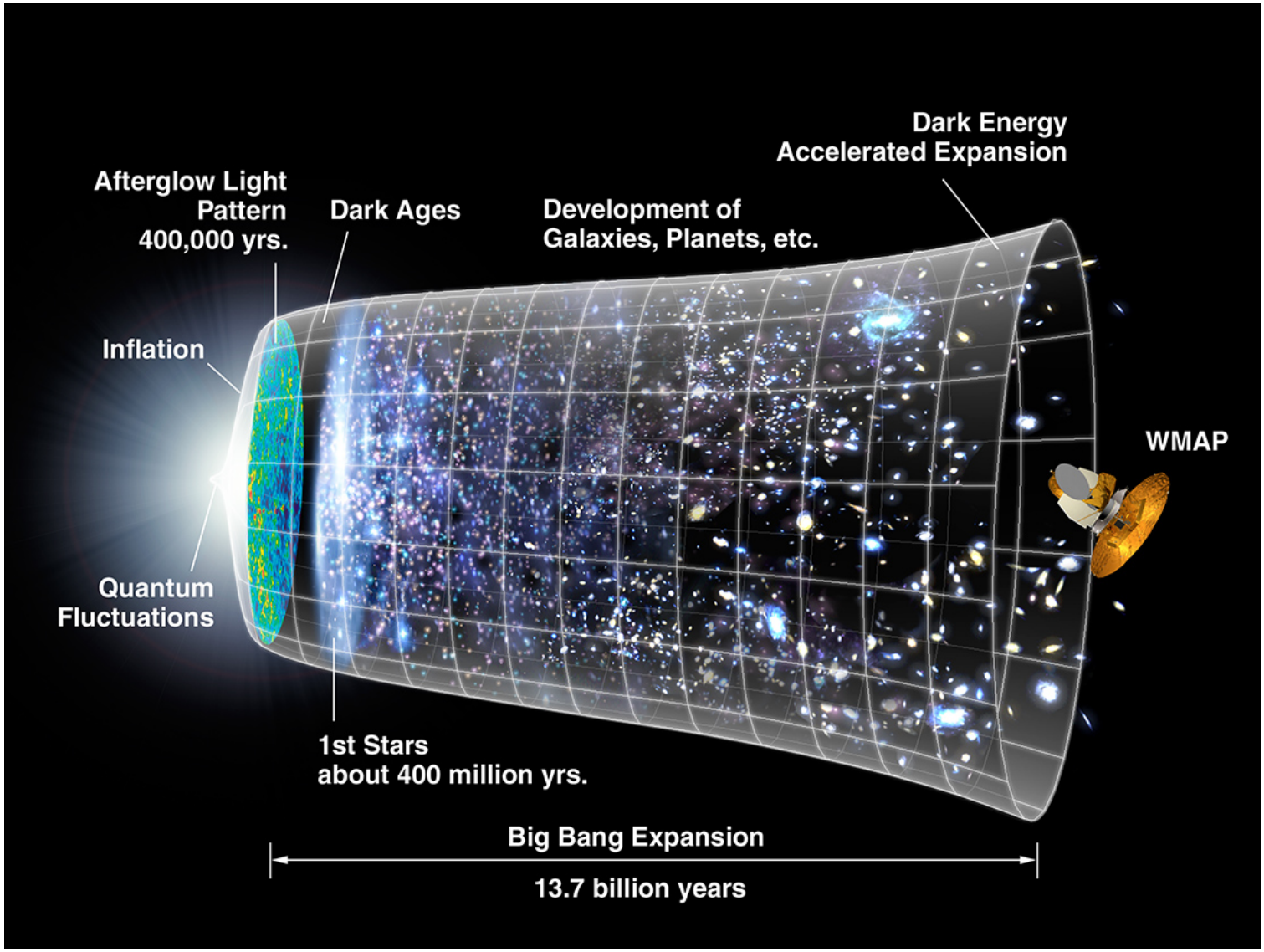
Lots of points of light-Stars like our sun but more distant

Fuzzy Diagonal Band- Galaxy in Greek means "milky circle"→ Milky Way our galaxy

Observing Wavelengths

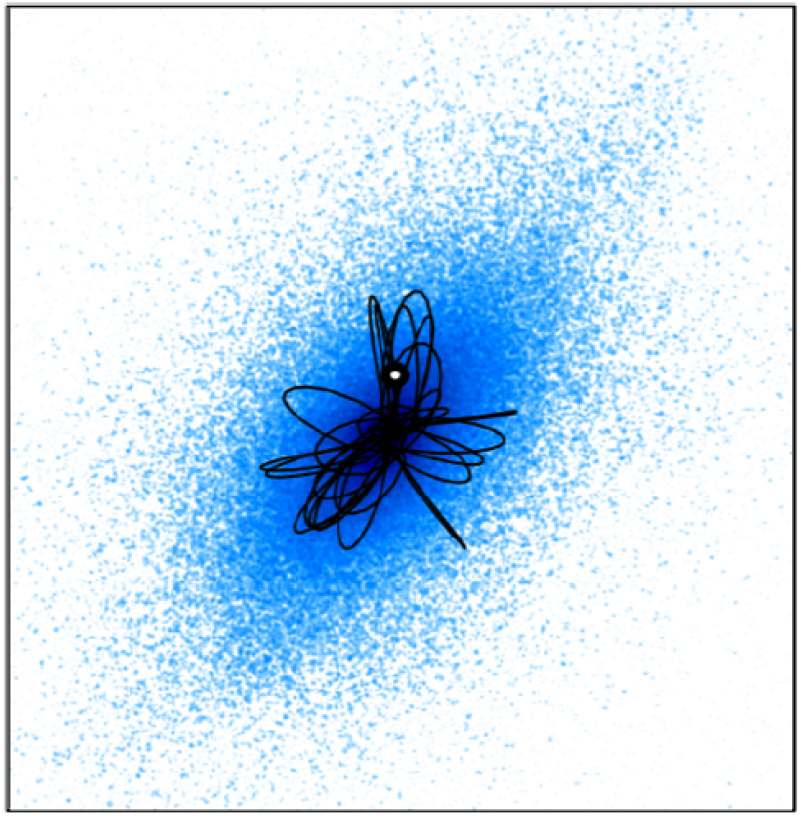


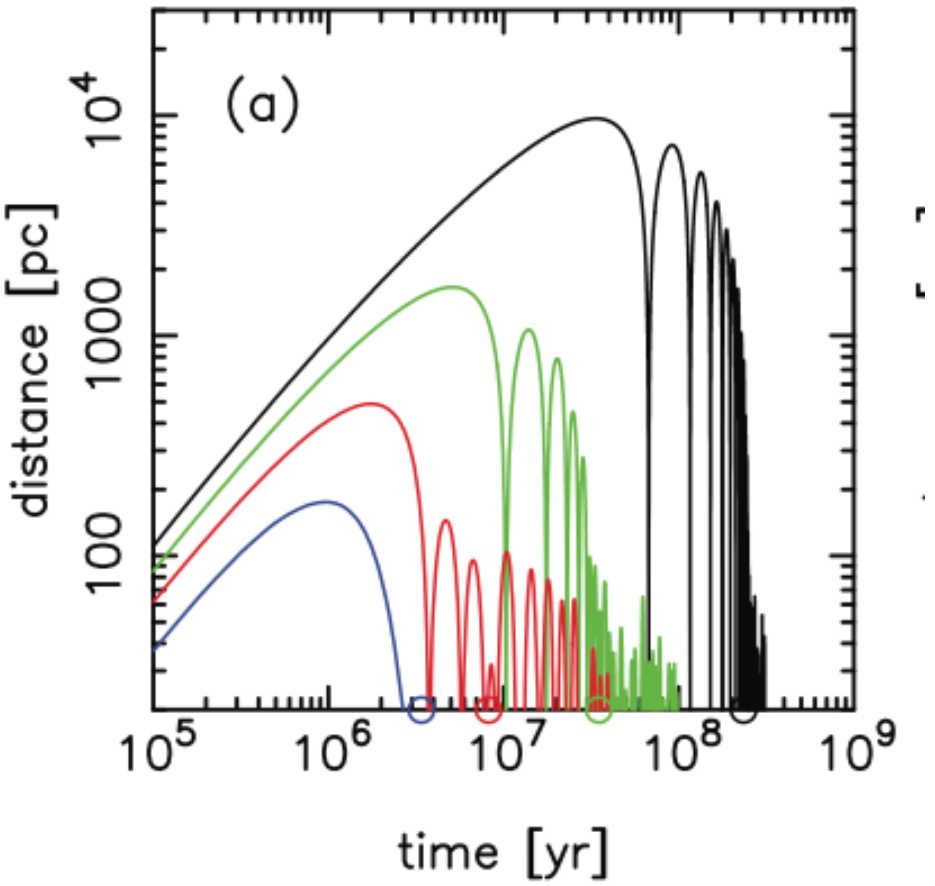
Because light takes time to travel, we can see the early universe by looking at distant objects



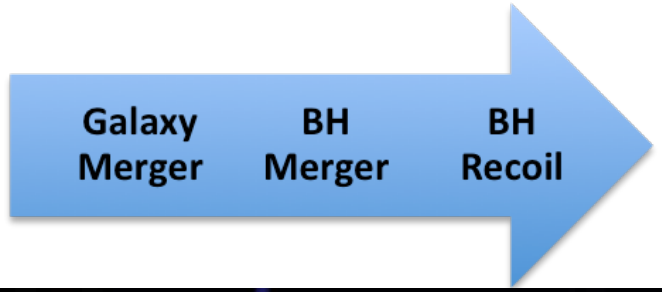
We have our own Time Machine !!!!!!

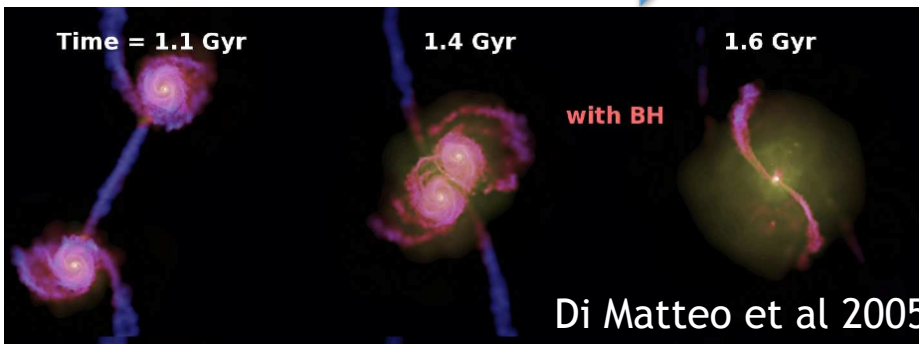
Specific Example:
BH Recoil Simulation





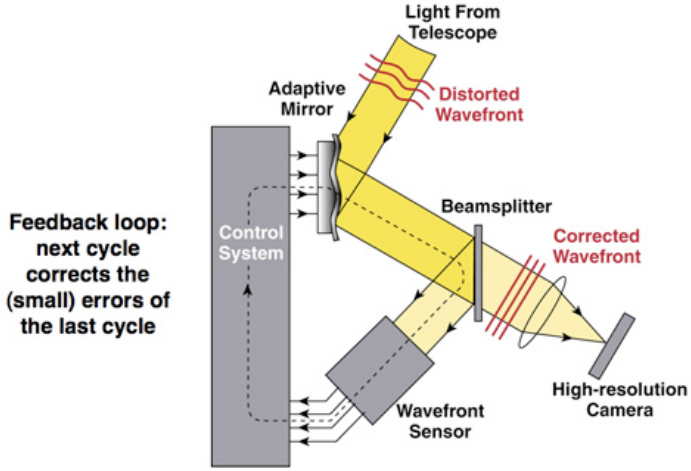
Galaxy Mergers and Recoiling Black Holes

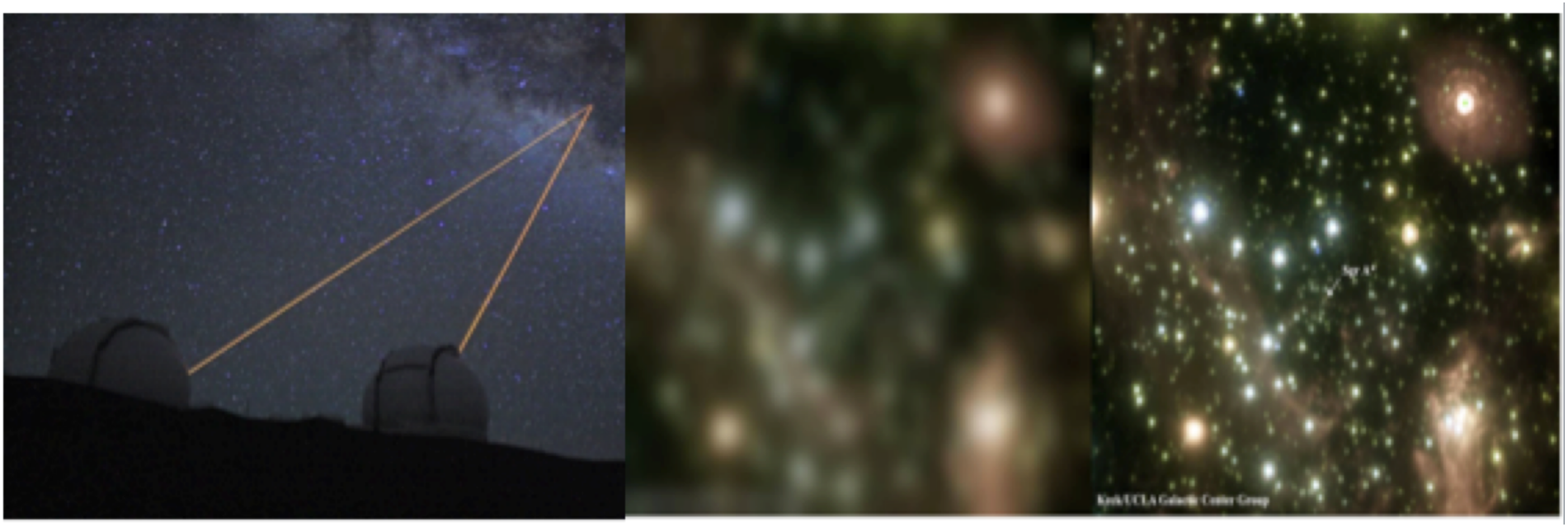




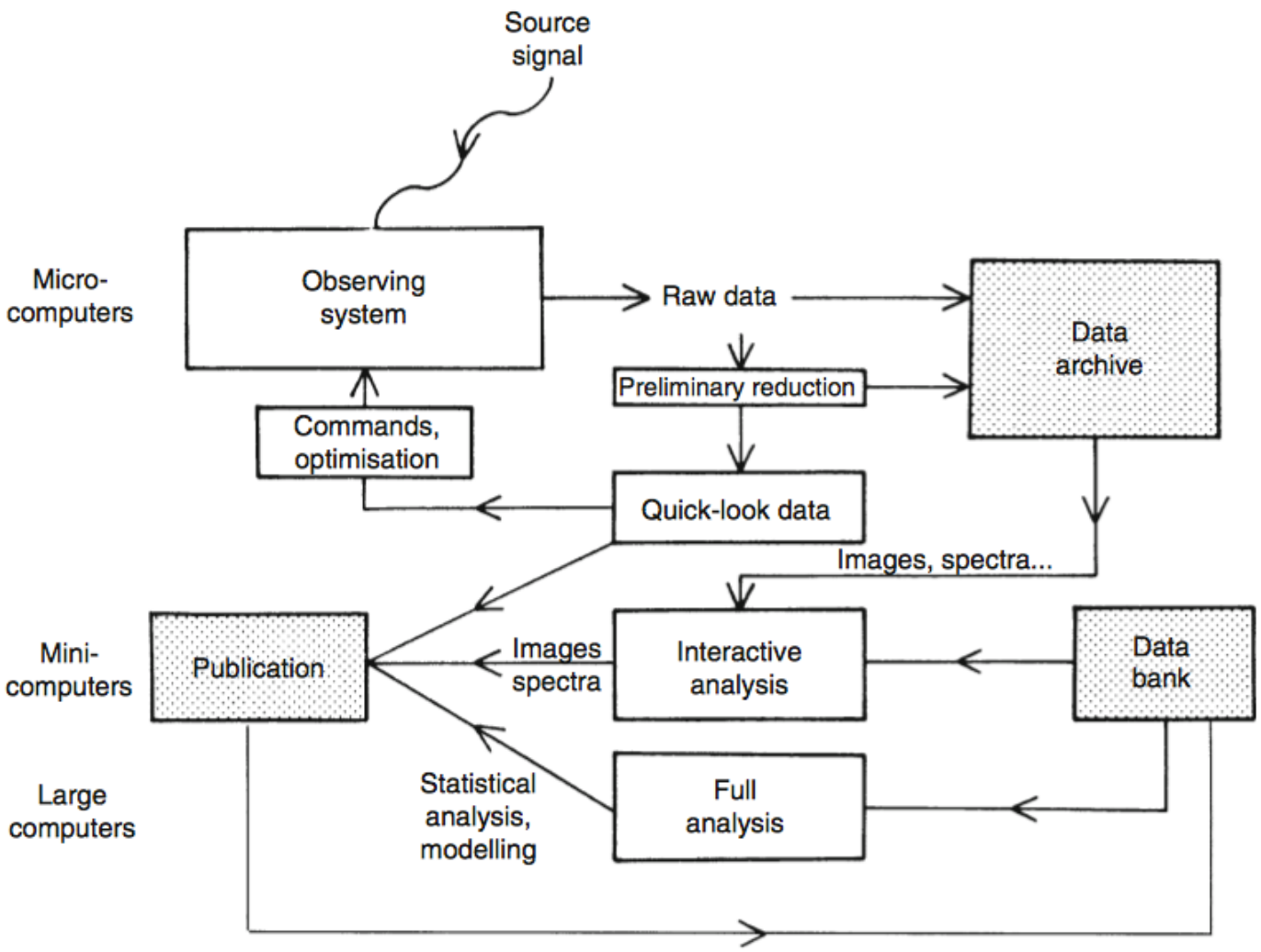
1. Is there Evidence of Recoiling BHs?
   - Indirect Method to detect GW emission

Specific Example: Adaptive Optics on Keck



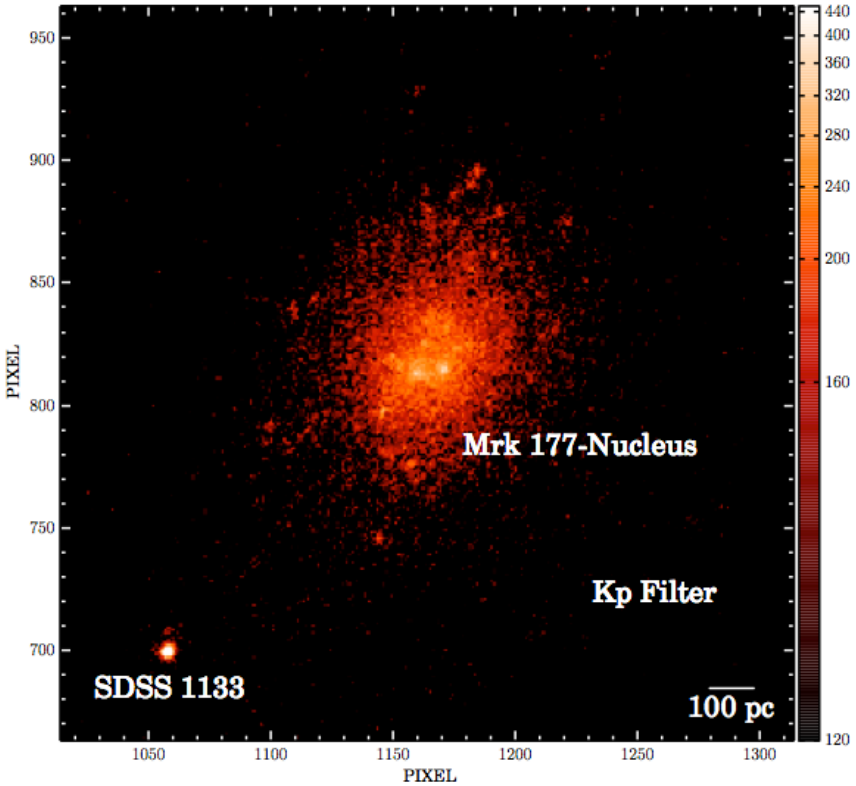


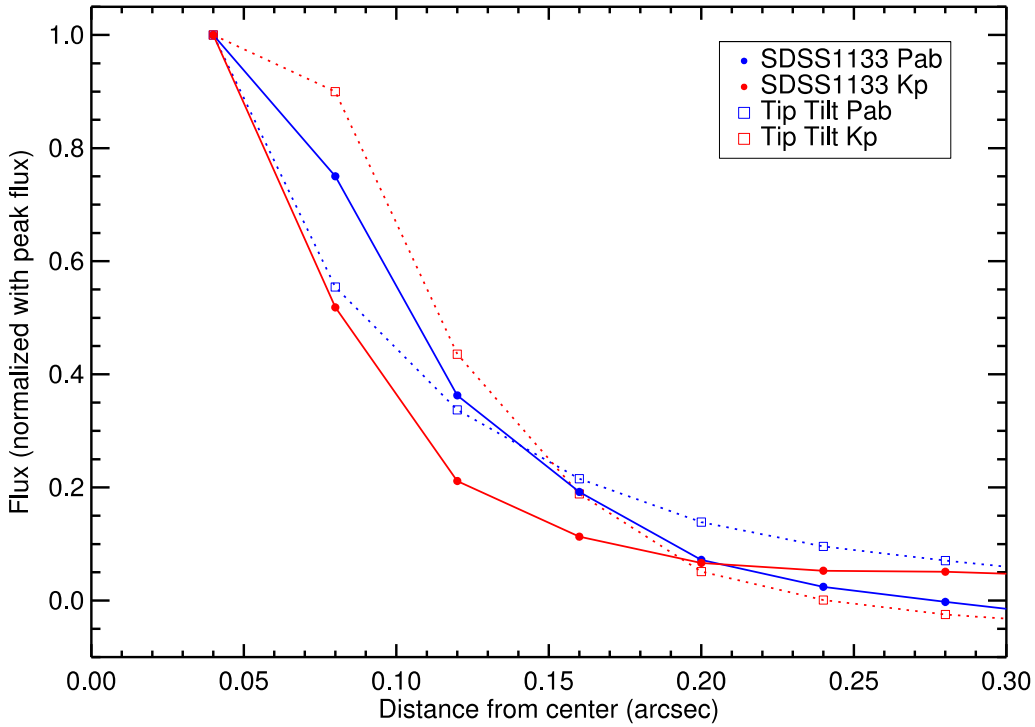
Data Analysis



The First Definitive Recoiling Black Hole?

SDSS1133 in High Resolution from Adaptive Optics

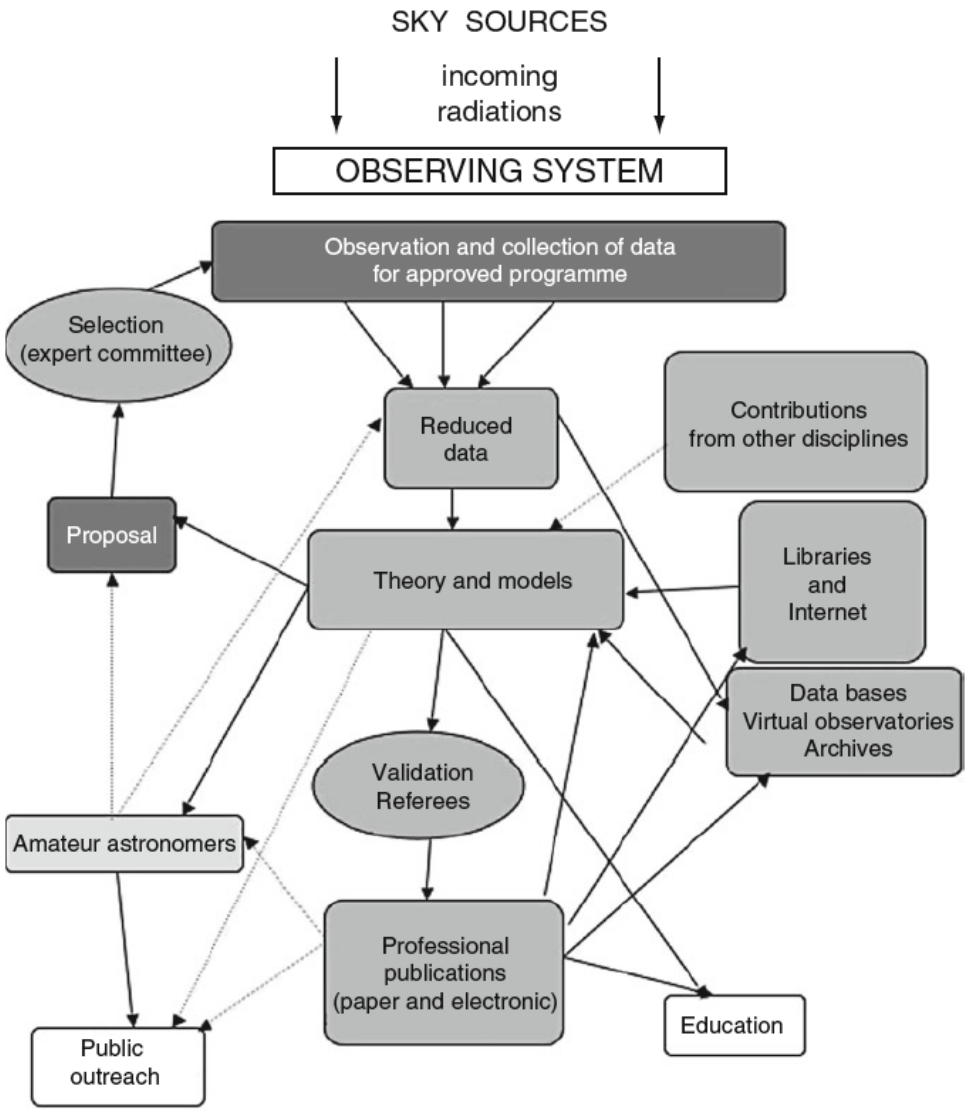




SDSS 1133 Consistent with telescope PSF imaging, Kp (12 pc), PaBeta (22 pc)

Shows expected Signature of Recoiling Black Hole (Koss et al. 2014)

Full Cycle

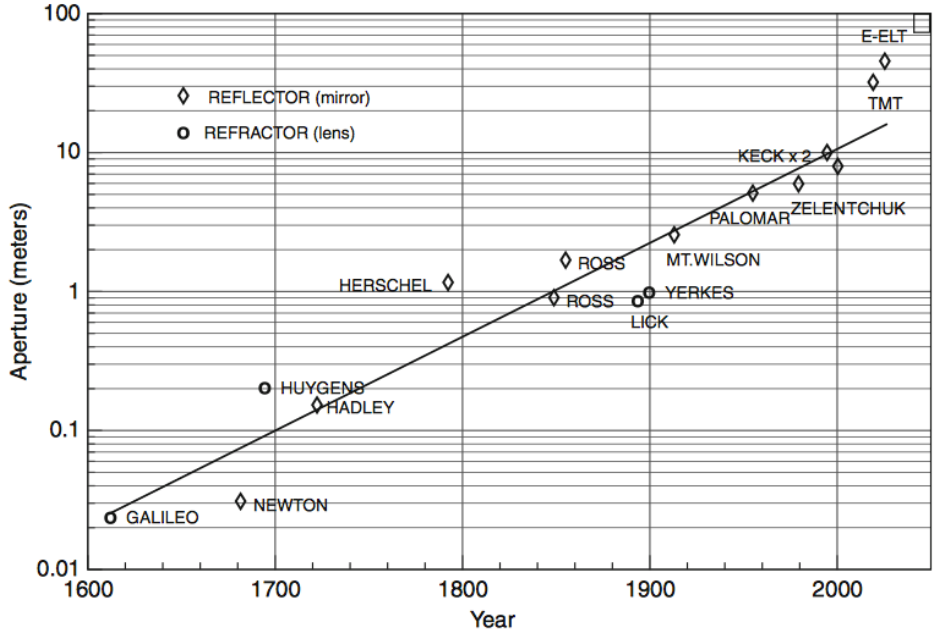

SKY SOURCES
incoming radiations
OBSERVING SYSTEM
Observation and collection of data for approved programme
Selection (expert committee)
Reduced data
Contributions from other disciplines
Proposal
Theory and models
Libraries and Internet
Data bases Virtual observatories Archives
Validation Referees
Amateur astronomers
Professional publications (paper and electronic)
Education
Public outreach

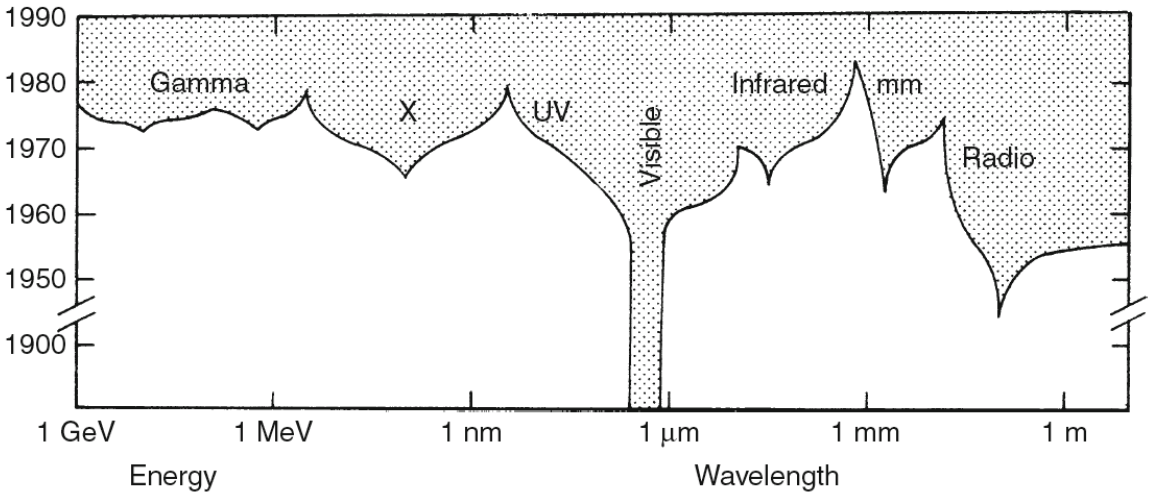
Other Examples of Observing Proposals

Successful Observing Proposals

Instrument	Year	Role	PI	Time Awarded
Space Based				
HST (COS)	2014	PI	M. Koss	4 orbits
Swift (XRT/UVOT)	2014	PI	M. Koss	15 ks TOO
XMM (EPIC)	2013	PI	M. Koss	115 ks
NuSTAR	2013	PI	M. Koss	100 ks
Swift (XRT/UVOT)	2013	PI	M. Koss	20 ks TOO
NuSTAR	2013	PI	M. Koss	200 ks
HST (WFC3/UVIS)	2013	2nd CoI	R. Mushotzky	8 orbits
Chandra (ACIS)	2012	PI	M. Koss	Archival $85k
Herschel (PACS/SPIRE)	2011	CoI	S. Veilleux	35 hours
Herschel (PACS/SPIRE)	2010	CoI	R. Mushotzky	56 hours
Chandra (ACIS)	2012	CoI	C. Max	215 ks
Chandra (ACIS)	2010-2011	Observing PI	M. Koss	358 ks, 2 Prop.
Ground Based				
ALMA	2013	2nd CoI	E. Treister	5 hours
VLT (SINFONI)	2013	CoI	R. Davies	5 nights
Keck (NIRC2)	2012-2013	PI	M. Koss	7 nights, 3 Prop.
VLT (XSHOOTER)	2013	CoI	R. Davies	4 nights
CARMA	2013	CoI	S. Vogel	6 nights
JCMT (SCUBA2)	2012-2013	PI	M. Koss	14 nights, 3 Prop.
CARMA	2013	CoI	K. Nguyen	5 nights
Gemini North (GMOS)	2011-2013	PI	M. Koss	3 nights, 2 Prop.
IRTF (SPEX)	2010-2013	PI	M. Koss	10 nights, 4 Prop.
UH 2.2m (SNIFS)	2012-2013	PI	M. Koss	22 nights, 4 Prop.
JCMT (RXA3)	2012	PI	M. Koss	8 nights, 3 Prop.
SOAR (GOODMAN)	2012	First Co I	M. Trippe	4 nights
JCMT (HARP)	2011	CoI	E. Treister	8 nights, 2 Prop.
Gemini South (GMOS)	2011	PI	M. Koss	0.5 night
Gemini North (GMOS)	2011	First CoI	E. Treister	1 night
KP 4m (FLAMINGOS)	2010	PI	M. Koss	12 nights, 2 Prop.
KP 2.1m (GOLDCAM)	2008-2009	Observing PI I	M. Koss	14 nights, 2 Prop.
KP 2.1m (T2KB-T1KA)	2008	Observing PI I	M. Koss	17 nights, 2 Prop.
Instrumentation				
Balloon Star Cameras	2008	PI	M. Koss	$15k

The Advance of History: Bigger, Better, More Wavelengths





Astrometry

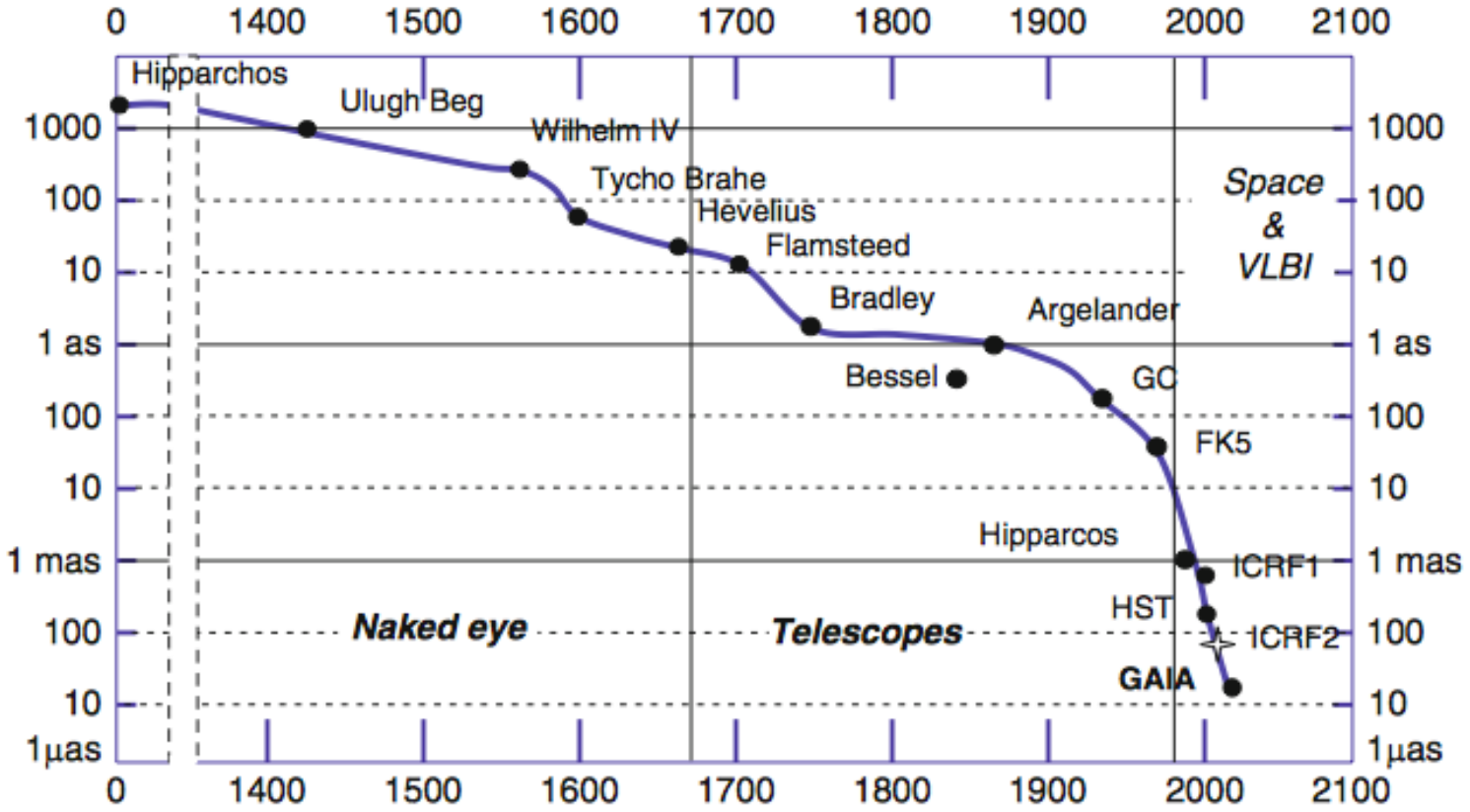
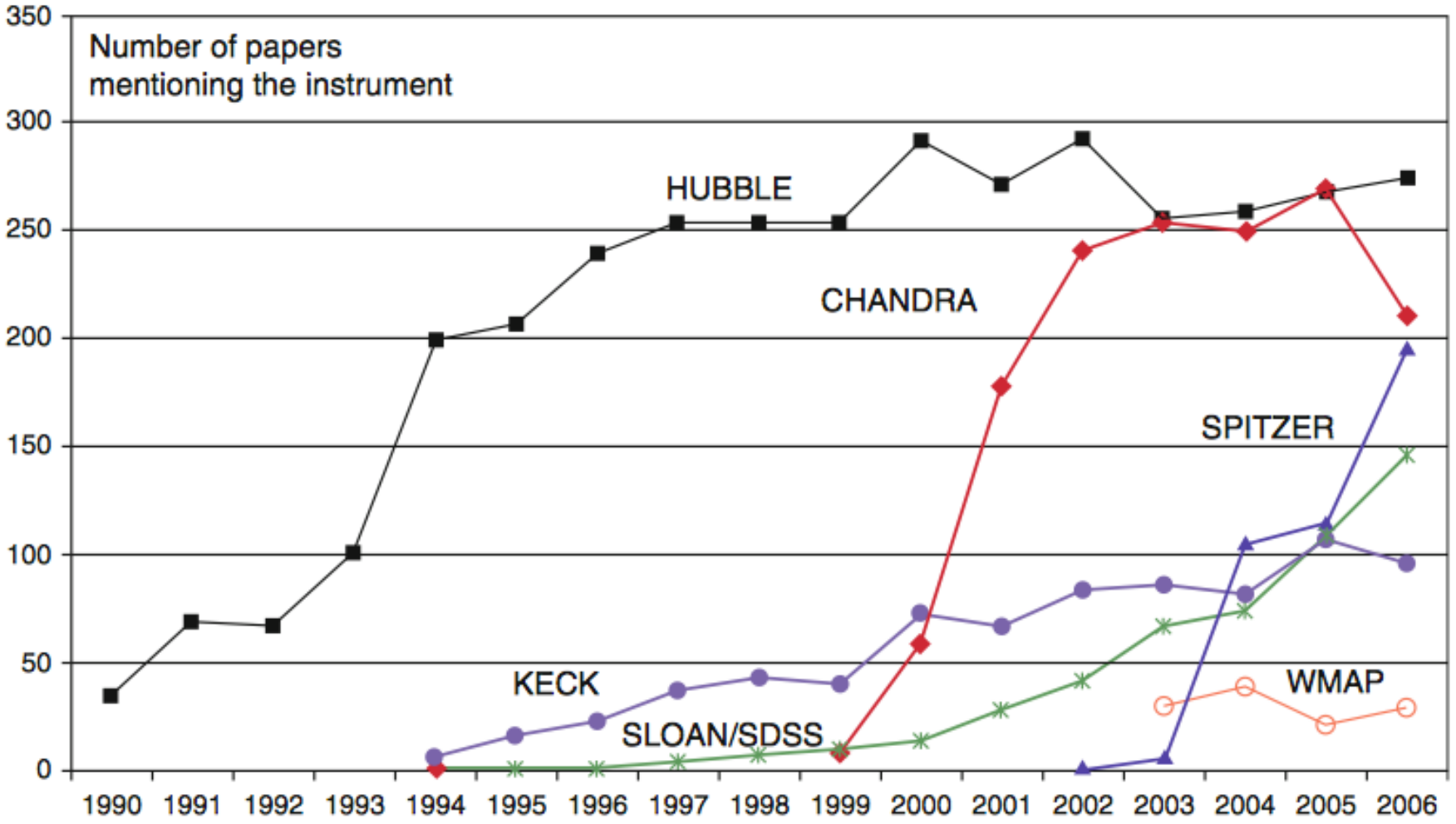
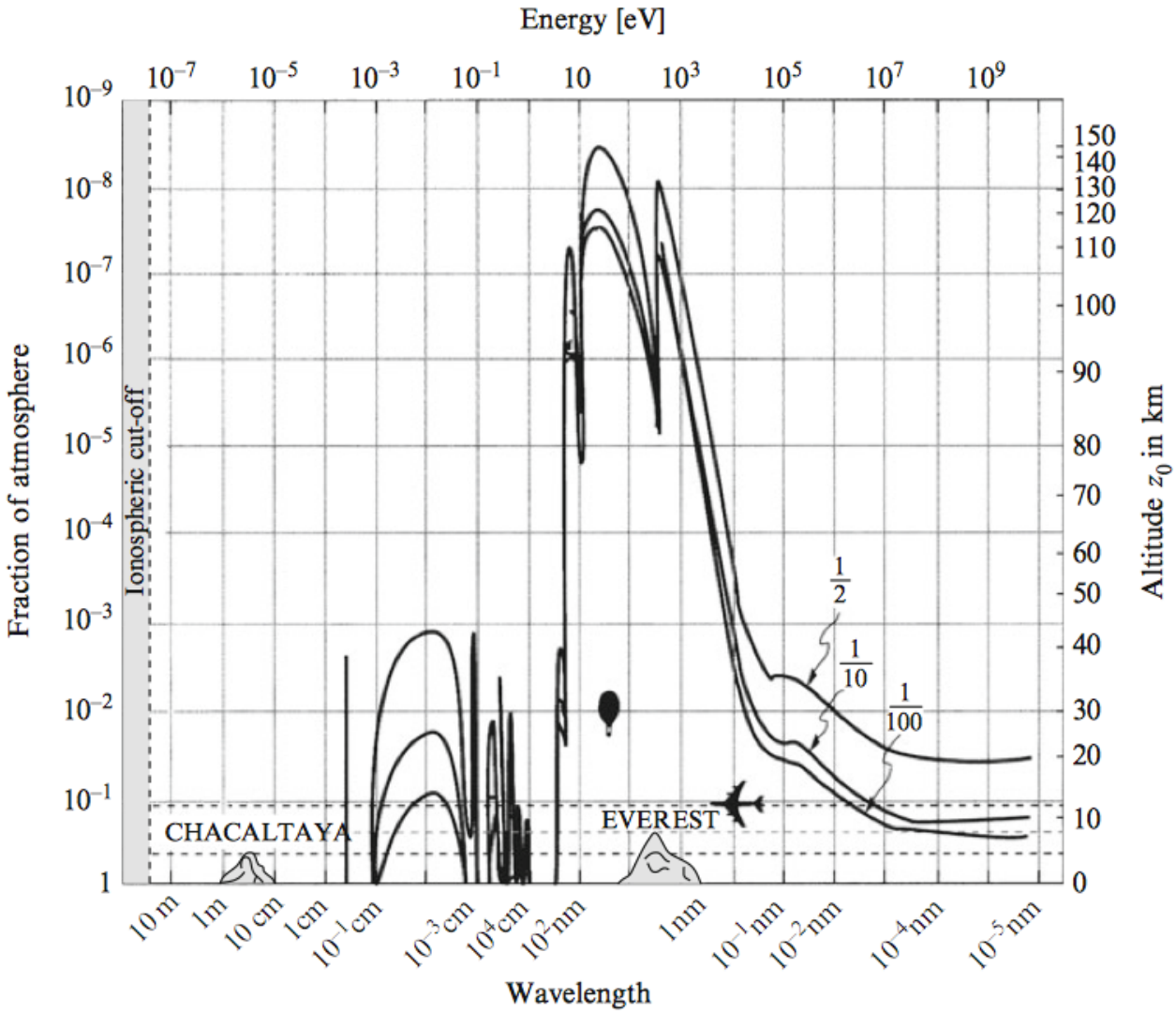


Fig. 4.1 Improving astrometric accuracy in the observations of stars and planets at different epochs

Types of Observatories



Why we use satellites



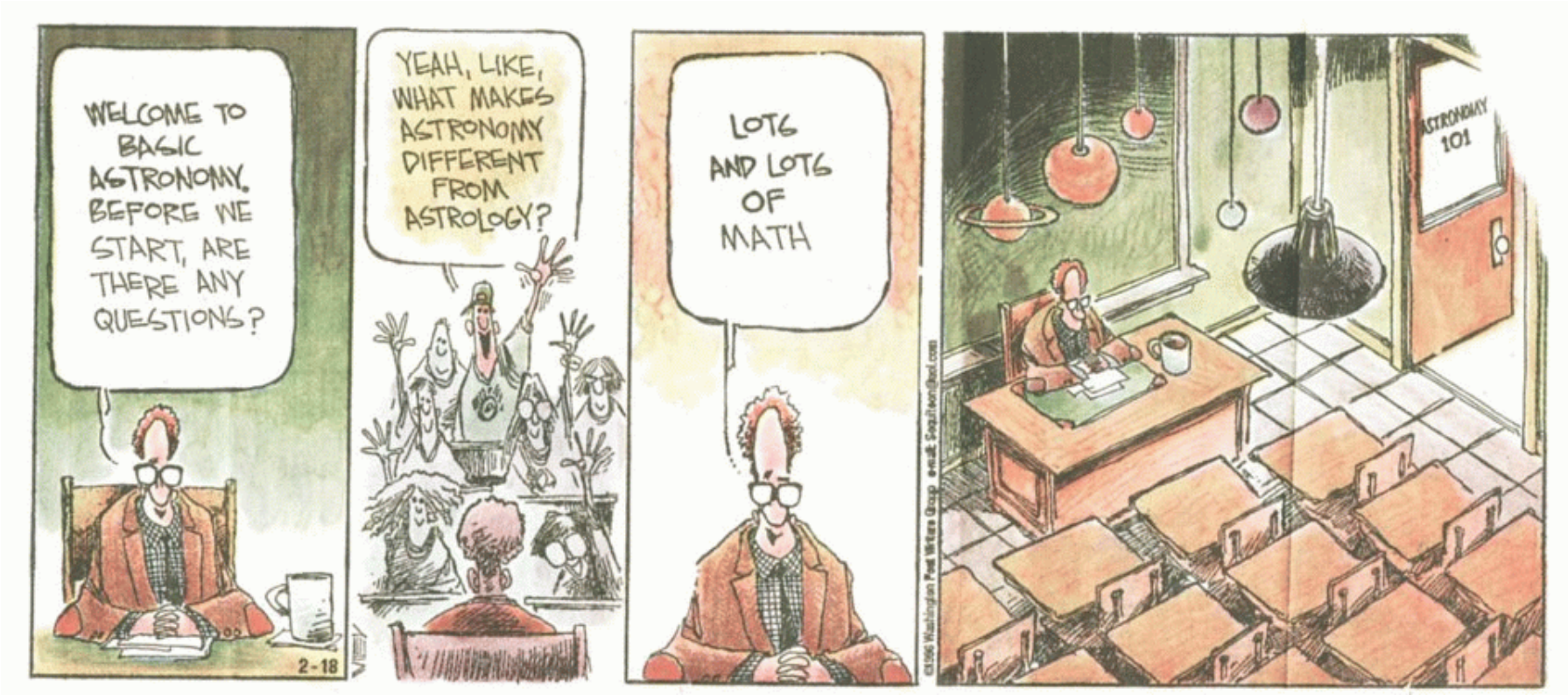
If you like this stuff and need a semester project come talk to us…

Left: JCMT submillimiter telescope on Mauna Kea in Hawaii (Credit JCMT). Middle: New SCUBA2 instrument, which saw first light in 2010. Right: Herschel and SCUBA2 instrument images at 500 and 450 um, showing the increased resolution of this instrument. The high resolution of SCUBA2 is critical to understanding the link between nuclear star formation and AGN in galaxy evolution. I am PI of the largest program of SCUBA-2 observations of nearby AGN with over 150 hours with the first ever complete large sample (>30).

Project GOALS

1). Determine the role of AGN and their co-evolution with galaxies.
2). Understand the importance of AGN to IR emission and it's link to molecular gas.
3). Use a sample selected by it's AGN emission.
Instruments: Herschel+Scuba2 +JCMT (CO)+BAT (X-ray)

A thought to leave you with…



Exercises

Exercise class: Tuesday, 11:45 - 12:30

HIT F 31.1

Assistant: Lia Sartori

Office: HIT J 33.2

email: lia.sartori@phys.ethz.ch

Requirements for the credits

- Submit reports for 50% or more of the exercise sheets (not necessarily perfect, but make some effort to do the exercises…)
- oral exam (winter session examination, 20 min)

Reports

- LaTeX is recommended (but not restricted)
- hand in a PDF via GitHub or email by the day before the next class

https://github.com/liasartori/ObsAstro_HS14

Did you already use one of the following tools or programming languages ? If yes, please write up your level (beginner, intermediate, advanced)

- ☐ Python .....
- ☐ IDL .....
- ☐ IRAF .....
- ☐ TOPCAT .....
- ☐ Galfit .....
- ☐ SExtractor .....
- ☐ CIAO .....
- ☐ Heasoft .....
- ☐ SAOImage DS9 .....
- ☐ GitHub .....

Would you like to give a short presentation (~ 30 min) about one of these tools ?
The presentation will count as one exercise sheet.

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Is there a specific analysis tool or observational technique that you would like to be discussed during the lecture and/or exercise classes ?

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Preliminary schedule

subject to change, will be updated

DATE	TOPIC
16-Sep	Basics of scientific computing (guest lecturer: Dr. Mike Koss)
23-Sep	Basics of observing, Imaging I
30-Sep	Imaging II
07-Oct	Spectroscopy I (guest lecturer: Dr. Mike Koss)
14-Oct	Spectroscopy II
21-Oct	Spectroscopy III, stellar evolution & models
28-Oct	Virtual Observatory, catalogue generation
04-Nov	Spectral Energy Distribution fitting
11-Nov	X-ray Astronomy
18-Nov	*cancelled/guest lecture*
25-Nov	Radio/sub-mm/FIR Astronomy
02-Dec	Proposal planning
09-Dec	Presentation of Proposals
16-Dec	TBD

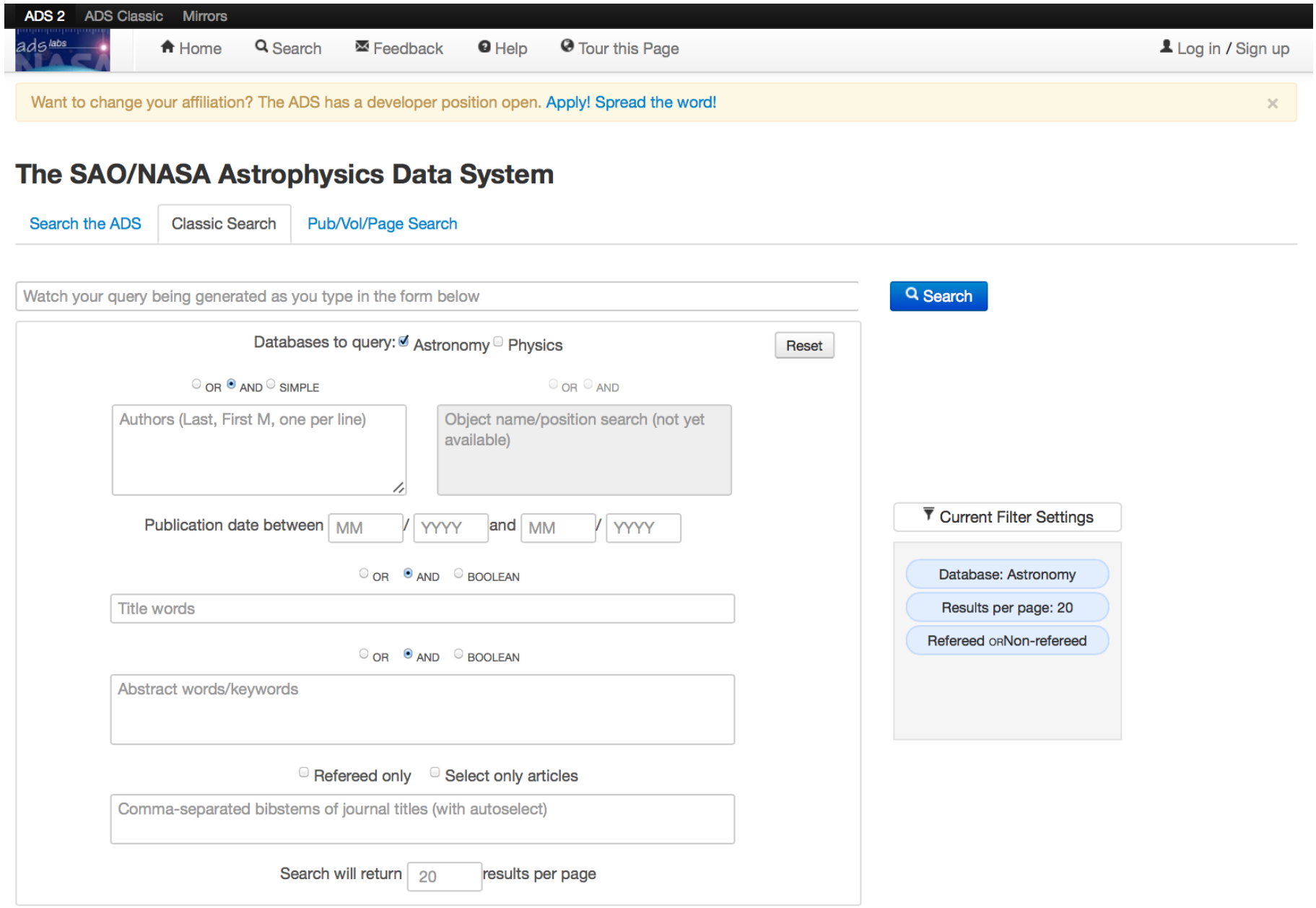
http://www.astro.ethz.ch/education/courses/Observational_Techniques_in_Astrophysics

Useful web resources

Stackoverflow

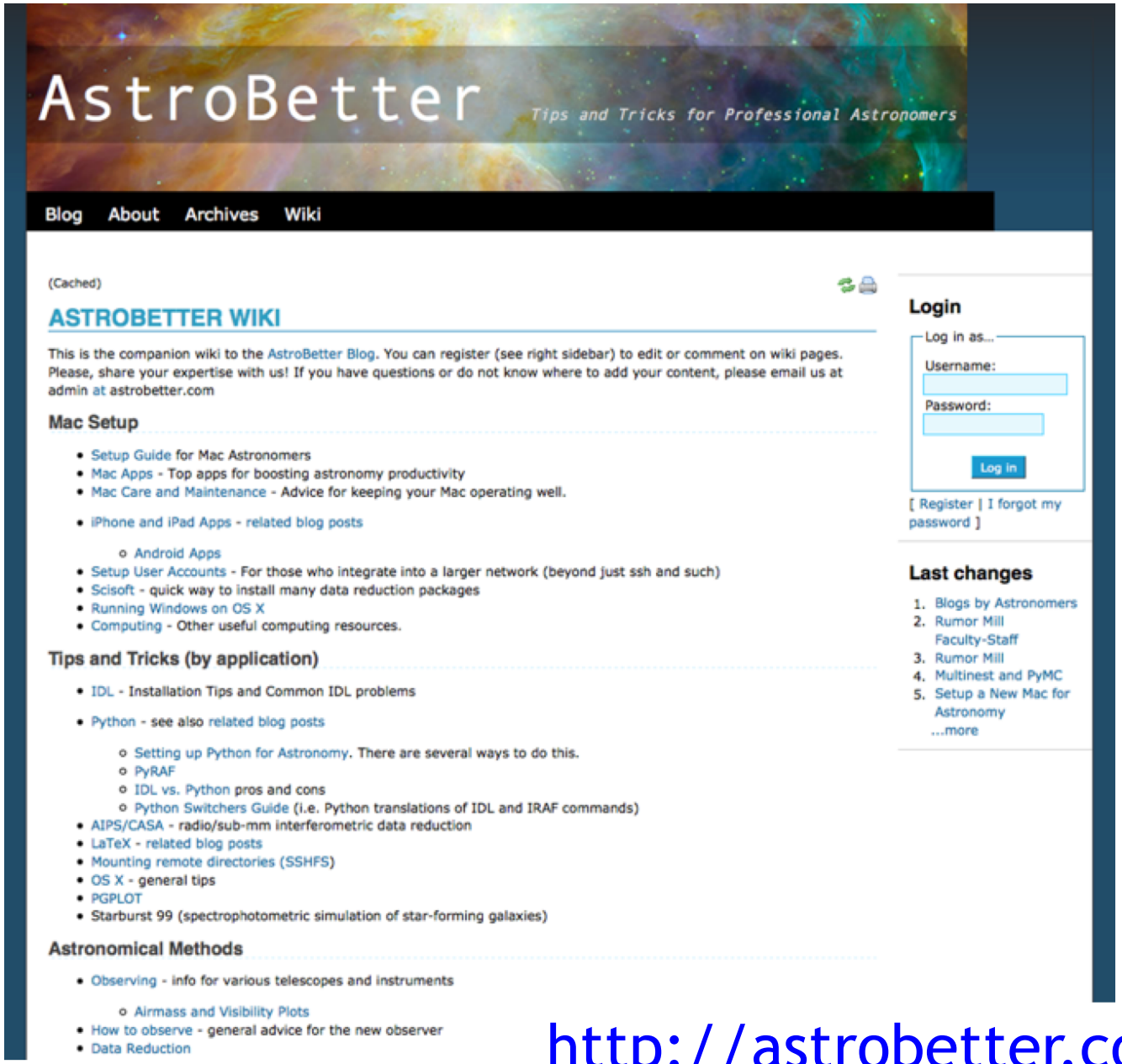
http://starckoverflow.com/

NASA Astrophysics Data System



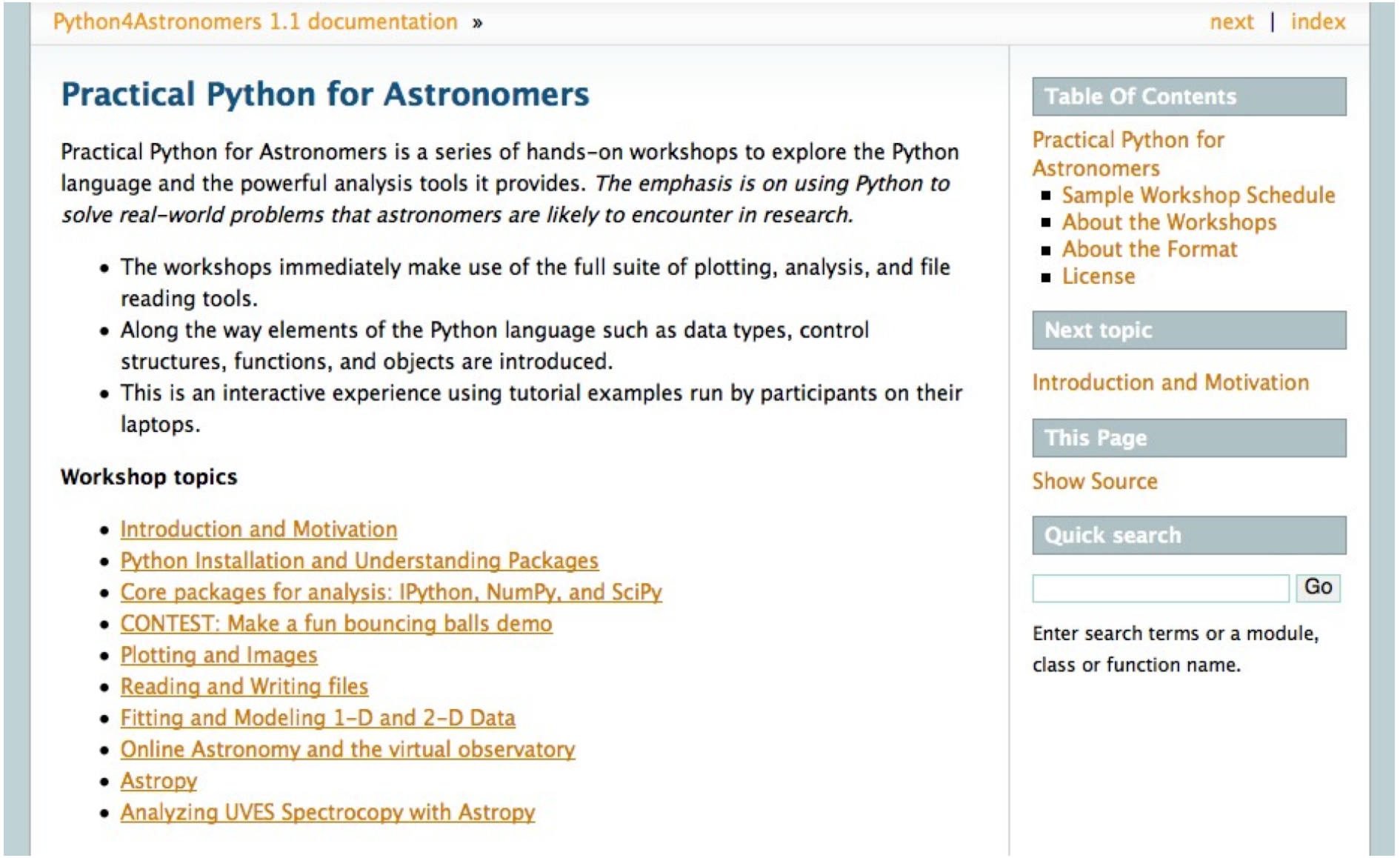
http://adslabs.org/adsabs/search/classic-search/

Astrobetter wiki



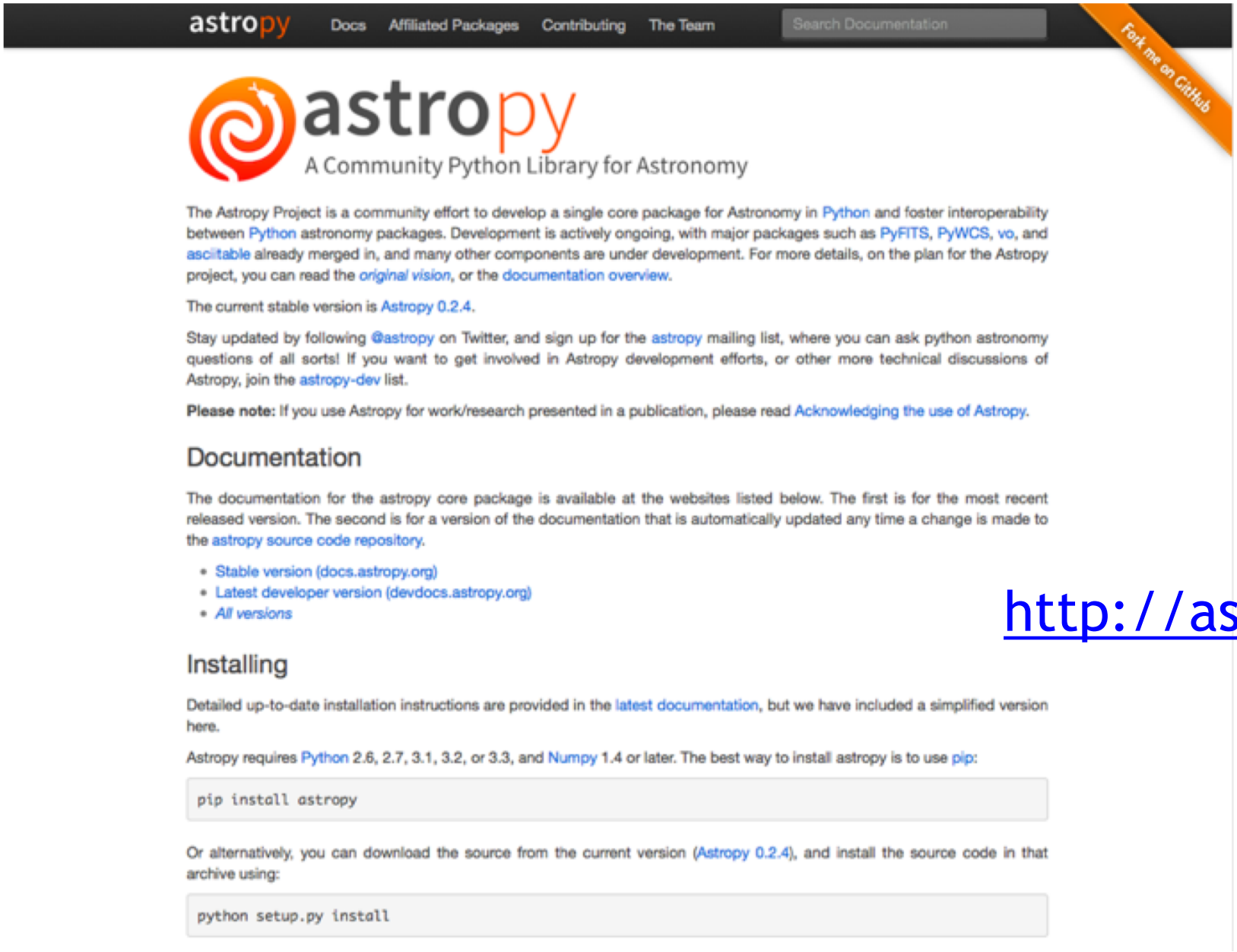
http://astrobetter.com/wiki/

Practical Python for Astronomers



http://python4astronomers.github.io/

Astropy



http://astropy.org/

Coyote's Guide to IDL Programming

http://idlcoyote.com/

IDL Astronomy User's Library

The IDL Astronomy User's Library

The IDL Astronomy Users Library is a central repository for low-level astronomy software written in the commercial language IDL. The Library is not meant to be an integrated package, but rather is a collection of procedures from which users can pick and choose (and possibly modify) for their own use. Submitted procedures are given a cursory testing, but are basically stored in the Library as submitted. Instrument-specific software is generally not included in the IDL Astronomy Library, but can be found at the Links to Other Astronomy and IDL related sites.

The entire contents of the Library can be downloaded in a tar file or in a .zip file from the the download site . Additional software, not included in the tar files, is available in a contrib directory. Individual procedures can be copied by browsing through a list of one-line descriptions. Changes to the contents of the Library are recorded in a news file.

The plotting routines in the IDL Astronomy Library make use of programs in the Coyote Graphics Library, which must be downloaded separately. Alternatively, one can download coyote_astron.tar.gz which contains a subset of the Coyote procedures needed for the Astronomy library.

Documentation is available describing the various options for working with FITS data in IDL.

The IDL Astronomy Library requires at least IDL V6.4. However, separate (frozen) versions of the Library that work with earlier versions of IDL are available at the /old download site.

The success of the IDL Astronomy User's Library depends on the willingness of users to give as well as take. Please inform Wayne Landsman of any possible contributions to the Library, programming bugs or documentation errors, or of relevant web sites.

- One-line descriptions of procedures
- Links to Other Astronomy and IDL related sites
- IDL Astronomy Library download site
- Searchable index of all IDL Astronomy Library procedures
- Chronological list of changes to the Library
- Frequently Asked Questions (FAQ)

http://idlastro.gsfc.nasa.gov/