Observational Astronomy
Introduction

Ast 401/Phy 580
Fall 2015

Dr. Philip Massey

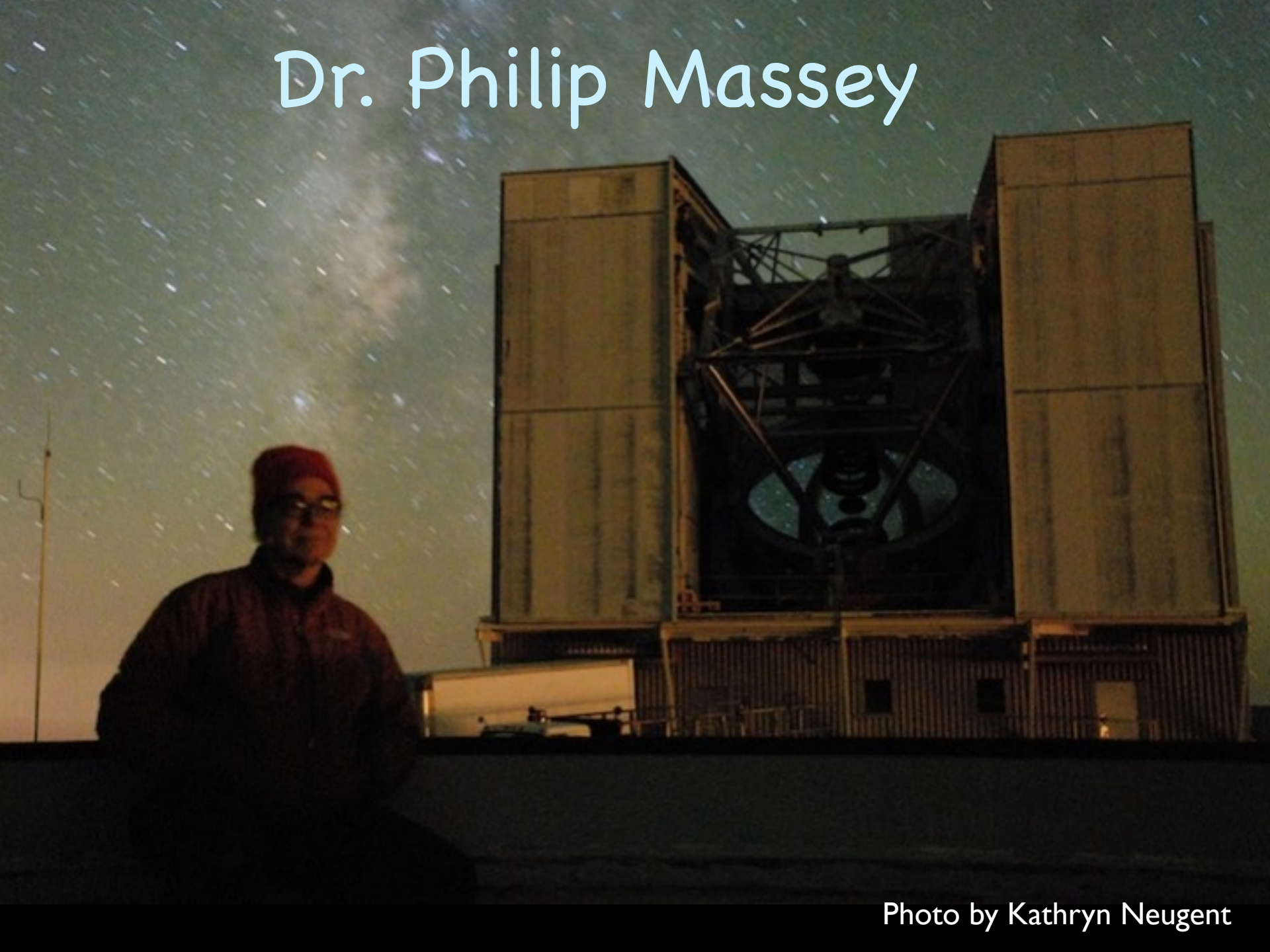
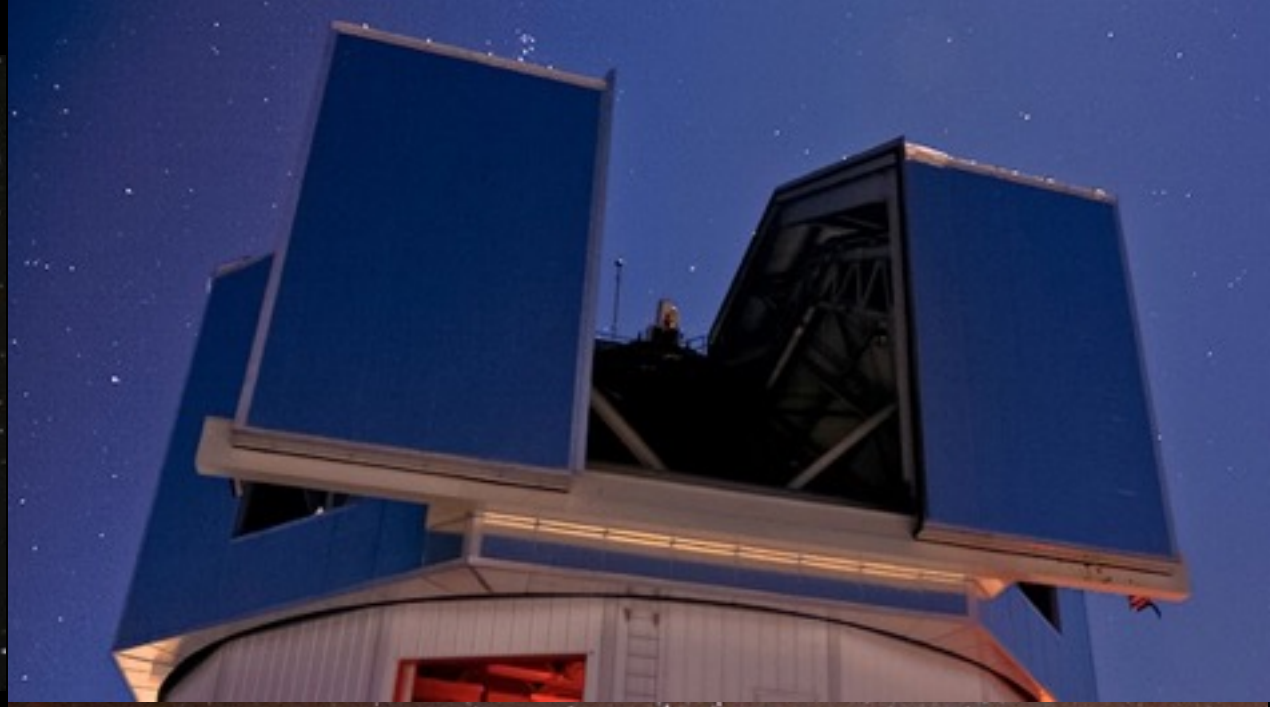


Photo by Kathryn Neugent

Phil

Photo by Kathryn Neugent

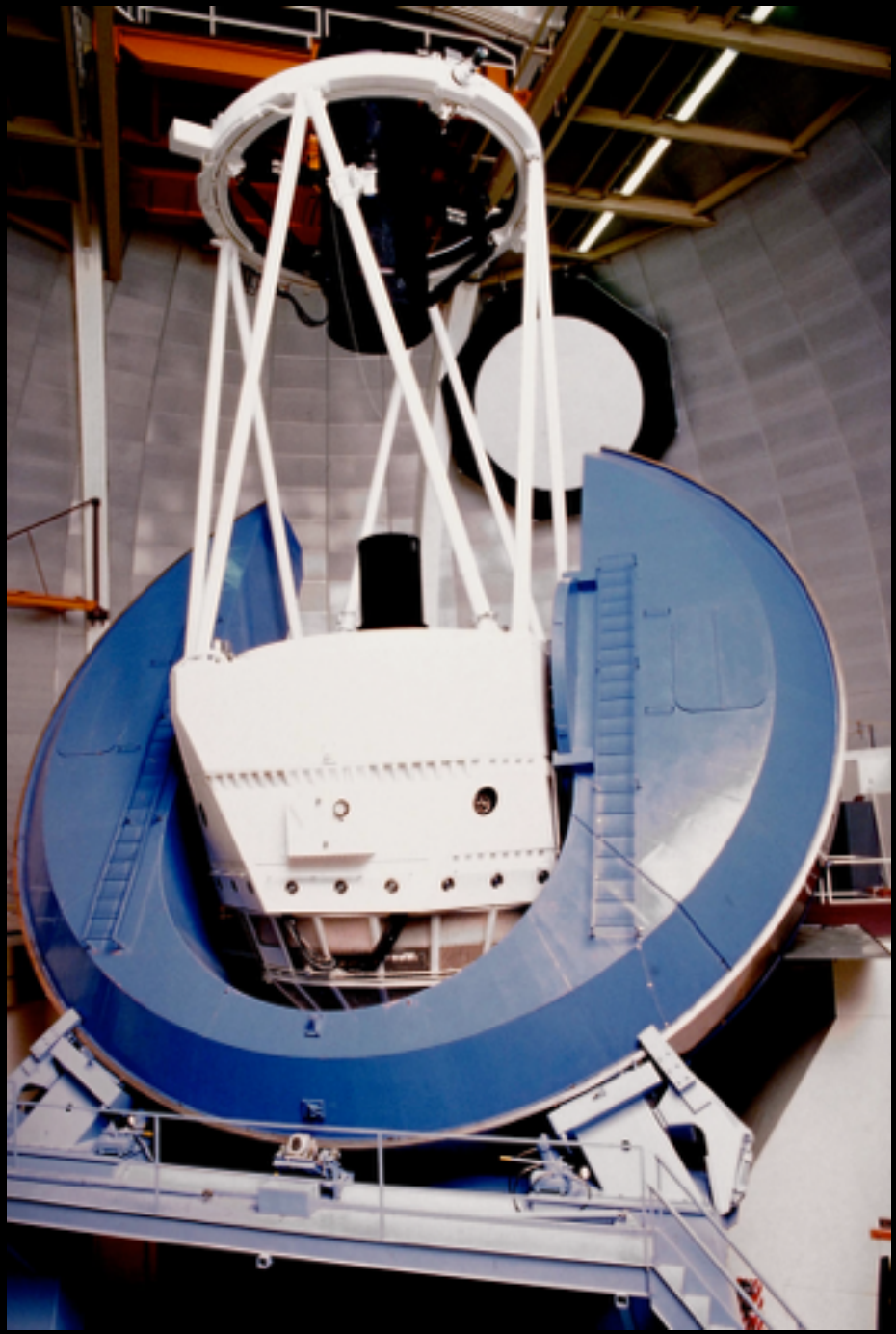

Astronomer at
Lowell Observatory
since 2000
Photo by Kathryn Neugent



Lowell Observatory


Astronomer at Kitt Peak National Observatory (1984-2000)
Photo by Kathryn Neugent

Kitt Peak 4-meter
Mayall telescope



A User's Guide to CCD Reductions with IRAF

Philip Massey

15 Feb 1997

Contents

A User's Guide to Stellar CCD Photometry with IRAF

Philip Massey Lindsey E. Davis

A User's Guide to Reducing Slit Spectra with IRAF

Phil Massey Frank Valdes Jeannette Barnes


Adjunct at NAU (1993-present)
Taught AST 180/181 various times
Teaching AST 401/PHY 580 since Fall 2013
Photo by Kathryn Neugent


Research Interests:
Massive Stars
Most luminous
Hottest (on MS)
Coolest (red supergiants)
Weirdest
Photo by Kathryn Neugent

Monthly Notices
of the
ROYAL ASTRONOMICAL SOCIETY

MNRASL **443,** L94–L98 (2014) doi:10.1093/mnrasl/slu080

Discovery of a Thorne–Żytkow object candidate in the Small Magellanic Cloud

Emily M. Levesque,[1]★† Philip Massey,[2] Anna N. Żytkow[3] and Nidia Morrell[4]

[1]*Center for Astrophysics and Space Astronomy, University of Colorado UCB 389, Boulder, CO 80309, USA*
[2]*Lowell Observatory, 1400 W. Mars Hill Road, Flagstaff, AZ 86001, USA*
[3]*Institute of Astronomy, University of Cambridge, Madingley Road, Cambridge CB3 0HA, UK*
[4]*Las Campanas Observatory, Carnegie Observatories, Casilla 601, La Serena, Chile*

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ABSTRACT

Thorne–Żytkow objects (TŻOs) are a theoretical class of star in which a compact neutron star is surrounded by a large, diffuse envelope. Supergiant TŻOs are predicted to be almost identical in appearance to red supergiants (RSGs). The best features that can be used at present to distinguish TŻOs from the general RSG population are the unusually strong heavy-element and Li lines present in their spectra, products of the star's fully convective envelope linking the photosphere with the extraordinarily hot burning region in the vicinity of the neutron star core. Here, we present our discovery of a TŻO candidate in the Small Magellanic Cloud. It is the first star to display the distinctive chemical profile of anomalous element enhancements thought to be unique to TŻOs. The positive detection of a TŻO will provide the first direct evidence for a completely new model of stellar interiors, a theoretically predicted fate for massive binary systems, and never-seen-before nucleosynthesis processes that would offer a new channel for Li and heavy-element production in our Universe.

Key words: stars: peculiar – supergiants.

M31: the Andromeda Galaxy

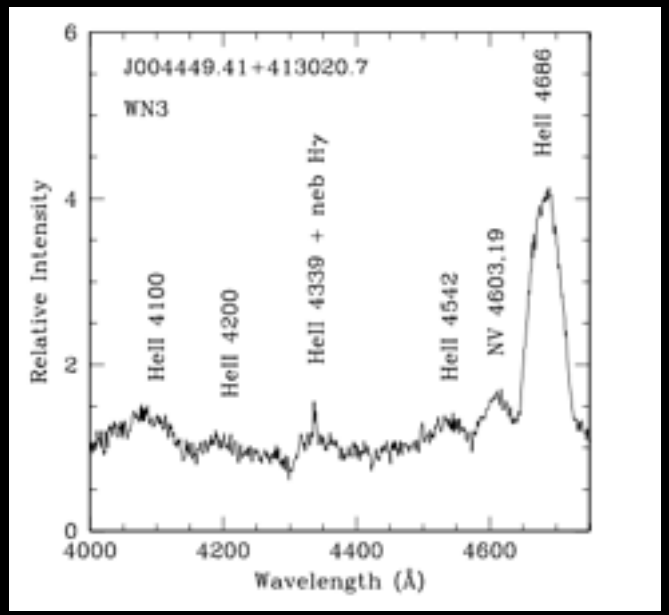
The Astrophysical Journal, 759:11 (19pp), 2012 November 1 doi:10.1088/0004-637X/7

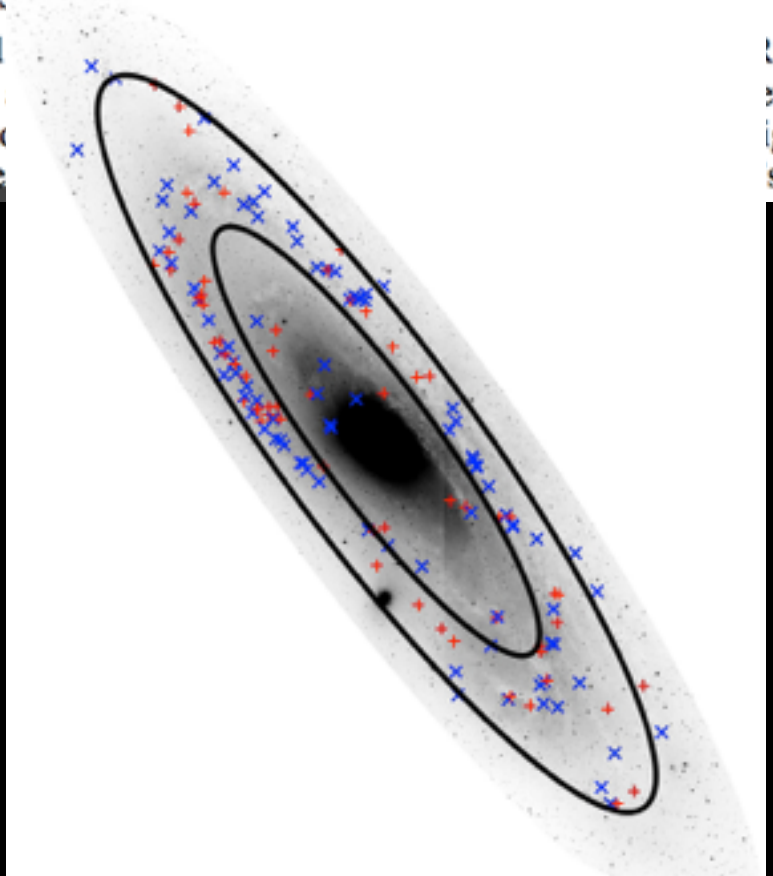
THE WOLF–RAYET CONTENT OF M31*

Kathryn F. Neugent[1], Philip Massey[1,3], and Cyril Georgy[2]
[1] Lowell Observatory, 1400 W Mars Hill Road, Flagstaff, AZ 86001, USA; kneugent@lowell.edu, phil.massey@lowell.edu
[2] Centre de Recherche Astrophysique de Lyon, École Normale Supérieure de Lyon, 46 allée d'Italie, F-69384 Lyon Cedex 07, France; Cyril.Georgy@ens-lyon.fr
Received 2012 June 14; accepted 2012 September 5; published 2012 October 11

ABSTRACT

Wolf–Rayet (WR) stars are evolved massive stars, and ...ts should vary with the metallicity of the host galaxy, providing ...ever, past studies of the WR content of M31 have been biased t... ...ignatures are much stronger than those of WNs. Here, we pre... ...s optical






SMC
LMC


The 6.5-meter MMT Observatory
Photo by Kathryn Neugent


6.5-meter Clay
Magellan telescope

Photo by Yuri Beletsky

Photo by Yuri Beletsky

How does it work?

- Two 75-minute traditional lectures per week (T, Th 9:35-10:50am), going a bit deeper than the text. Instructor: me (Philip Massey)
- Lab every Wednesday afternoon 3:00-5:30pm with telescope reserved Wednesday evenings (7:00-9:30pm). Instructor: Ed Anderson
- Single grade (60% class, 40% lab)

How does it work?

- Ast 401/401L is "advanced" class for astronomy majors.
- Phy 580 students will also give a short presentation.
- Study some of techniques of research astronomy.
- Much more computer analysis than observing.
- Use campus 20-in to collect data for analysis.
- Field trip to the 4.3-meter DCT---pretty pictures!

Overview

1. The Basics
    A. Celestial sphere and coordinates--Chapter 1+suppl.
    B. Time--Chapter 2+suppl.
    C. Spherical triangles—Chapter 4
    D. Catalogs (Guest lecture: Brian Skiff)—Chapter 3.
    E. More practical astrometry—-Chapter 4
2. The rainbow and beyond
    F. Light--Chapter 5
    G. Optical telescopes—Chapter 6
3. Effects of the atmosphere and ISM--Chapter 7
4. Review and midterm (chapters 1-7+lectures+suppl. reading)

Overview

5. Seeing clearly
    A. Detecting light--Chapter 8
    B. Statistics+Using CCDs—Chapter 9+suppl. material
    C. CCD calibrations--Chapter 9+suppl. material
6. Astronomical photometry—Chapter 10+suppl. material
7. Astronomical Spectroscopy
    A. Spectrographs--Chapter 12+suppl. material
    B. The art of astronomical spectroscopy--Chapter 13
8. Other wavelengths
    A. Radio astronomy (Guest lecture: Deidre Hunter)
    B. Infrared astronomy (David Trilling)
9. Astrometry—Chapter 11
10. Things that vary—Chapter 14
11. REVIEW and FINAL EXAM

Overview

- BBLearn: https://bblearn.nau.edu
  - ★ Lecture notes will be posted in advance.
  - ★ Supplemental reading material will be found there.
  - ★ Announcements, homework assignments will be found there.

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Philip Massey 18

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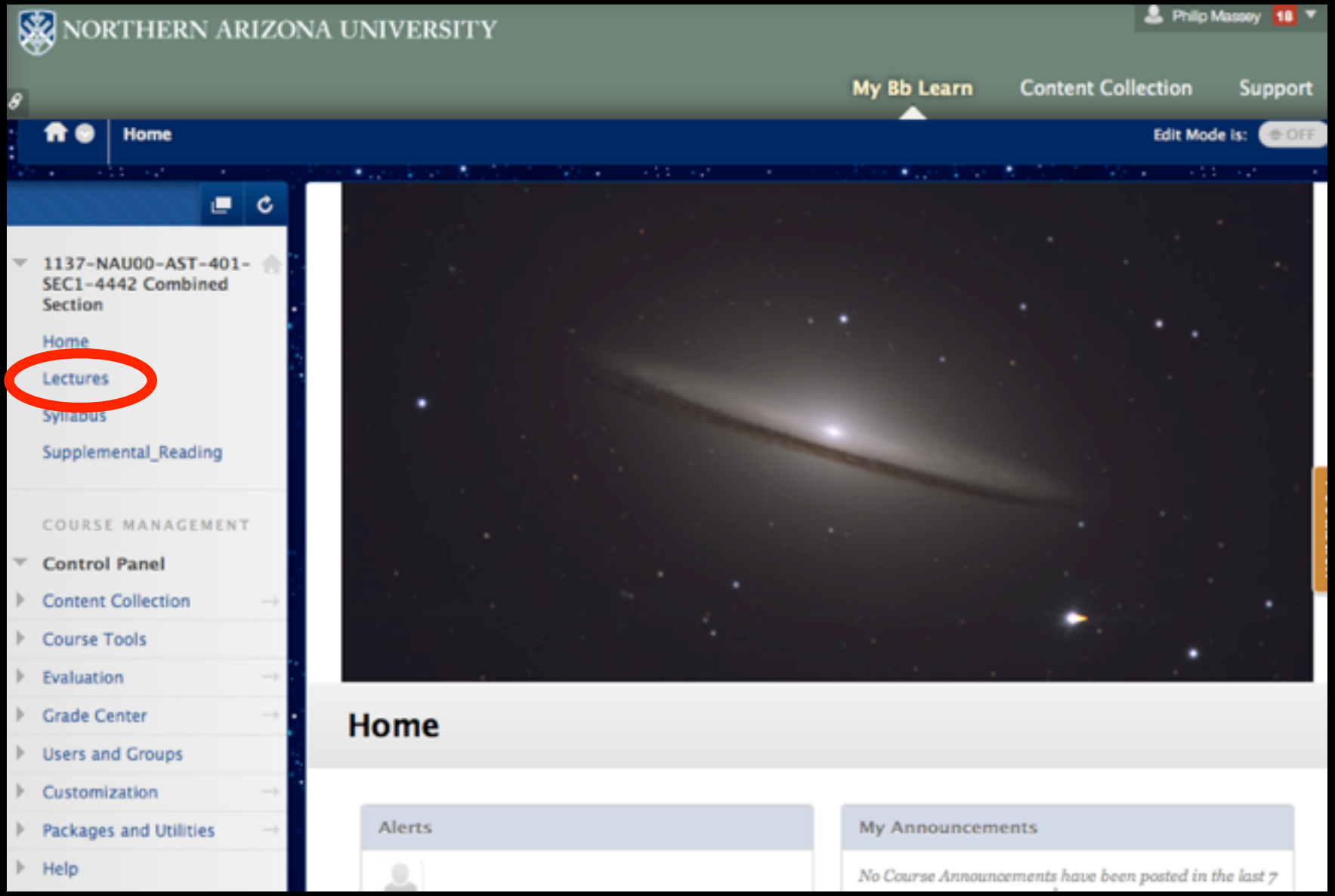
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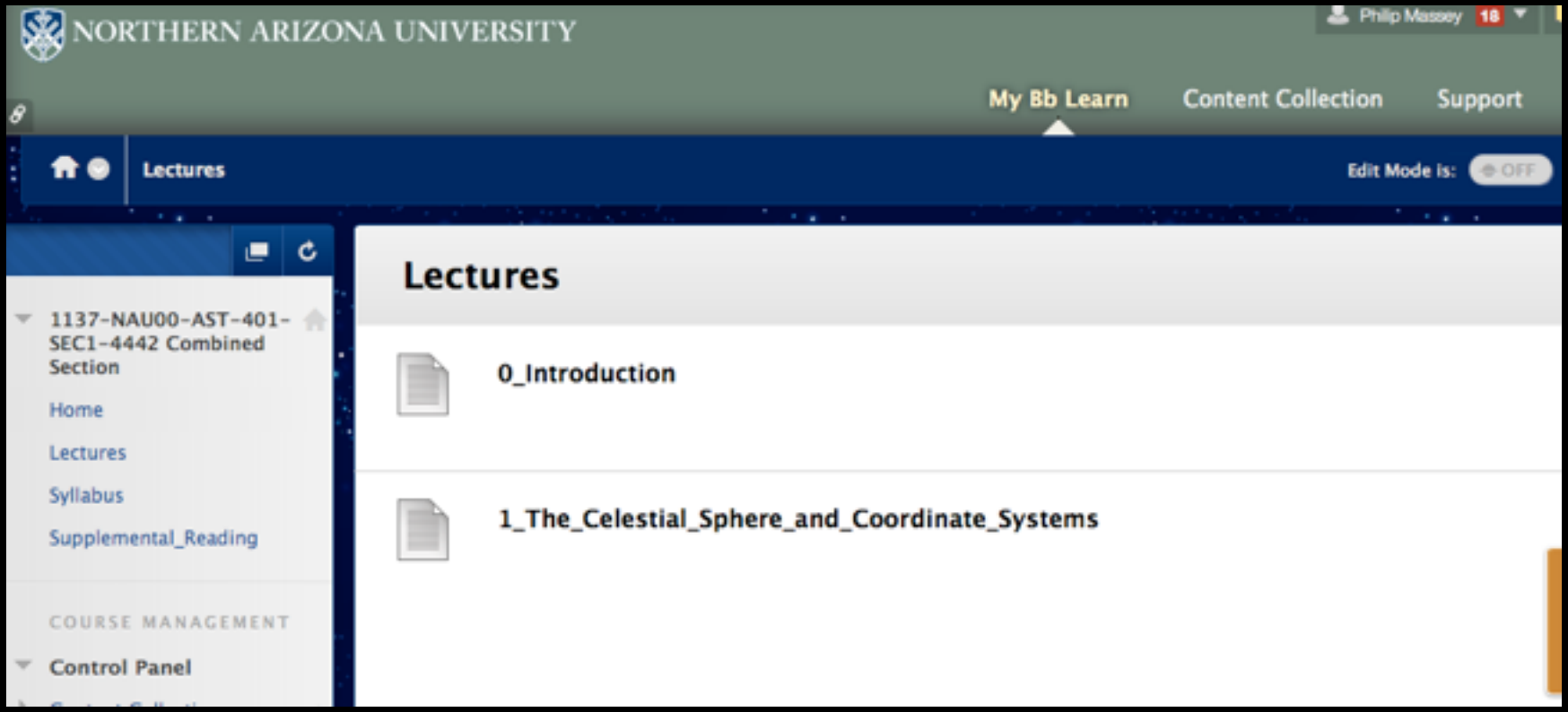
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1_The_Celestial_Sphere_and_Coordinate_Systems

Overview

- Keeping class interesting. Basic format:
  - ★ Questions at start of class
  - ★ Quiz (not graded)
  - ★ Lecture

Overview

- "Required" text: Observational Astronomy, 2nd edition, Birney et al.
  - ★ One copy on 4-hour reserve at Cline.
  - ★ Useful background reading.
  - ★ Not going to assign questions from text.

Overview

- Supplemental reading:
  - ★Intended as supplement to the text.
  - ★Good stuff to know.

Overview

LABORATORY:

- In the computer lab (Wed afternoons)
  - ★ Develop a qualitative understanding of CCD cameras.
  - ★ Learn Unix, IRAF, basics of CCD reductions and photometric analysis.
- At the observatory (Wed evenings)
  - ★ Review/learn motions of the sky
  - ★ Learn general procedure for using large telescopes
  - ★ Learn general procedure for using CCD cameras

NOTE: Weather may demand that some observing be done on nights other than Wednesdays.

Overview

LABORATORY:

- Term project: Light-curve of binary star!
  - ★ Take data on the 20-inch Lutz telescope
  - ★ Reduce data
  - ★ Do photometry
  - ★ Make sense of it all
  - ★ Compare to others
  - ★ Write term paper
- Field trip to the 4.3-meter Discovery Channel Telescope
  - ★ Take pretty pictures, turn them into color!

Overview

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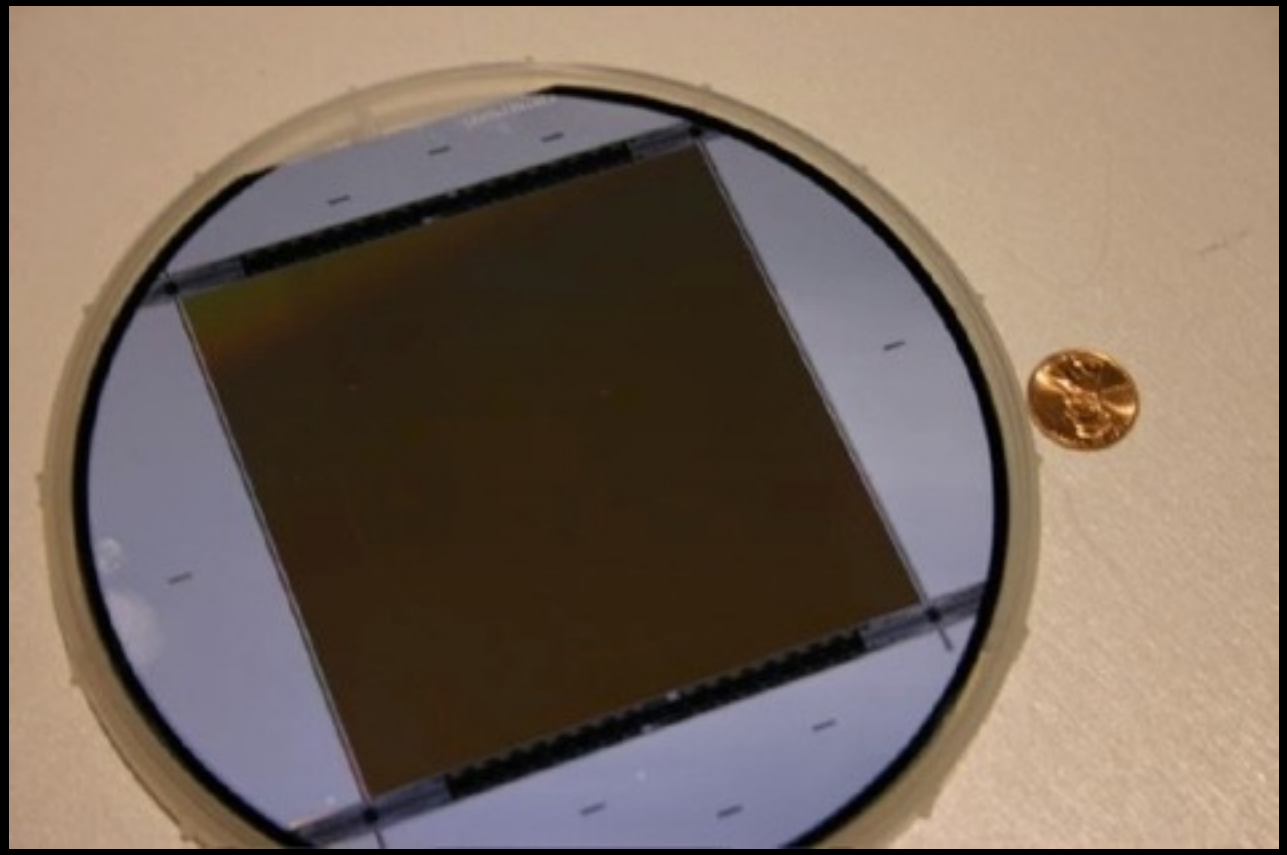
Campus Telescope

Discovery Channel Telescope (4.3-meter)

Large Monolithic Imager



NGC 891, an edge-on spiral at a distance of 10Mpc (32 million light-years)

Massey/Neugent/Dunham/Lowell Obs./NSF

NGC 6946, a face-on Sc-type spiral galaxy, at a distance of 6Mpc (20 million light-years)

Massey/Neugent/Levine/Lowell Obs./NSF

Stephan's Quintet—taken by AST401 student

Barandi/Massey/Lowell Obs./NSF

Resources

Goal is for everyone to learn everything and get an A!
What should you do if you're having problems?

- Come to Phil's office hours!
  - Every Tuesday + Thursday 11am-noon, Room 203
    - ★ If that doesn't work for you, send email to phil.massey@nau.edu and set up a time.
- Come to Ed's office! (Room 323)
- Contact the TAs:
  - Liz Gehret (epg34@nau.edu)
  - Cassandra Lejoly (cl968@nau.edu)

Phil will be off observing sometimes!

- Great guest lecturers lined up, experts in their field:
  - Deidre Hunter (radio astronomy)
  - Brian Skiff (catalogs and computer searches)
  - David Trilling (infrared astronomy)