

ASTR 535

Observational Techniques

Fall 2023

Introduction

Today

- Describe what is meant by observational techniques in the context of this class
- Outline course content
- Discuss the changing nature of observations in astronomy
- Class logistics
- Pre-course assessment
- Introduction to NMSU observing facilities / opportunities
- Data puzzles (as time permits)

Observational Techniques

- Goal: how to understand and optimally collect astronomical data and extract information, in principle and in practice. Position you to take advantage of NMSU facilities if you are interested.
- Observational techniques
 - Recover intrinsic information from observations: need to understand instrument, atmosphere etc
 - Need to understand and minimize uncertainties in measurements: random and systematic
 - Recognize that techniques evolve with new instrumentation and analysis techniques
- Learning components
 - Knowledge: light, uncertainties, atmospheres, telescopes and instruments, data analysis
 - Different techniques/issues/features for different wavelength regimes: we will restrict to UV/optical and near-infrared (not high energy or radio)
 - Practical tools: important, but not a class on data reduction packages (why not?)
 - Questioning and independent learning

Example: extrasolar planet transits

- Imagine you want to detect extrasolar planets like the Earth by the transit method
 - What is the transit method?
 - What is the amplitude of the effect you want to measure?
- What limits your ability to make this measurement?
 - Sufficient accuracy of the measurement, limited by
 - Statistics
 - Systematics, e.g., atmosphere
 - Calibration, e.g., flat fielding

Class outline / modules

- Properties of light /photons
- Uncertainties
- Observing concepts and tools
- Effects of the Earth's atmosphere
- Optics / Telescopes
- Instruments / Detectors
- Data reduction/analysis

Changing nature of astronomical observations

- Observing modes
 - Traditional scheduling
 - Remote observing
 - Service observing
 - Survey observing
 - Virtual observatory
- Data analysis
 - Traditional
 - Observatory/instrument provided tools
 - Observatory/instrument provided results
- Do we need to understand observational techniques, and at what level?
 - Understanding what is done to data is important even if you don't do it
 - Understanding how instruments work is important even if you don't build them. Future projects likely involve instrumentation proposals
 - Someone has to write/do the analysis!
 - Current state of flux in data analysis, e.g., for APO

Class logistics

- Class sessions
 - Flipping the classroom:
 - Watch lecture segments carefully before class : don't plan to repeat presentation of material in class
 - Supplement with reading as needed/desired
 - Start class with brief student discussions in groups
 - Collect and address questions
 - Individual quiz questions
 - Problems to be completed (individual or group) and submitted in Canvas by next class session; also, Slack channels
 - Time management (2.5 hrs in class, 2.5? hrs for videos, 1-2.5? hrs for completing problems/reading/thinking)
- Grading:
 - Quiz questions (25%)
 - Problems (25%)
 - Module summaries (5%)
 - Engagement/participation (5%)
 - midterm (20%)
 - Final (20%)
- Resources: [Canvas](#), class web pages, notes, books
- APO trips: likely weekend of 10/20-22

NMSU observations resources / opportunities

- ARC 3.5m
 - Instruments: ARCTIC, AGILE, DIS, KOSMOS, ARCES, NICFPS, TRIPLESPEC
- SDSS 2.5m. SDSS projects
 - SDSS: (2000-2005). SDSS galaxy survey
 - SDSS-II (2005-2008): galaxy survey, SDSS-SN, SEGUE
 - SDSS-III (2005-2014): BOSS, MARVELS, SEGUE-2, APOGEE
 - SDSS-IV (2014-2020): eBOSS, APOGEE (including APOGEE-S), MaNGA
 - SDSS-V (2020-) : MWM, BHM, LVM
- NMSU 1m /SONG
- Sunspot Solar Observatory: Dunn Solar Telescope
- Tortugas Mt. Observatory: operation sessions TBD soon!
- Campus Observatory: TBD

Data puzzles

See the data puzzles Jupyter notebook!

Assignments by next class

- Course questionnaire by Friday
- Pre-course assessment by Friday
 - Purpose
 - Helps me understand level (and diversity of levels) of students
 - Possible course baseline for evaluation of effectiveness
 - Ungraded!
 - More helpful to mark “Don’t know” than to guess
- Two video segments
- Reading