Lecture 1 Notes: Introduction to Astronomy and Astrophysics

Supplementary Material

August 2024

1 Historical Context of Astronomy

While the lecture introduced astronomy as the oldest science, it's worth exploring why certain astronomical discoveries preceded others. Early civilizations focused on:

- Tracking celestial motions for agricultural purposes
- Developing calendars based on lunar and solar cycles
- Navigation using stars
- Understanding seasons through solar motion

For an excellent overview of ancient astronomy across cultures, see:

- Neugebauer, O. (1969) "The Exact Sciences in Antiquity"
- Pingree, D. (1997) "From Astral Omens to Astrology: From Babylon to Bīkāner"

2 The Modern Scientific Revolution

The invention of the telescope around 1610 marked the beginning of modern astronomy. Key developments included:

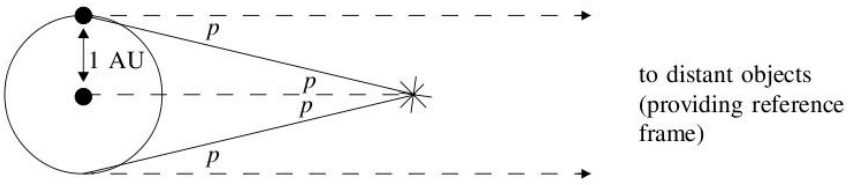
- Galileo's observations of Jupiter's moons
- Discovery of Saturn's rings by Huygens
- Newton's laws of motion and universal gravitation

For detailed reading on the telescope's impact:

- Van Helden, A. (1974) "The Telescope in the Seventeenth Century", Isis 65(1)
- Gingerich, O. (2011) "Galileo, the Impact of the Telescope, and the Birth of Modern Astronomy"

3 Distance Measurements in Astronomy

3.1 Parallax Method



The parallax method remains fundamental to astronomical distance measurements. Modern improvements include:

- Hipparcos mission (1989-1993): 100,000 stars, 0.97 mas precision
- Gaia mission (2013-present): 1 billion stars, 20 as precision

For technical details on modern astrometry:

- Perryman, M. (2012) "Astronomical Applications of Astrometry: Ten Years of Exploitation of the Hipparcos Satellite Data"
- Lindegren, L. et al. (2021) "Gaia Early Data Release 3: Parallax bias versus magnitude, colour, and position", A&A, 649, A4

4 Contemporary Interdisciplinary Nature

Modern astronomy's interdisciplinary nature requires understanding multiple physics domains:

- Nuclear physics: stellar interiors
- Quantum mechanics: atomic spectra
- General relativity: compact objects
- Plasma physics: stellar atmospheres
- Statistical mechanics: gas dynamics

Recommended textbooks for foundational physics:

- Shu, F.H. (1991) "The Physics of Astrophysics, Volume I: Radiation"
- Shu, F.H. (1992) "The Physics of Astrophysics, Volume II: Gas Dynamics"

5 Power Laws in Astrophysics

The lecture's "cheat sheet" about power laws reflects their ubiquity in astrophysics. Examples include:

- Luminosity-mass relation for main sequence stars: $L \propto M^{3.5}$
- Initial mass function: $N(M) \propto M^{-2.35}$ (Salpeter)
- Galaxy luminosity function: $\phi(L) \propto L^{-1.25}$ (Schechter)

For deeper understanding:

- Newman, M.E.J. (2005) "Power laws, Pareto distributions and Zipf's law", Contemporary Physics, 46, 323
- Clauset, A., et al. (2009) "Power-law distributions in empirical data", SIAM Review, 51(4)

6 Additional Resources

For general astronomy introduction:

- Carroll, B.W. & Ostlie, D.A. "An Introduction to Modern Astrophysics"
- Ryden, B. & Peterson, B.M. "Foundations of Astrophysics"

Online resources:

- NASA's Astronomy Picture of the Day (`https://apod.nasa.gov`)
- ESA's Gaia Mission Page (`https://www.cosmos.esa.int/web/gaia`)