Modern Astronomical Optics
- Observing Exoplanets

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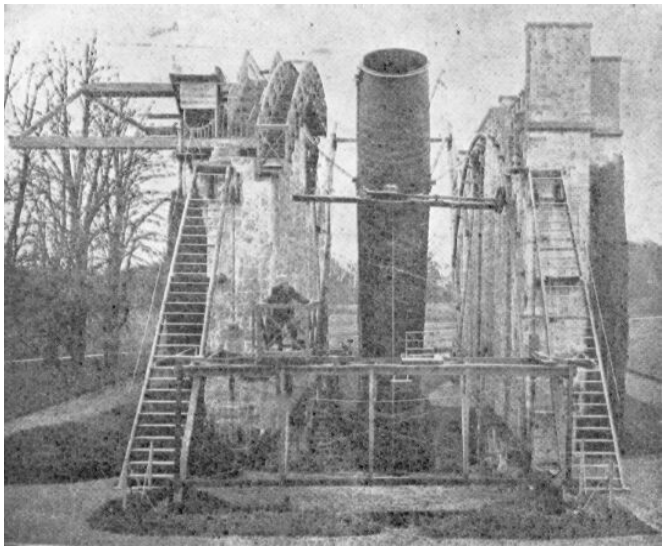
→ Astronomical Optics Course → Observing Exoplanets (2012)

Modern Astronomical Optics – Course Introduction

Astronomy relies heavily on **observation of light emitted by distant objects** with limited ability to perform experiment. Proper physical understanding therefore requires:
- sensitivity (distant objects are faint)
- angular resolution (distant = small apparent size)
- spectral coverage and spectroscopic resolution (temperature, light emission process, chemical composition)
- polarization (magnetic fields, optical scattering of light)

Proxima Centauri – closest star, but still 4.2 lyr away

Astronomy relies on optics, and is largely driven by (and driving) technology advances in optics, with ripple effects in other fields
- The largest optical imaging systems are built for astronomy, but telescopes are also used for Earth sciences & defense
- Advances in interferometry and adaptive optics are largely driven by astronomy, but are also used for medical imaging, defense, telecommunications etc...



Lord Rosse's 1.8m telescope Completed in 1845, in the Irish countryside

Modern Astronomical Optics

Solving astronomy problems requires new and more capable telescopes and instruments. In most fields in astronomy, advances in astronomical optics are (badly) required. For example:
- **characterizing exoplanets and finding life on other worlds is currently largely an astronomical optics challenge** (need for large telescope + coronagraph + special adaptive optics)
- understanding origin and evolution of universe requires large telescopes, able to image distant (=old) galaxies

Very Large Telescope, Chile

Astronomy offers some of the most challenging (and fun) optical problems. Major advances in astronomy are often done by those who improve/solve optical challenges (ex: Galileo's improvement of the telescope).

Sharp understanding of optics enables astronomers to do ground-breaking new astronomical research:
- develop, build and use new optical concepts for astronomy
- understand how modern complex astronomical optical systems work to extract information

Modern Astronomical Optics

This course will provide astronomy students with a physical understanding of optics for astronomy. Will enable astronomy and optics students to understand what optics can do for astronomy.
Observing exoplanets used as example and motivation for course material

This course will provide an overview of current astronomical optics techniques, limits and capabilities. This knowledge is essential for astronomers:
- how can I solve my astronomy problem ? (exoplanet related or not)
- what type of instrument will allow me to measure xxxx ?
- can I build a telescope + instrument that can do xxxx ?

Optics students will find in this course many exiting optics challenges, some of them solved, others not (yet !).

Course will have team projects, where astronomy and optics students will work together to solve problems and think hard about how to build telescopes/instruments for astronomy. The goal of the project is not to do a detailed optical design, but to get the overall physics right, and identify suitable approaches to solve problems (and have fun !)

Why use exoplanets to teach modern astronomical optics ?

Many scientifically exciting questions

- Is Earth unique ?
- Life in the universe - Are we alone ? Did we get lucky ?

Exoplanet science is the most optics-demanding area of astrophysics: Observing exoplanets is not easy !
Planets are small & faint compared to star → observing them requires:

- large telescopes (imaging), large field of view (transit searches)
- high precision… photometry (transit, microlensing) … astrometry (mass measurement) … spectroscopy (radial velocity) … wavefront sensing and control (imaging) … interferometry (astrometry / imaging)

Exoplanets are increasingly driving requirements for current and future telescopes/instruments, and are driving innovation and technological progress in modern astronomical optics.