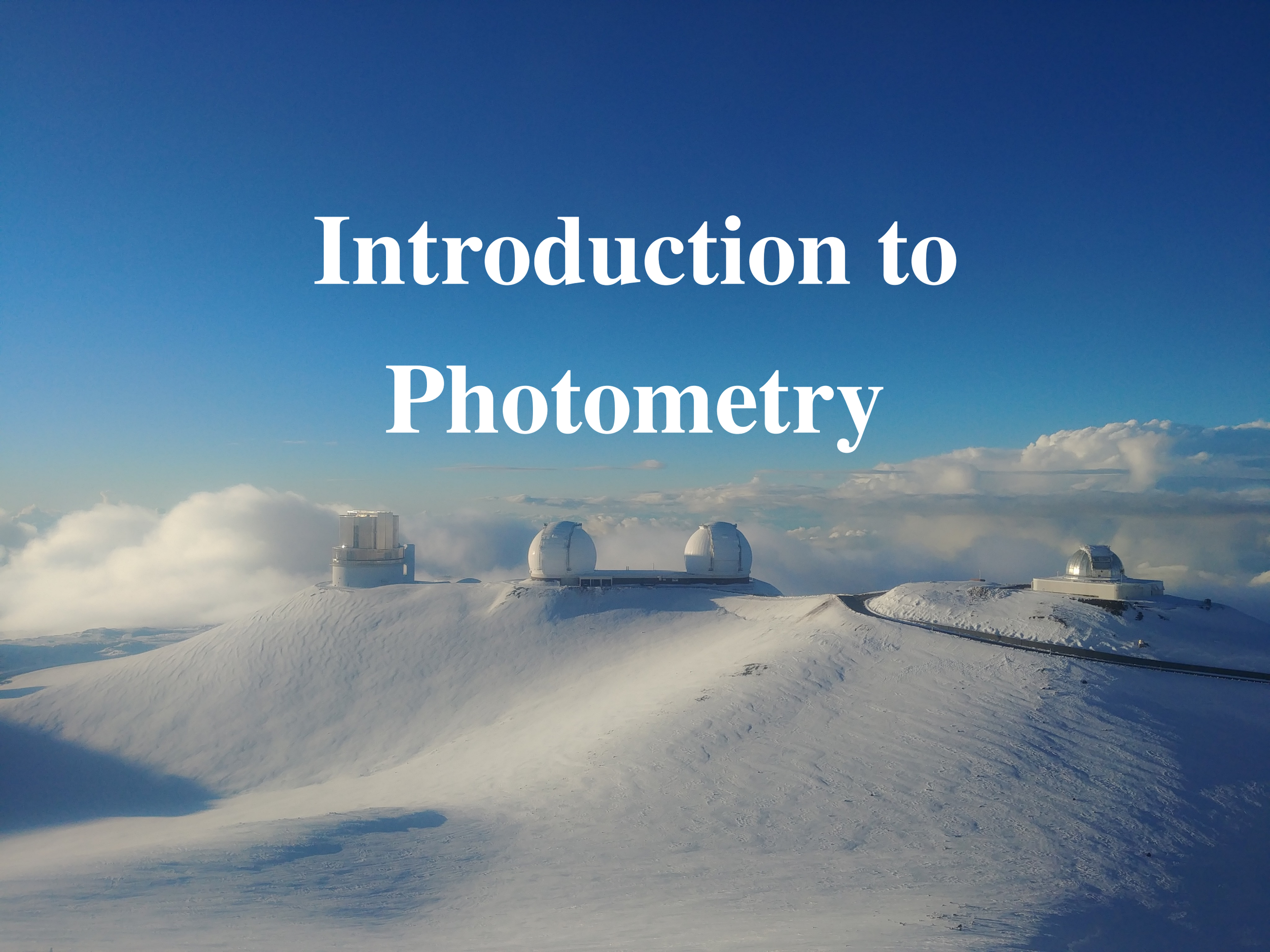
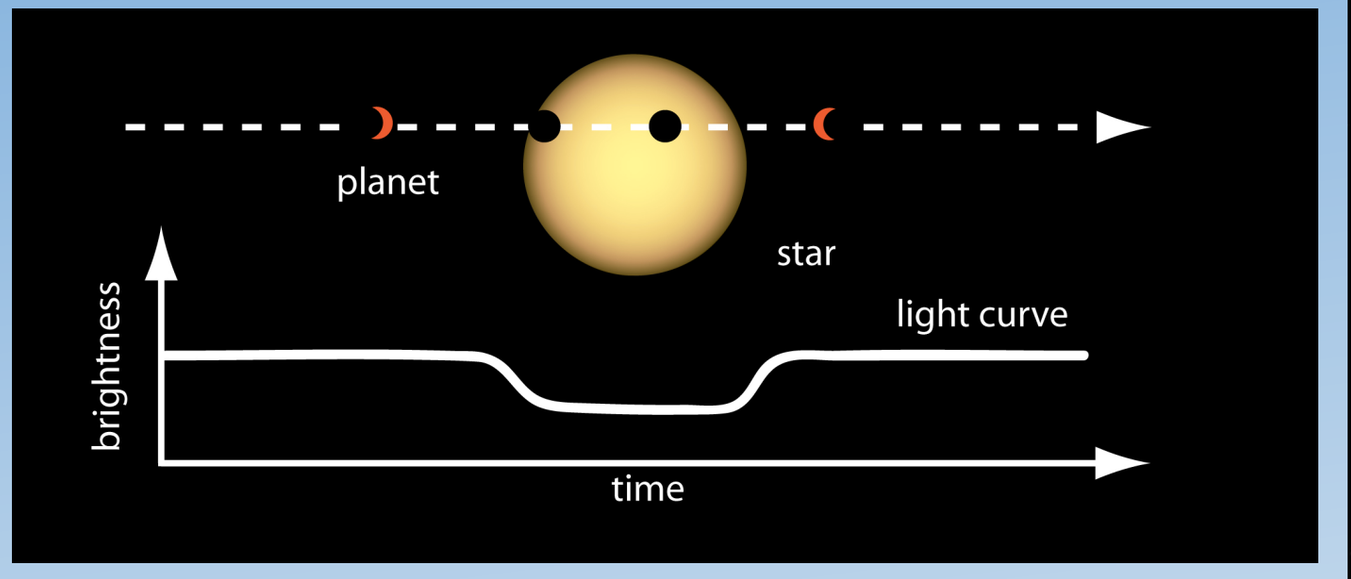
Introduction to Photometry

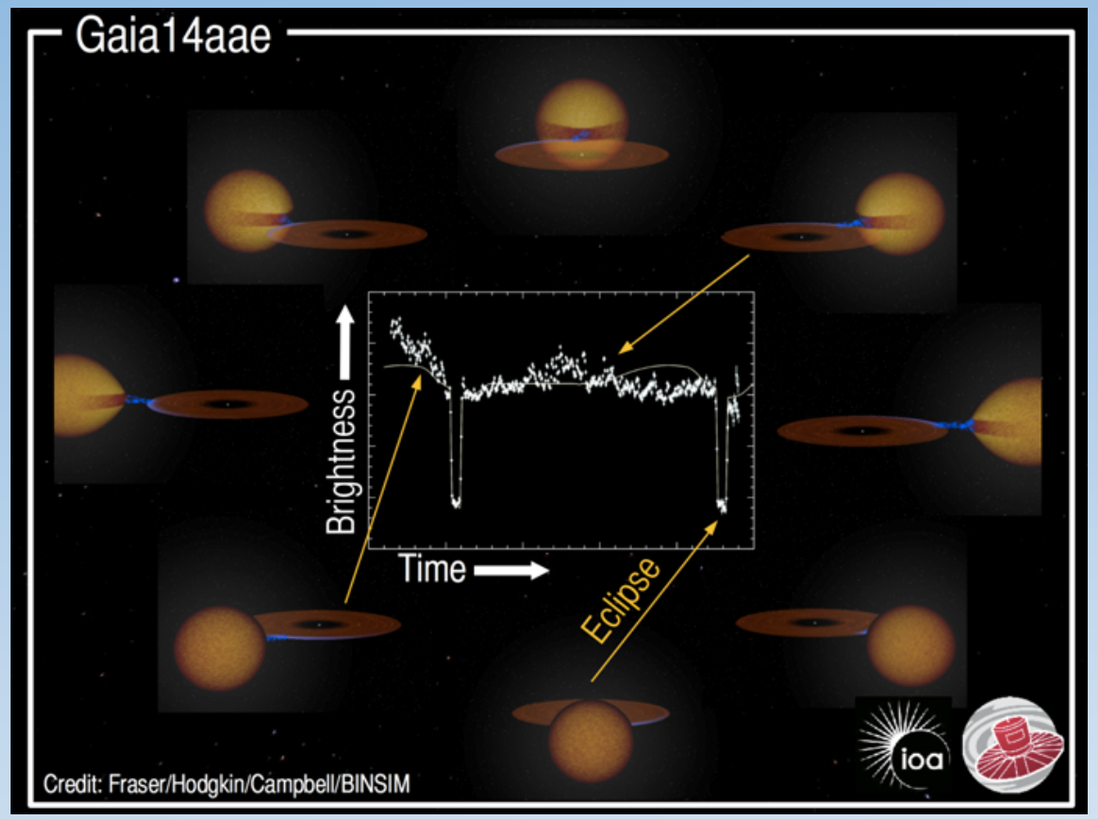


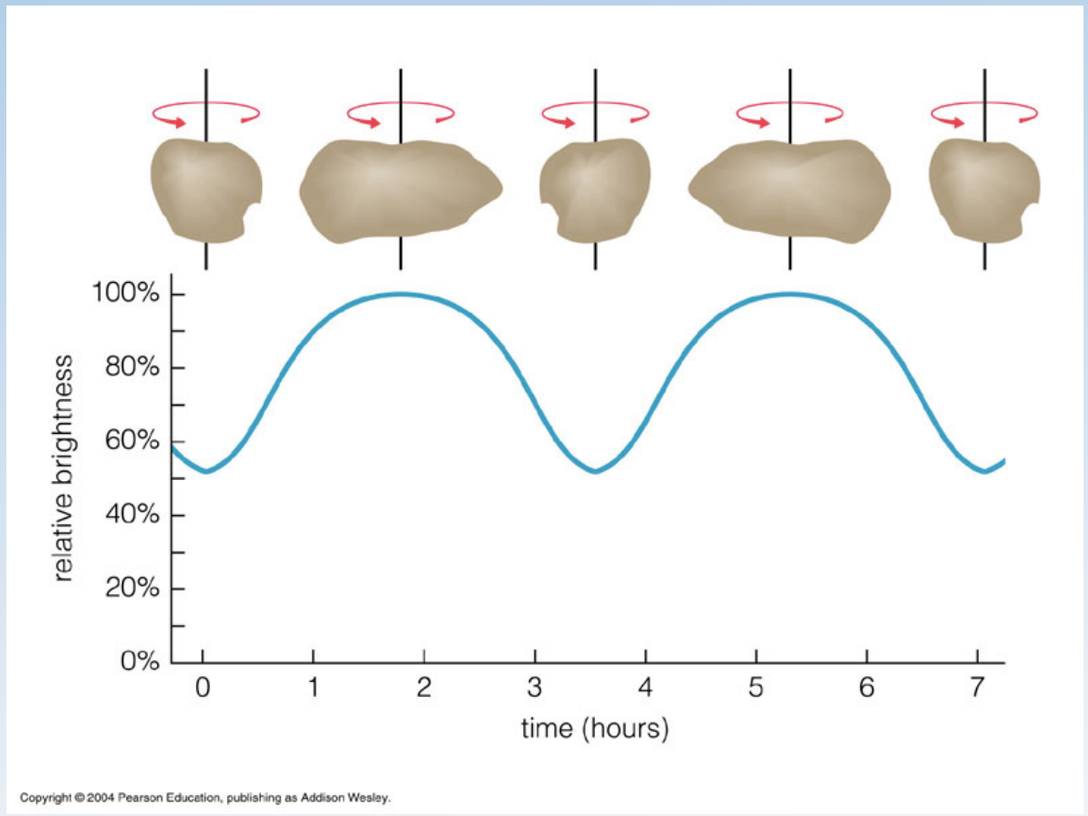
What is photometry?

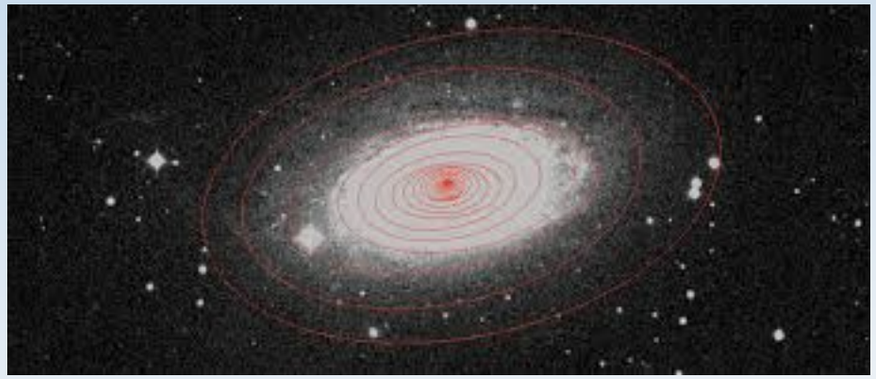
- Photometry: measurement of light
- How much? What colour?

Examples of photometry

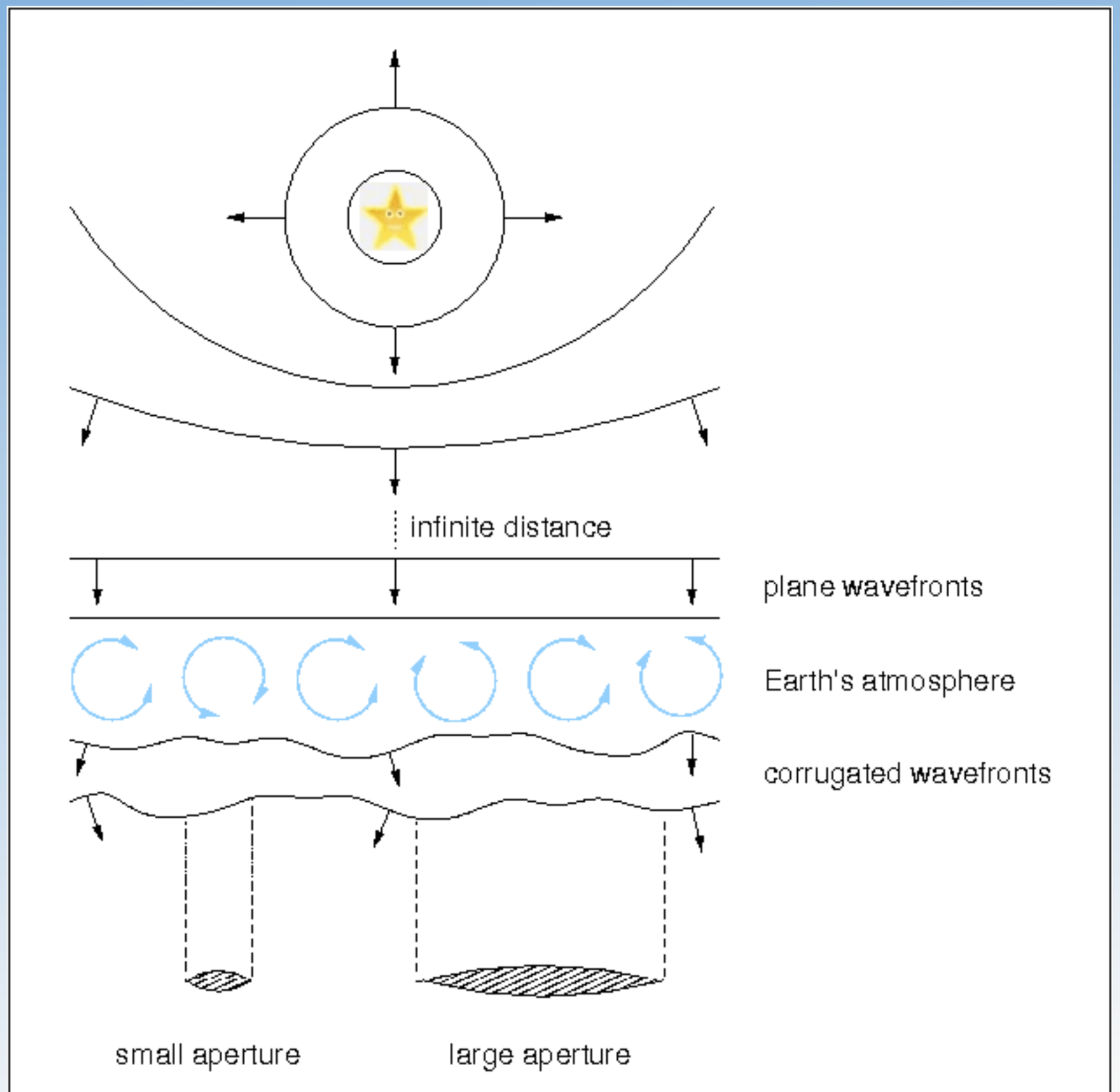




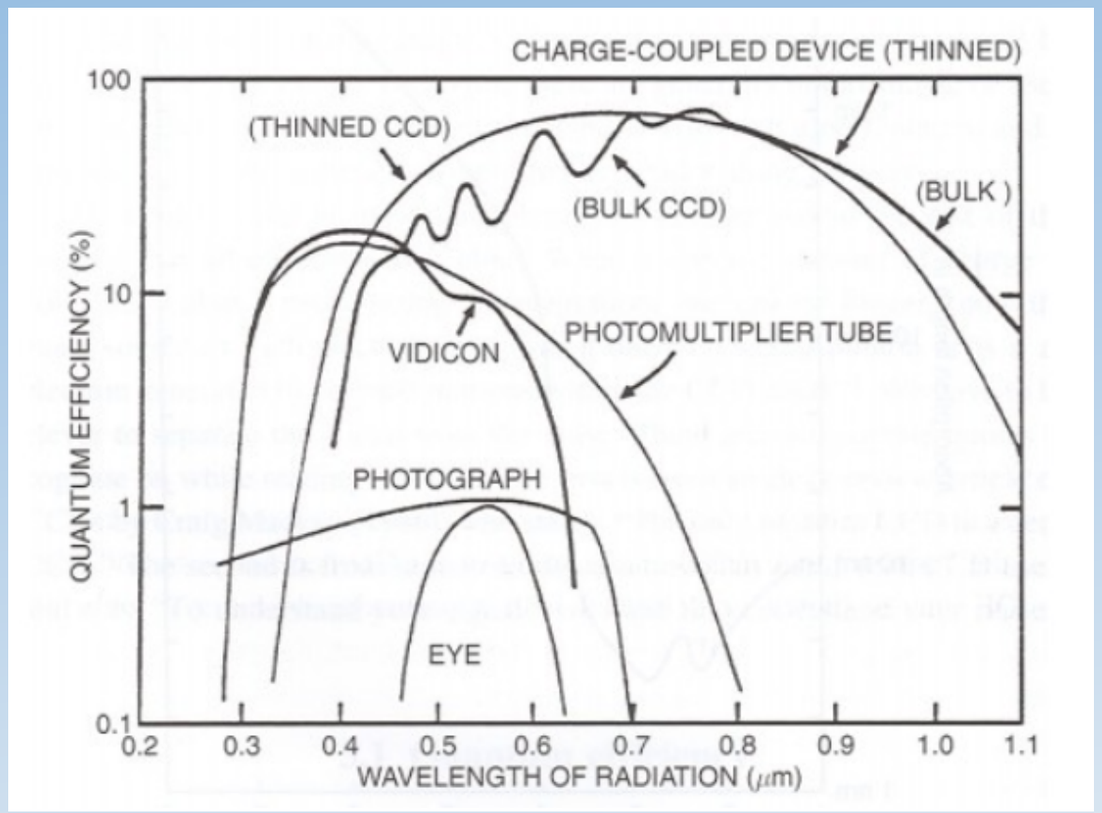


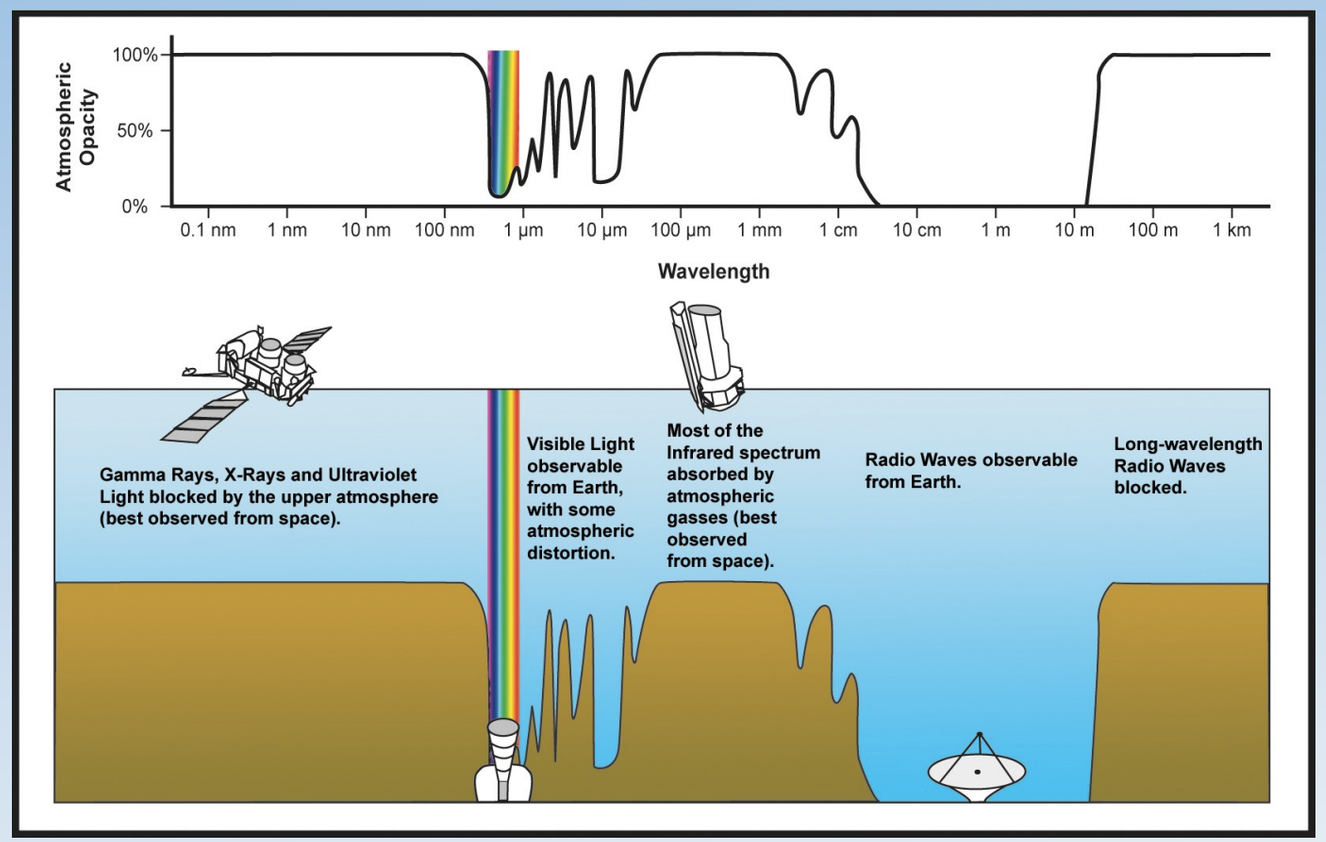


Light From a Source

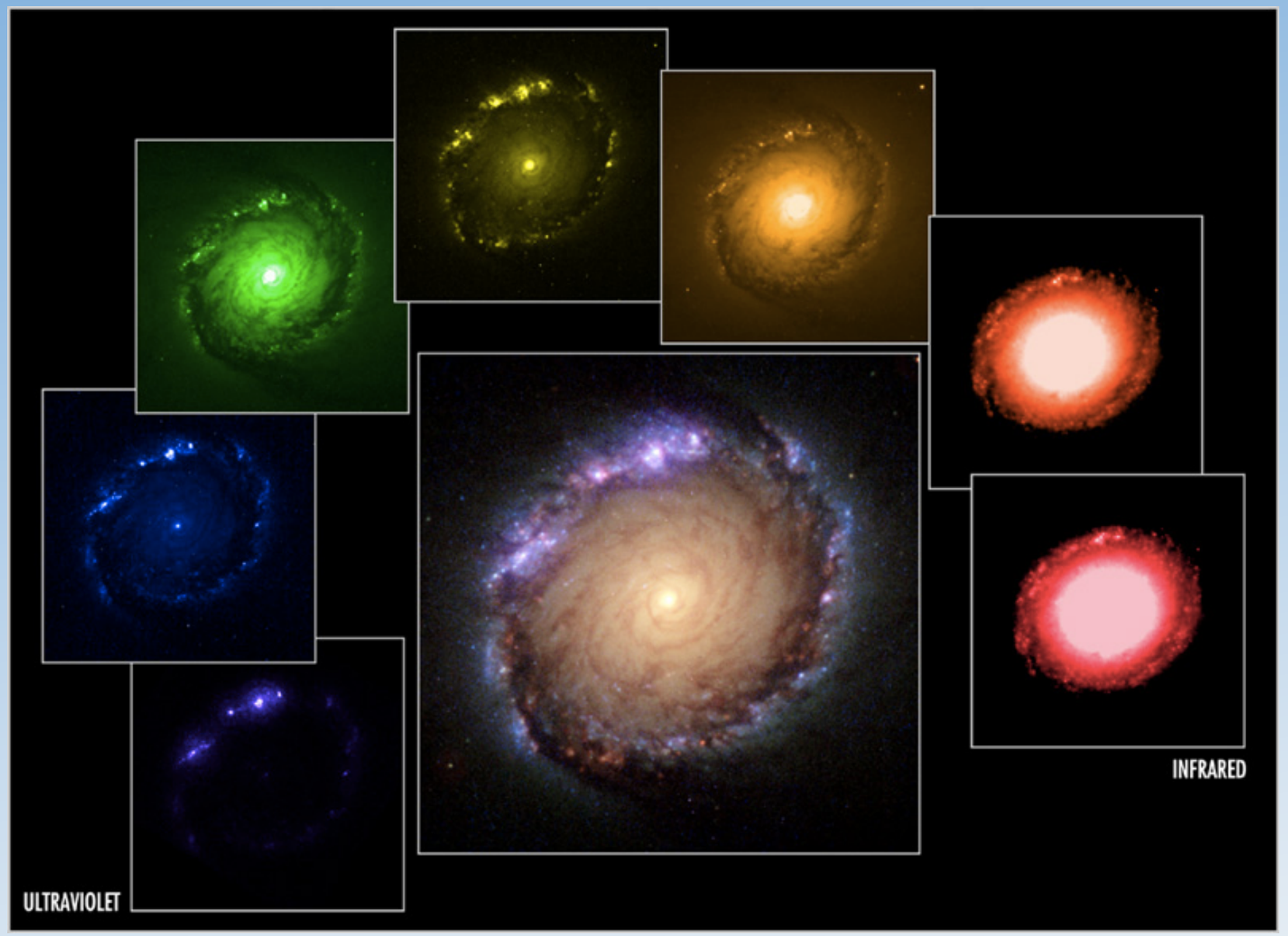


Transmission Curves

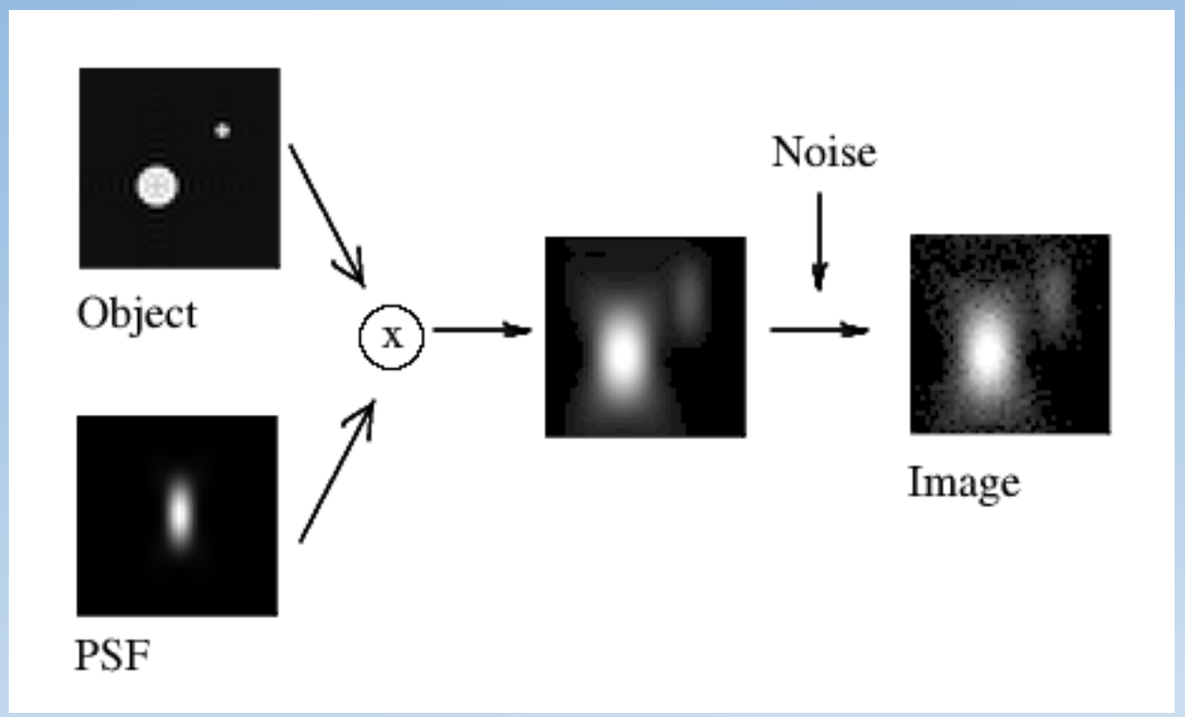


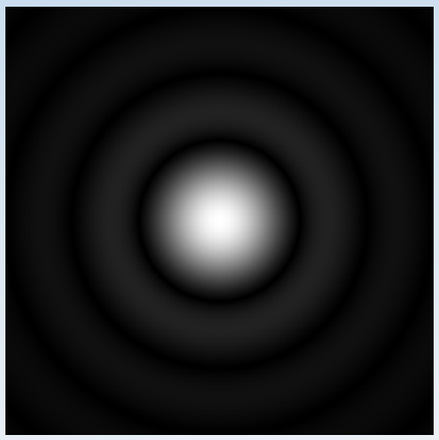


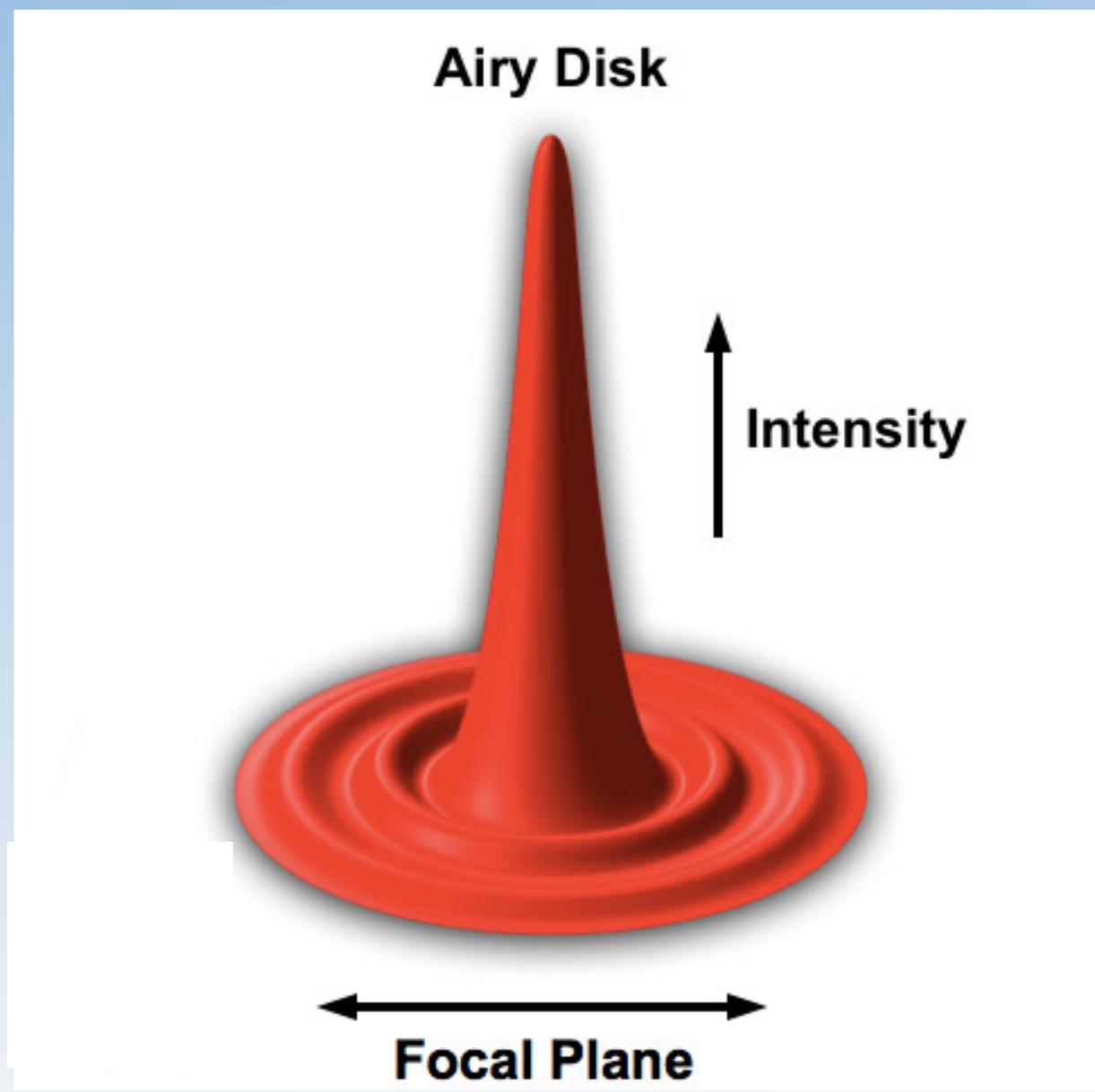
Filters



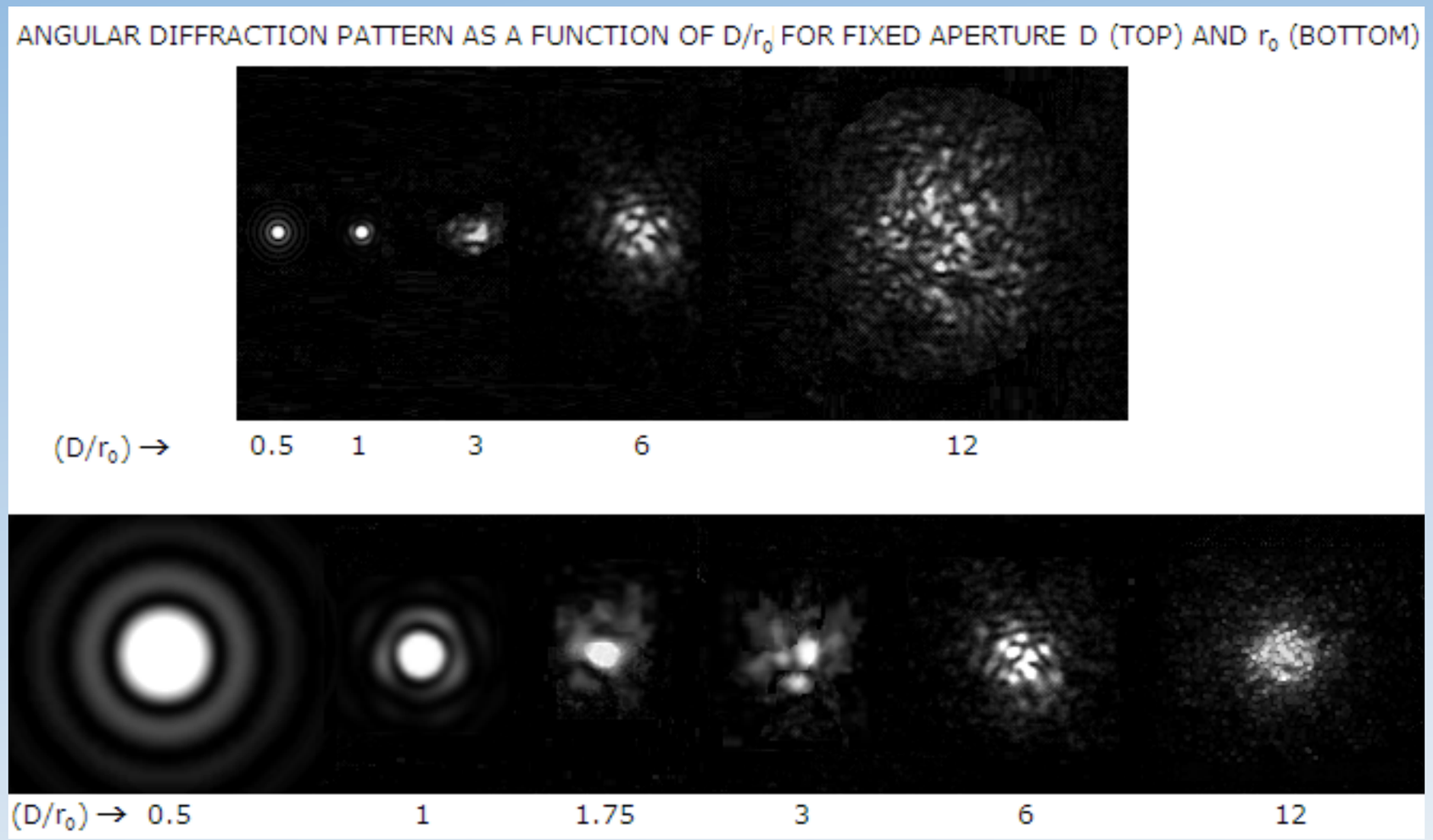
Point Spread Function



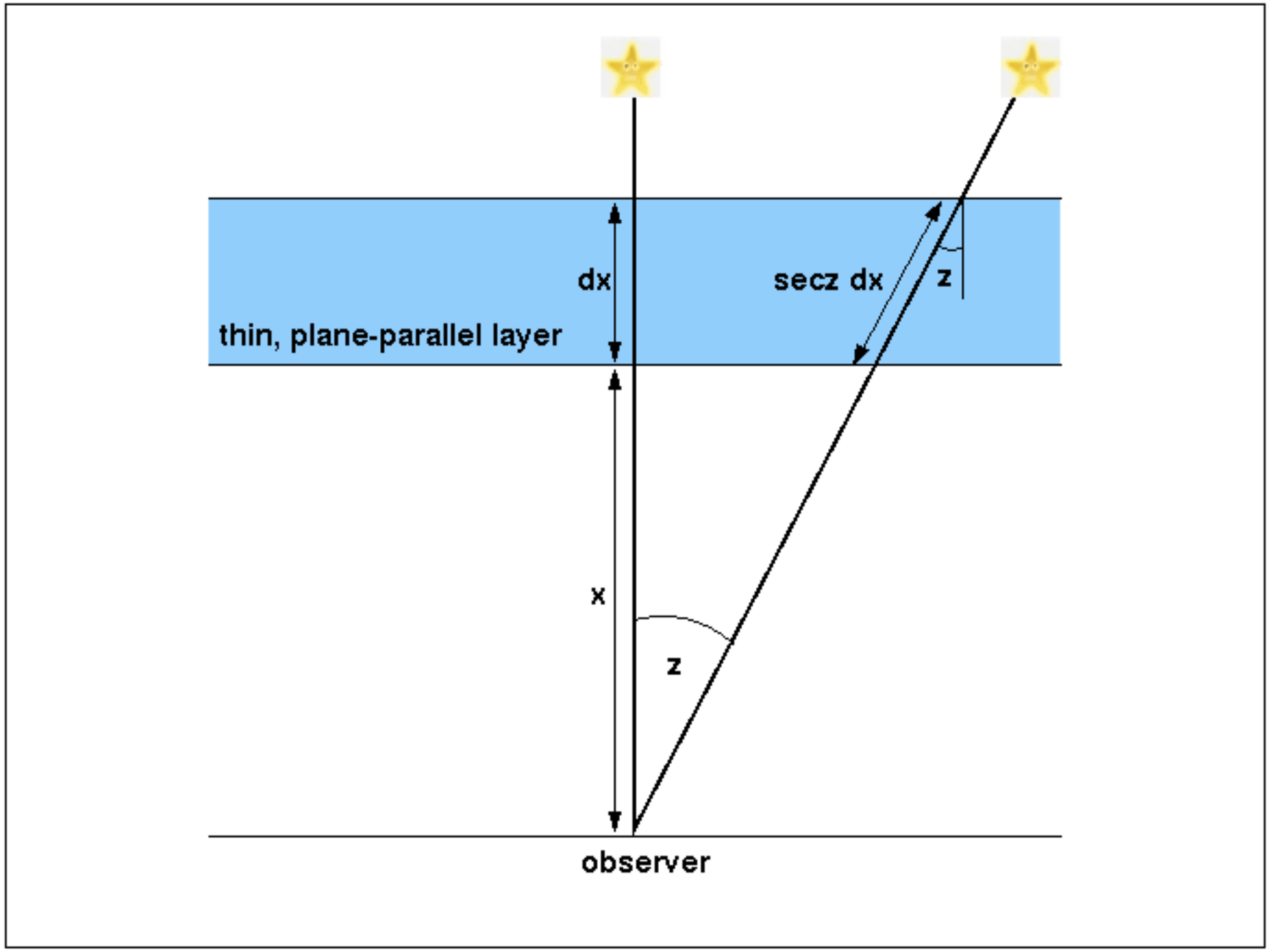




Atmospheric Effects

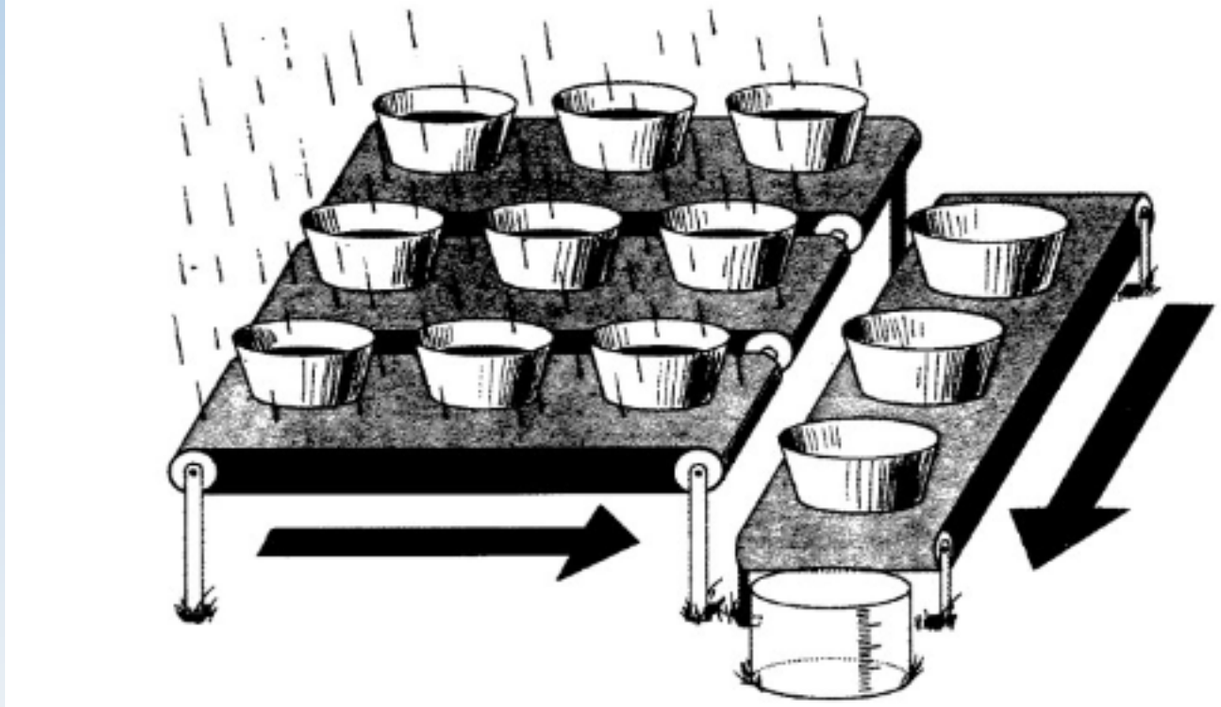


Extinction



Detector Response

- GAIN = the number of required electrons to produce 1 ADU (-e/ADU)



(Janesick & Blouke 1987, Sky and Telescope Magazine, September, 74, 238)

Calibrating Photometric Data

- Once the sky-subtracted signal of a star has been extracted from a CCD image, it is usually desirable to calibrate the signal by converting it to a magnitude tied to a photometric system. Unless very accurate photometry is required, this involves only 5 steps:

- Convert the signal from the target star, which is usually in units of counts, to a signal per unit time interval. This can be achieved by dividing the signal by the exposure time in seconds, giving units of counts per second.

- Calculate the instrumental magnitude from the number of counts per second.

- Determine the extinction coefficient, and then correct the instrumental magnitude to the above-atmosphere value.

- Repeat the above steps for a standard star and use the resulting above-atmosphere instrumental magnitude of the standard star to calculate the zero point.

- Use the zero point to transform the above-atmosphere instrumental magnitude of the target star to the required photometric system.

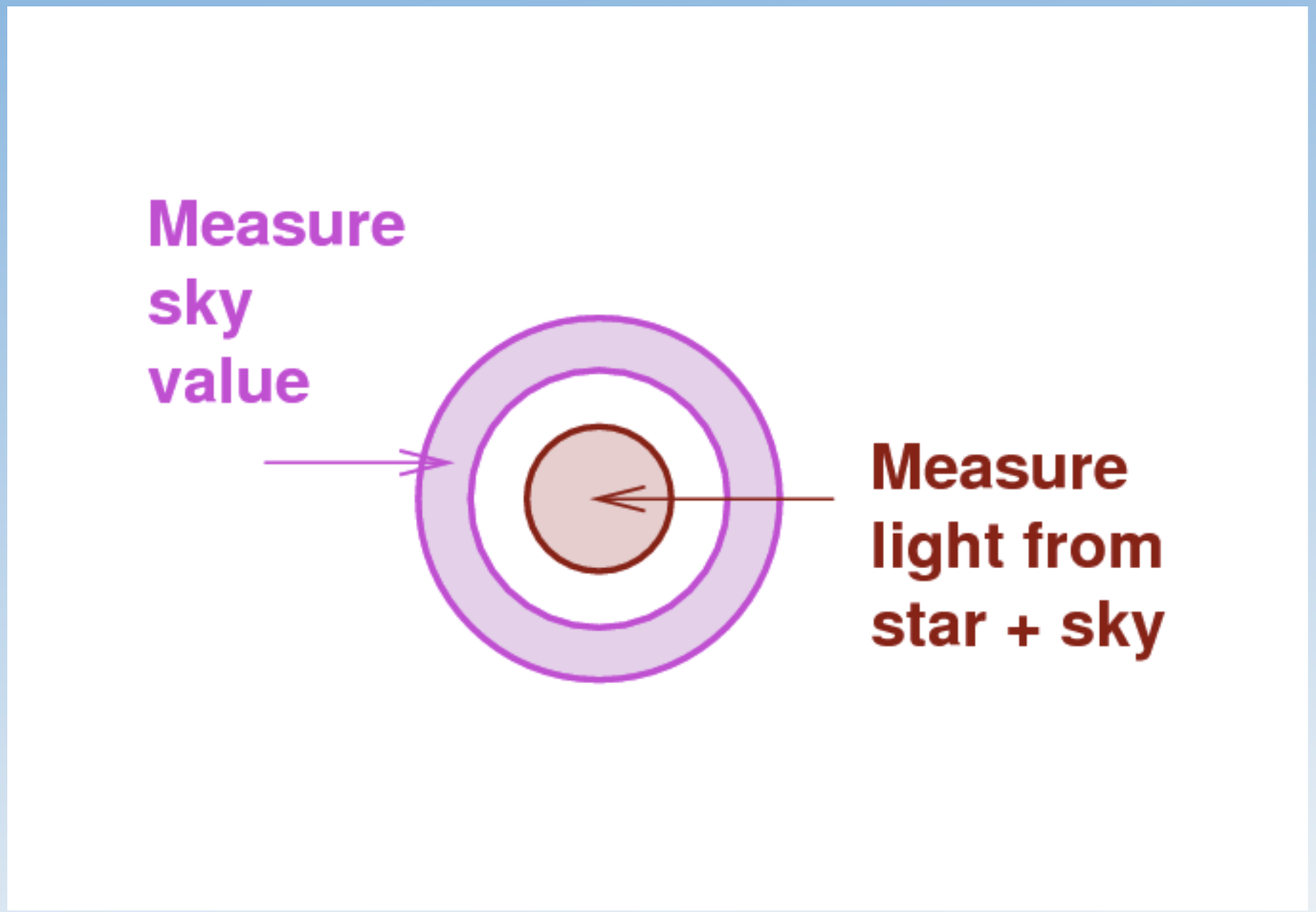
Magnitudes

Hipparchus ~120 BC

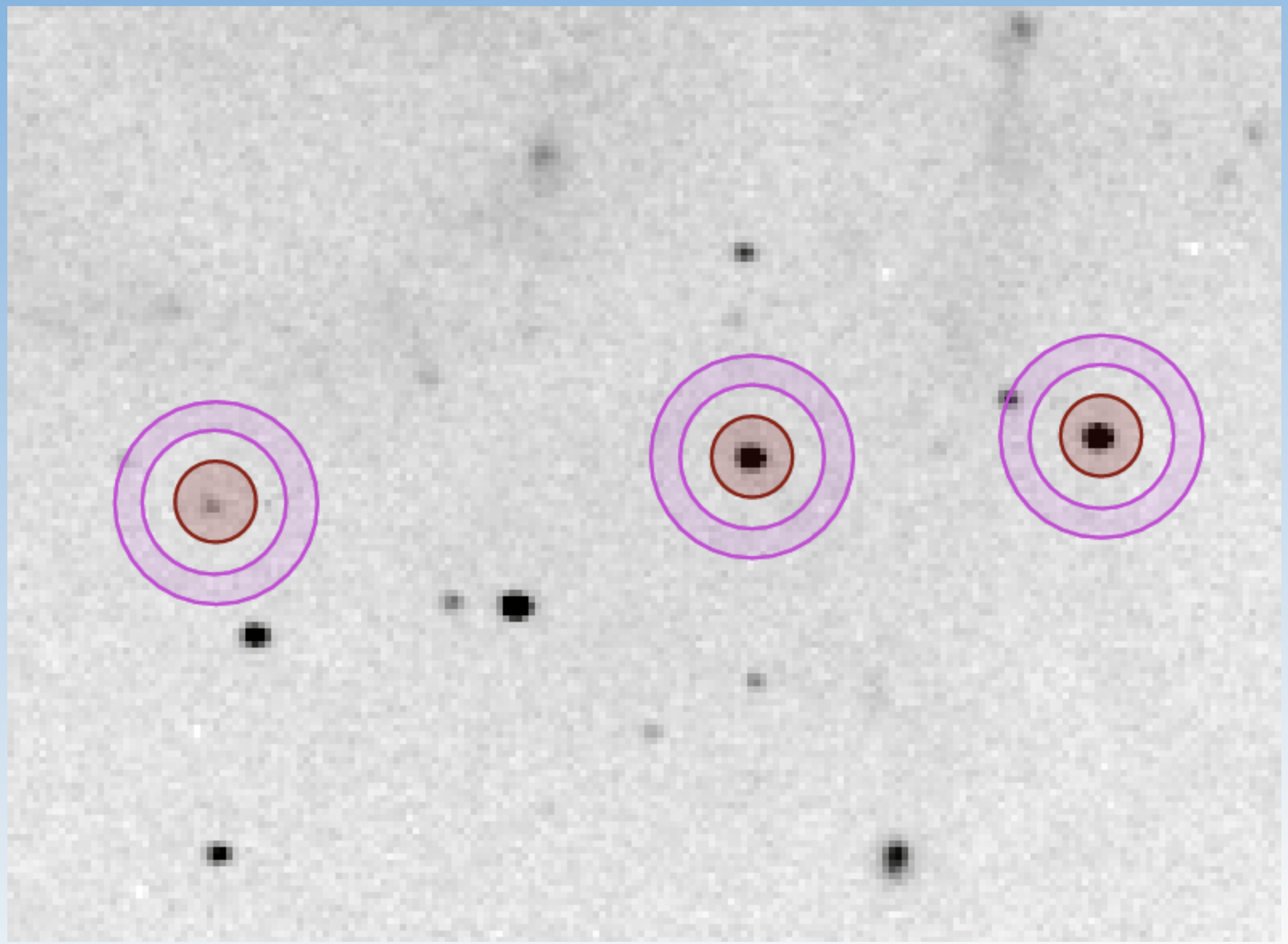
The magnitude difference between two source is the ratio of the fluxes:

$$m_1 - m_2 = -2.5 \log\left(\frac{B_{Star1}}{B_{Star2}}\right)$$

Aperture Photometry



Aperture Photometry



Signal-to-Noise Ratio

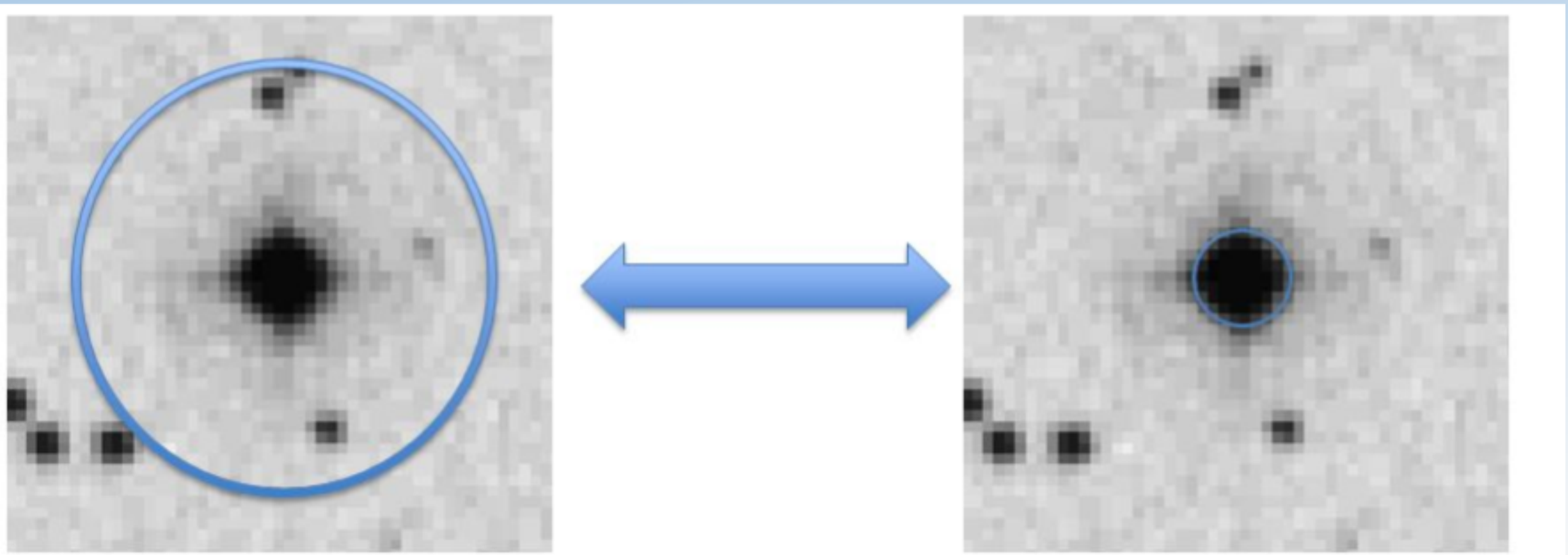
$$SNR = \frac{S_{object}}{\sqrt{\left[S_{object} + S_{sky} + S_{Darkcurrt} + R_n^{\,2}\right]}}$$

S_{object}	Signal from the object
S_{sky}	Signal from the sky ie light pollution
$S_{Darkcurr't}$	Dark Current Signal
R_n	Read Noise of the camera

Best Aperture Size?

- Large aperture:
- include more light -> more signal
- more contamination
- more noise from sky
- -> lower S/N

- Small aperture:
- less contamination
- lose signal from source
- -> lower S/N



Standard Stars

Standard Stars Catalogues

Standard Stars Data

Below follows a non-exhaustive list of on-line standard star catalogues. Note that the information might note be fully up-to-date and that some further improvements may be needed.

Optical

- Landolt's Standard Fields, with finding charts scanned
- The General Catalogue of Photometric Data (GCPD)
- Optical and UV Spectrophotometric Standards
- Spectrophotometric Calibration OBs for EMMI (gZipped PostScript, 1.6 Mb)

Infrared

- Photometric Standard Stars: NICMOS and ARNICA
- Spectrophotometric Standards
  - Mid-IR spectrophotometric standard stars
  - List of InfraRed Telluric Standards
  - Sky map of InfraRed Spectrophotometric standard
  - UVESPOP: A Library of High-Resolution Spectra of Stars across the Hertzsprung-Russell Diagram
- Siebenmorgen MidIr Standards, and Siebenmorgen/Sterzik list

Adaptive Optics Guide Stars

- Guide Star Finder: A Web tool aimed at searching for suitable adaptive optics guide stars, either for single objects as for a list of observing targets.
  The tool is based on the USNO-SA2.0 catalogue. Work is in progress to use USNO-B catalogue as an option. The tool also offers the possibility to choose the selection criteria from a short list of different strategies.

Image Centering

Background Level Estimation