ASTC02 - PROF. HANNO REIN

LECTURE 11

COURSE EVALUATIONS

- **Please fill them out**
- **Mention new equipment**
- **Cookies for the final exam if the response rate >75%**

PRACTICAL 4

- **Background light pollution**
- **Fit**
- **Citations**

NEXT WEEK

- No new material
- Observing if clear
- Review for final exam

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SPECTROSCOPY

TWO ASTRONOMY MODES:

(1) IMAGES

Source: NMSU, N. Vogt

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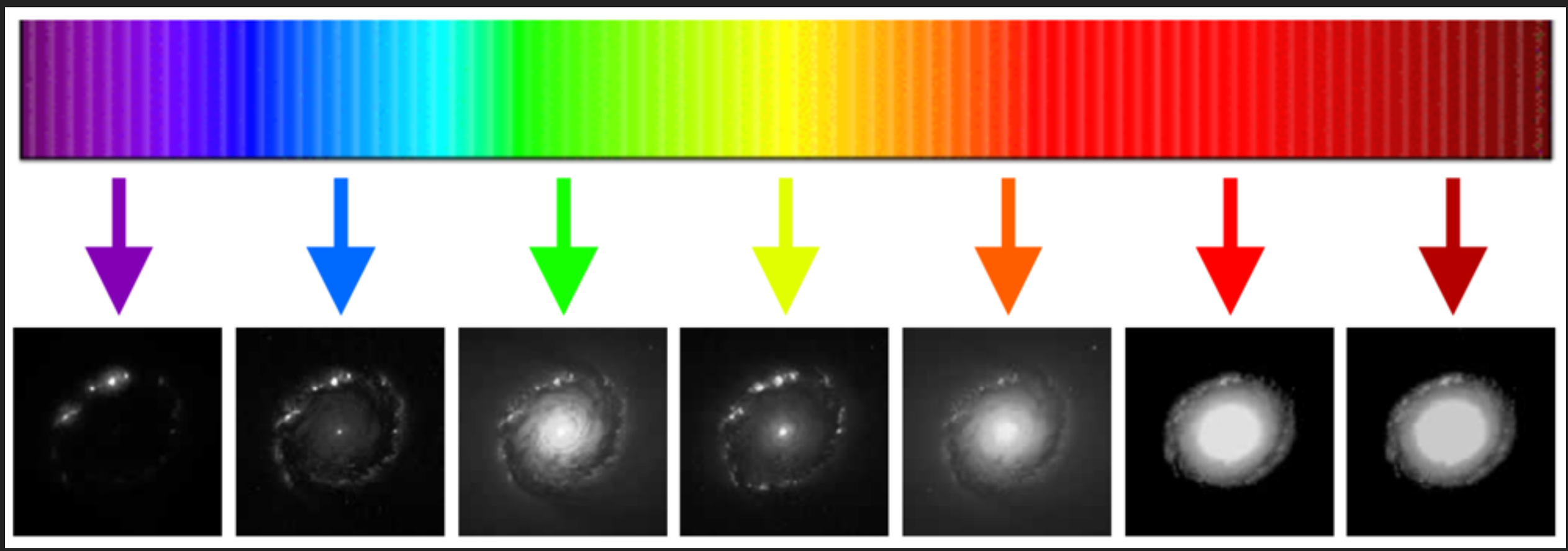
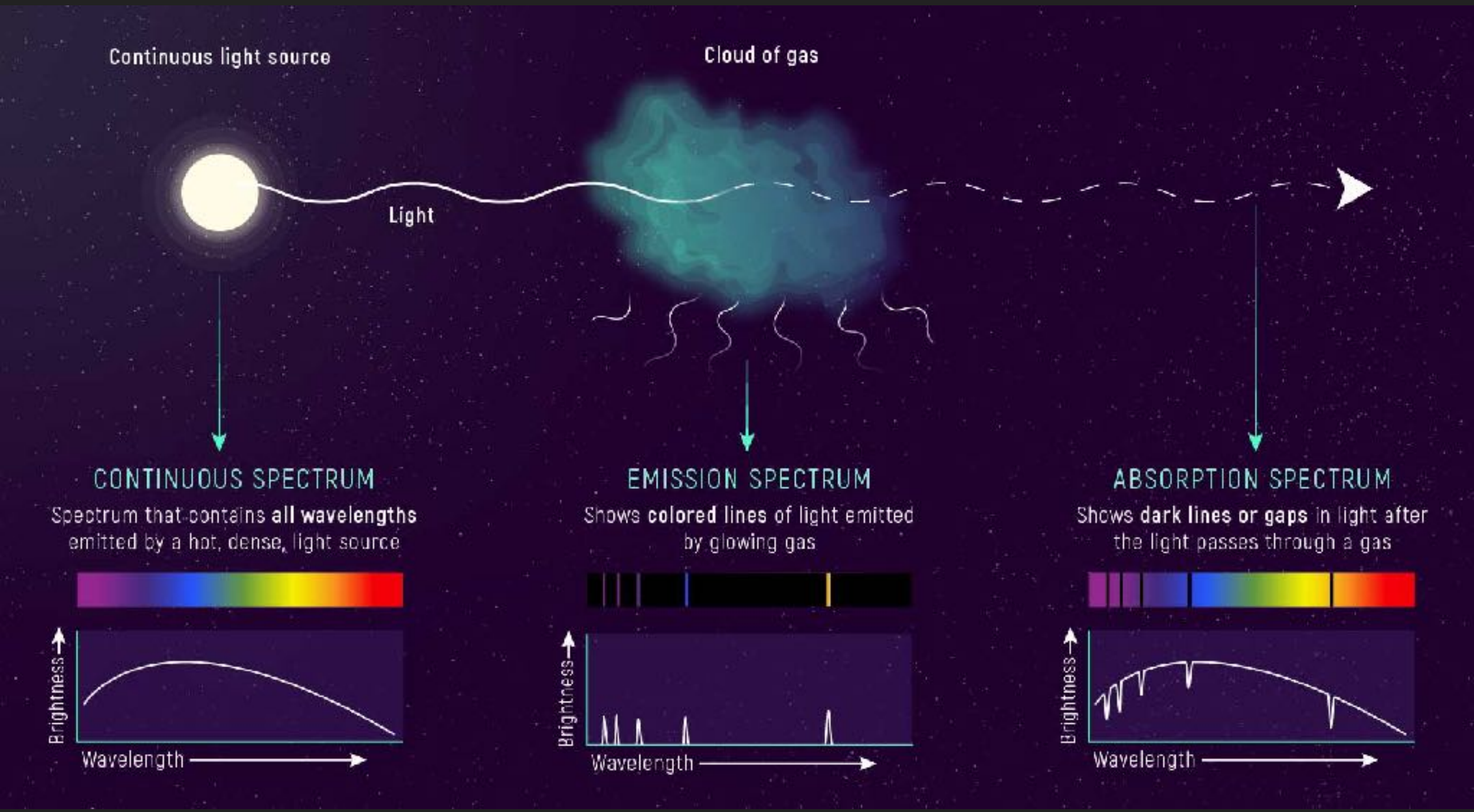
(1) IMAGES



Source: NMSU, N. Vogt

TWO ASTRONOMY MODES: (2) SPECTRA

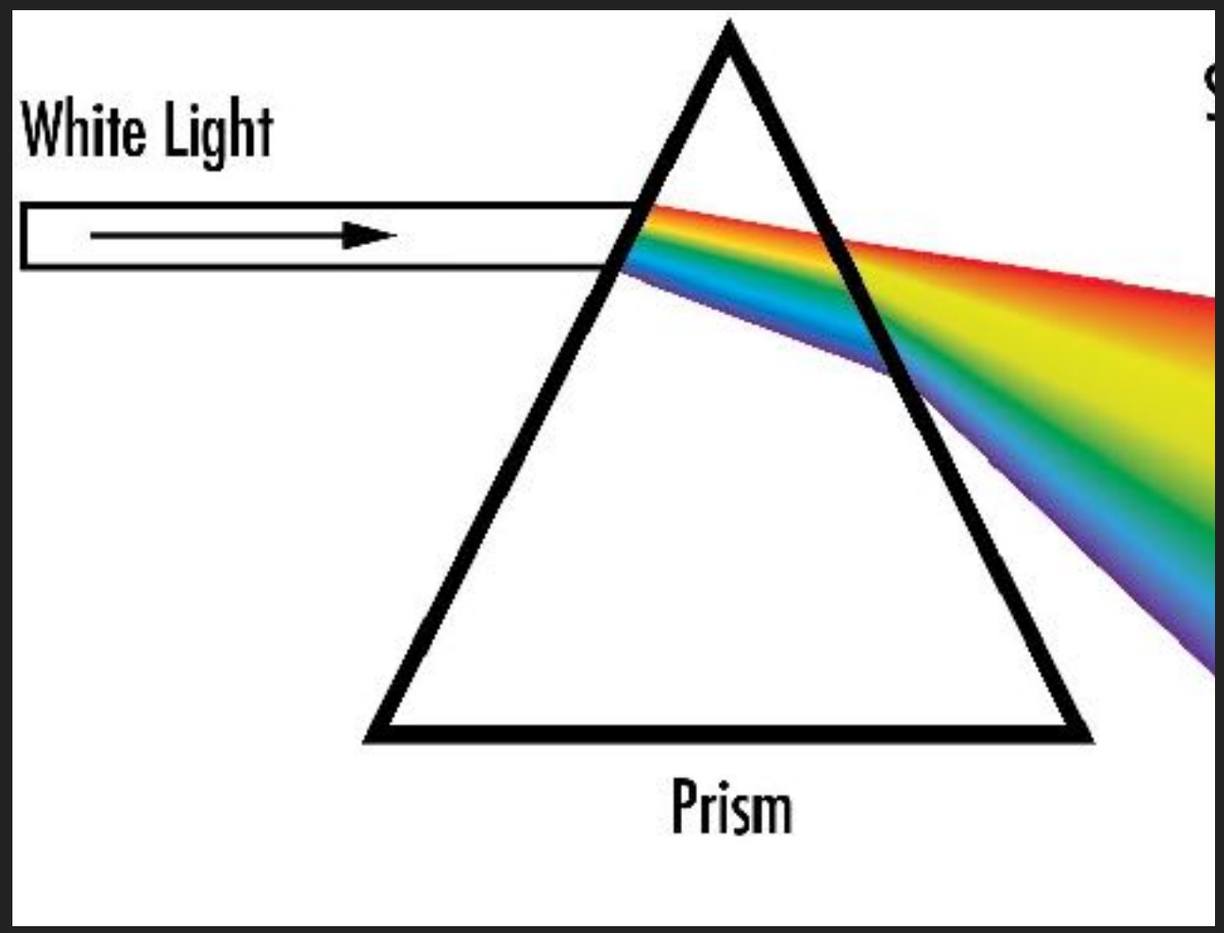


Source: NASA, ESA, and L. Hustak (STScI)

DISPERSIVE VS NON-DISPERSIVE

- **Dispersive**: convert wavelength to one detector coordinate, so we really measure x, y and infer x, λ.
- **Non-dispersive**: measure or reject photons in a way that relies directly on wavelength.

REFRACTION

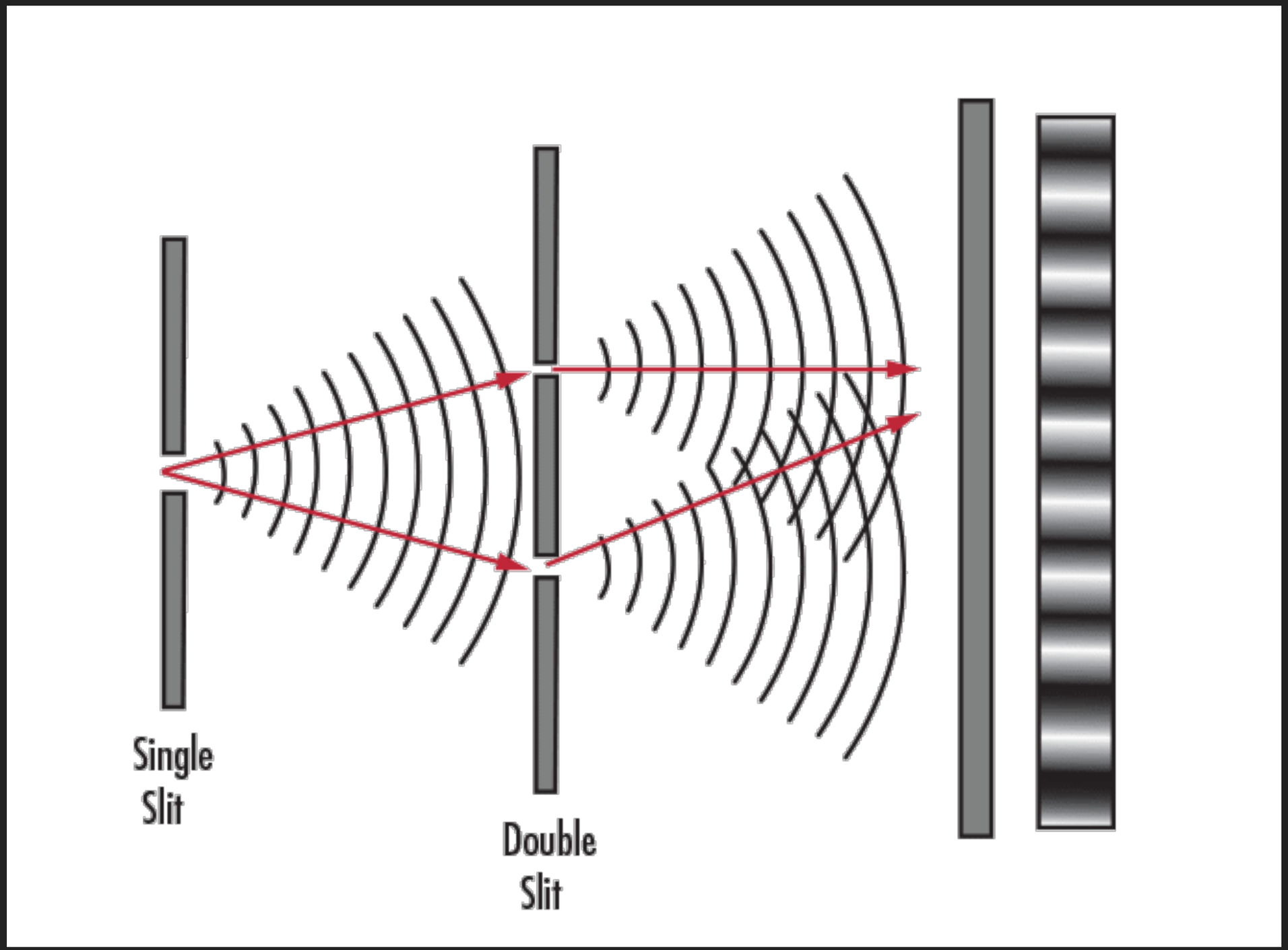


- Two surfaces
- Wavelength dispersion highly non-linear

Source: https://www.edmundoptics.ca/

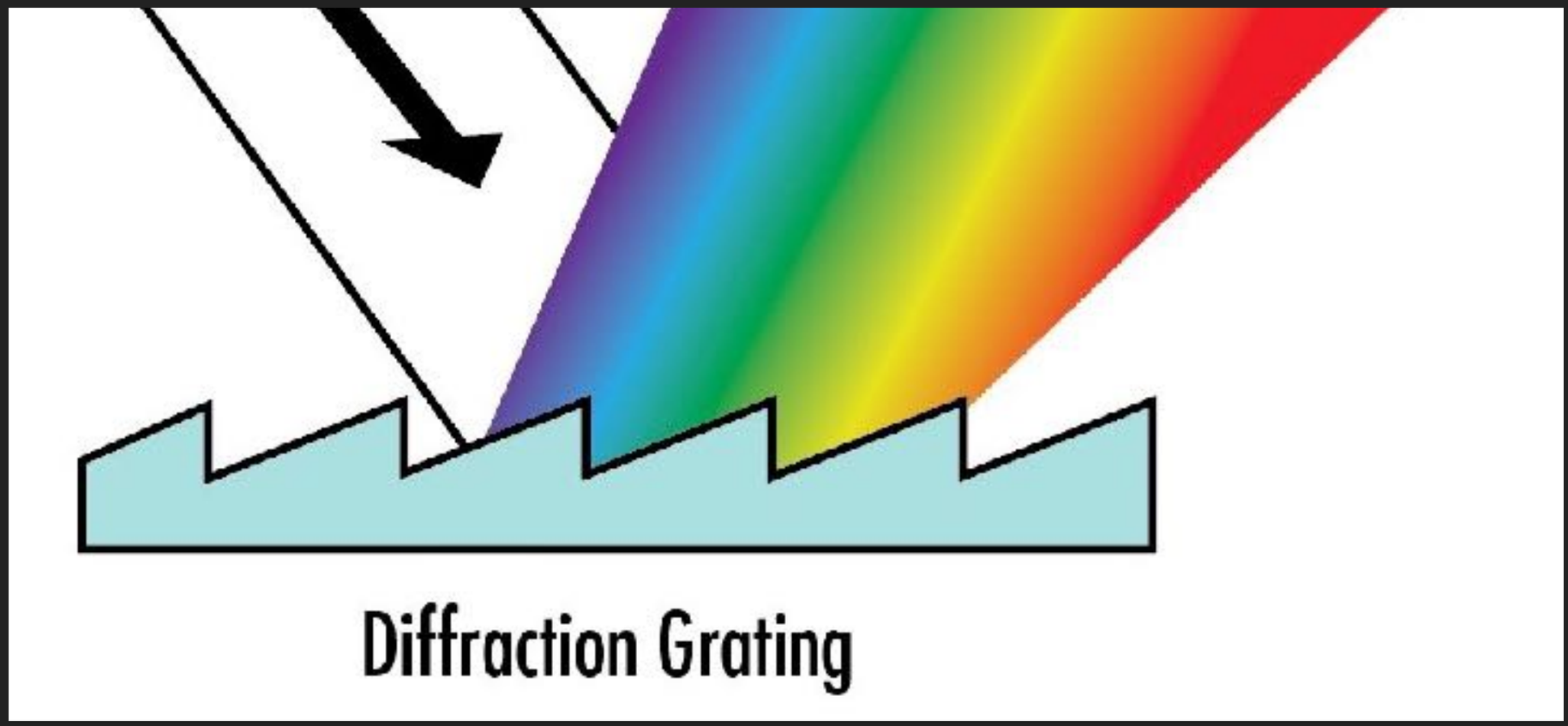
WHAT IS THIS?

DIFFRACTION



Source: https://www.edmundoptics.ca/

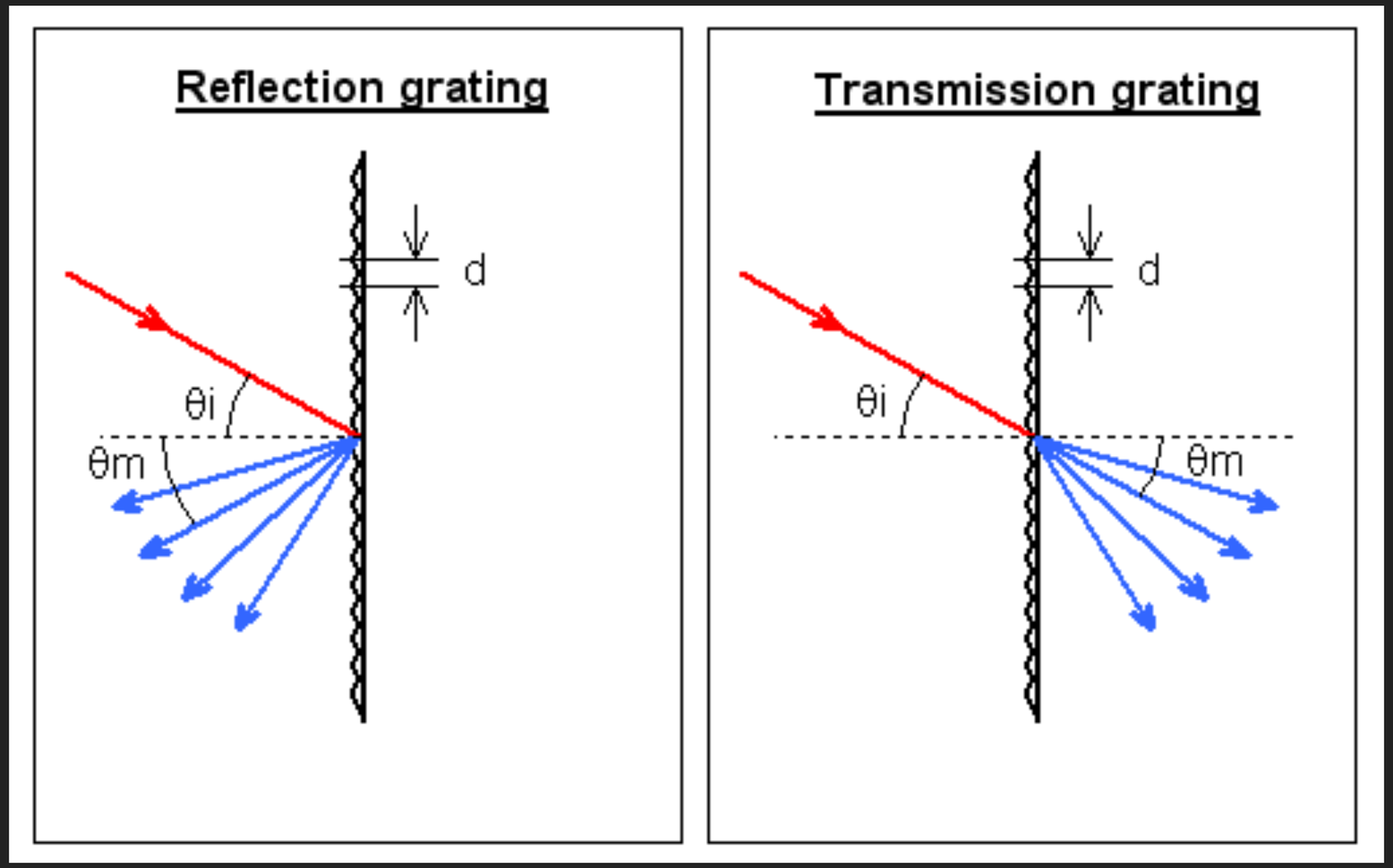
DIFFRACTION GRATING



- Only one surface
- Various orders might overlap

Source: https://www.edmundoptics.ca/

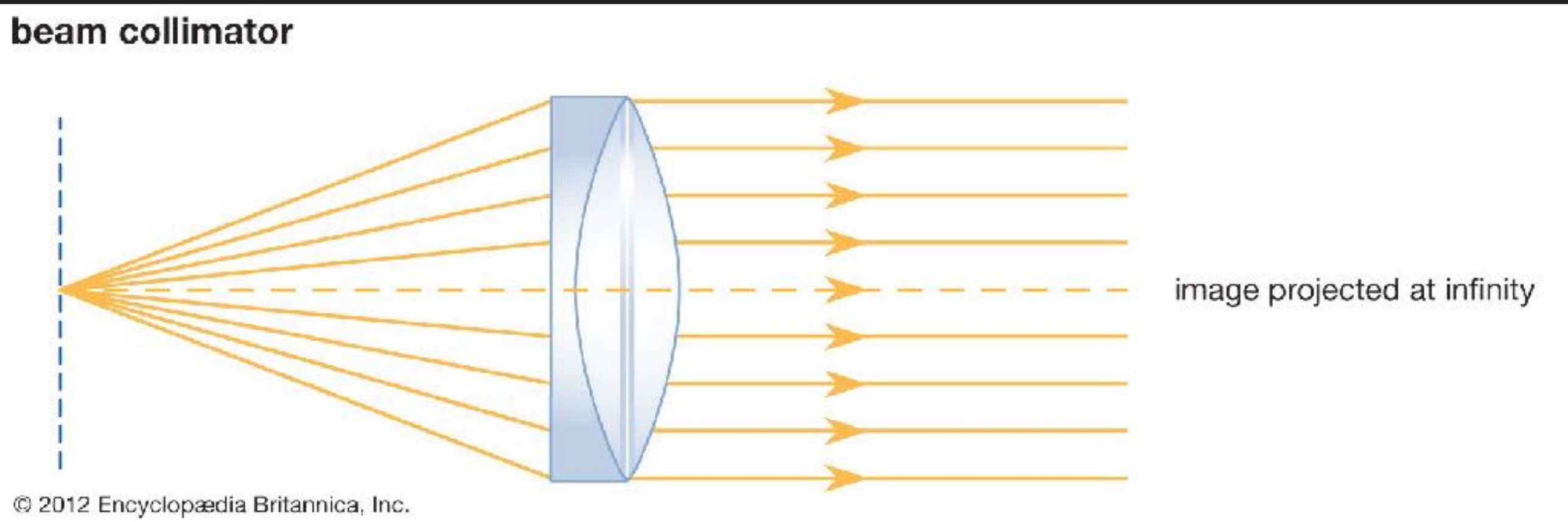
DIFFRACTION GRATING



$$\theta_m = \arcsin\left(\sin\theta_i - \frac{m\lambda}{d\sin\gamma}\right)$$

Source: physicsforum.com

COLLIMATOR

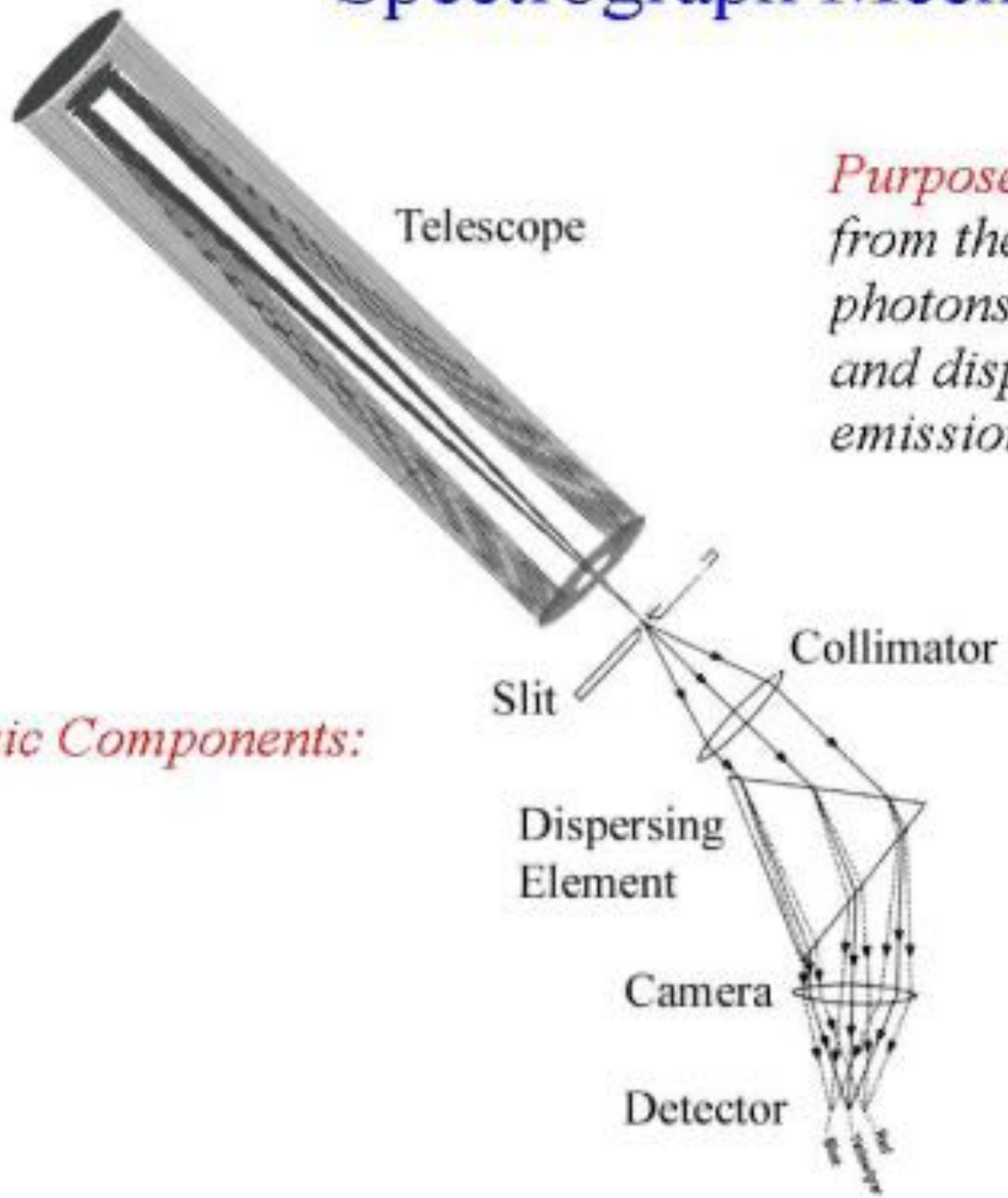


- Required for dispersing spectroscopy

Spectrograph Mechanics

Purpose: *Take the light collected from the telescope, select only photons from the object of interest, and disperse the broadband emission in wavelength space.*

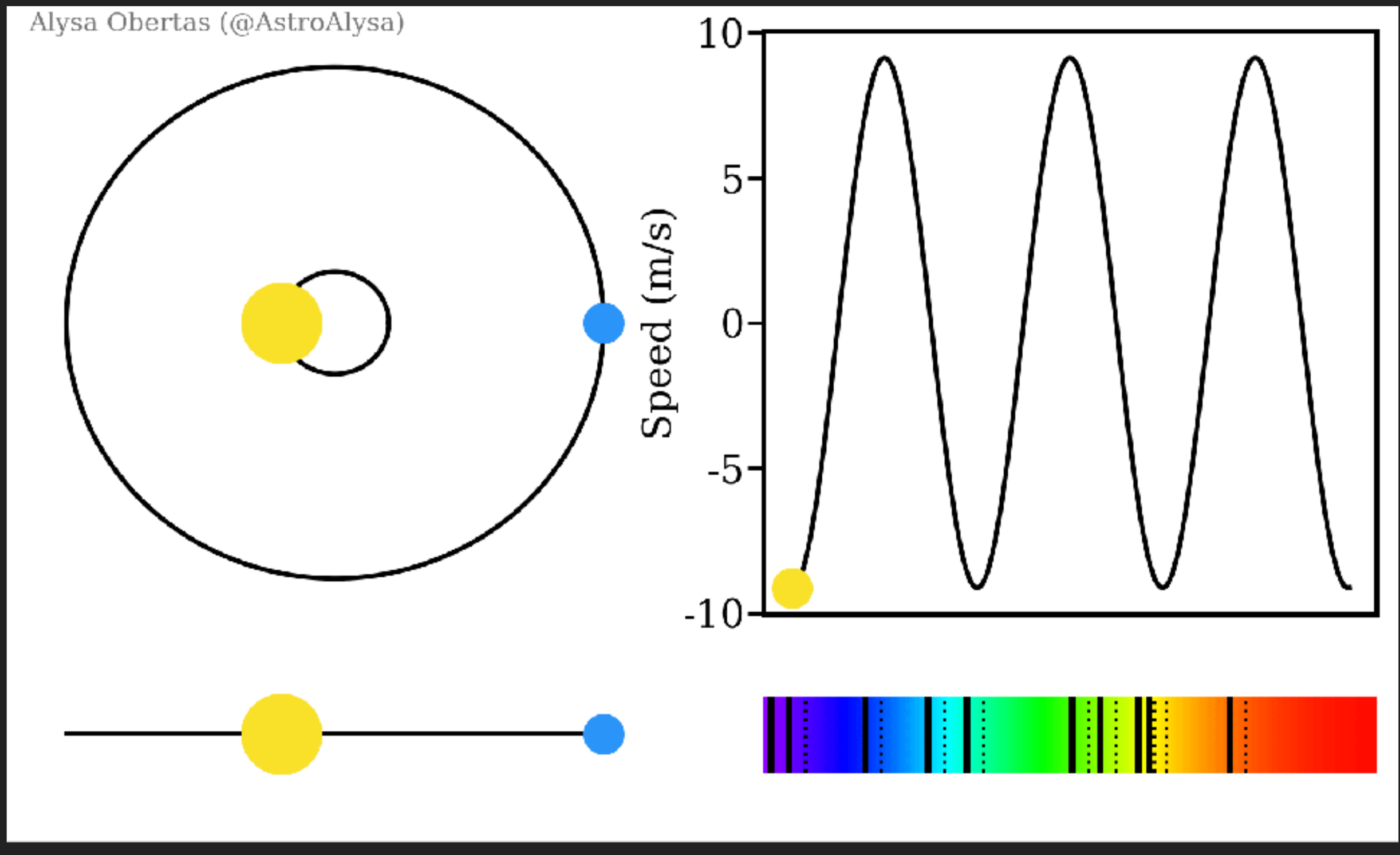
Basic Components:



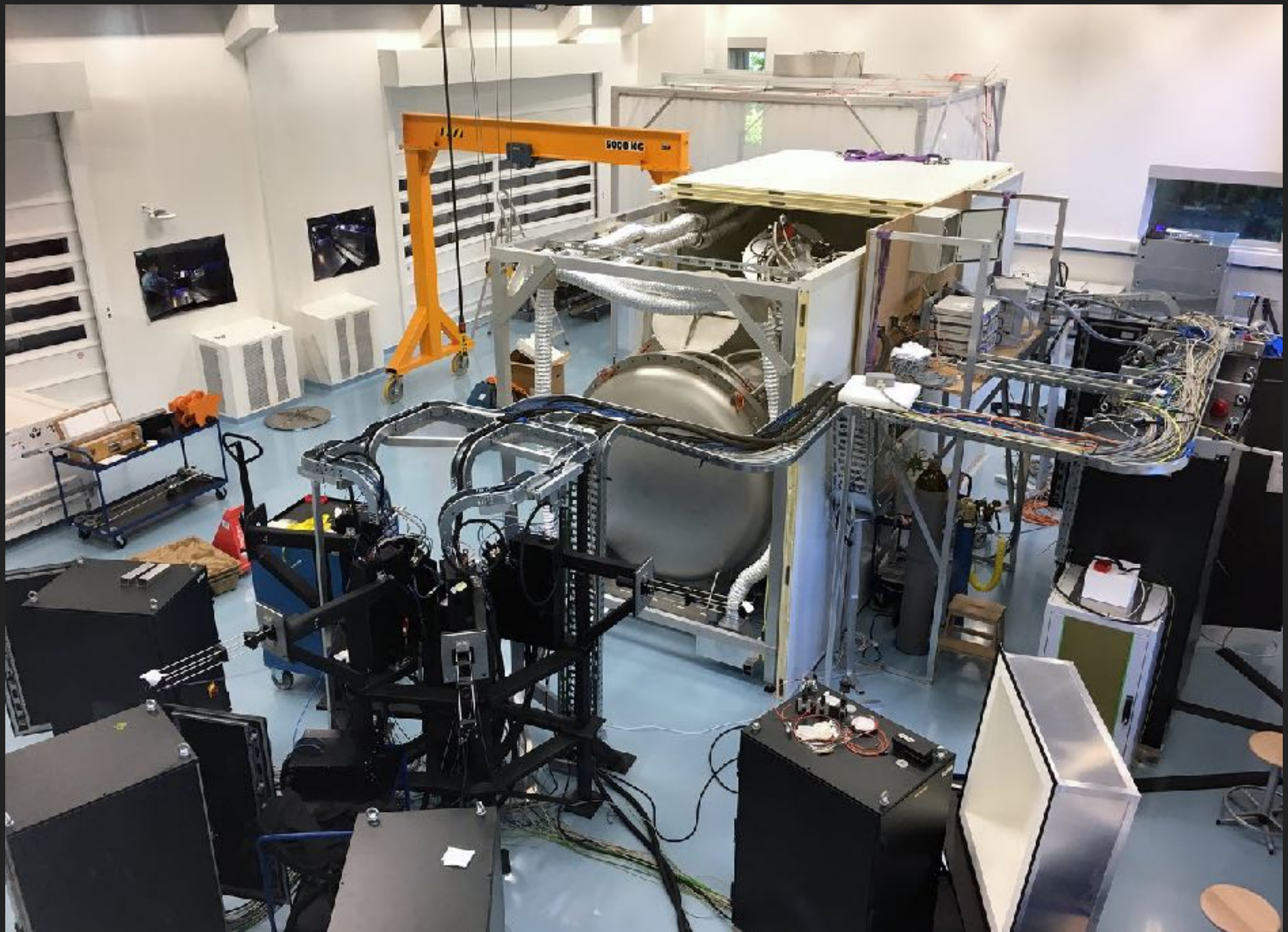
DATA REDUCTION

- For detector:
  - Dark frame
  - Flat field / Bias
- Determine coordinate-wavelength mapping
  - Internal emission-line lamp
- Subtract foreground night-sky emissions
- Absolute flux calibration

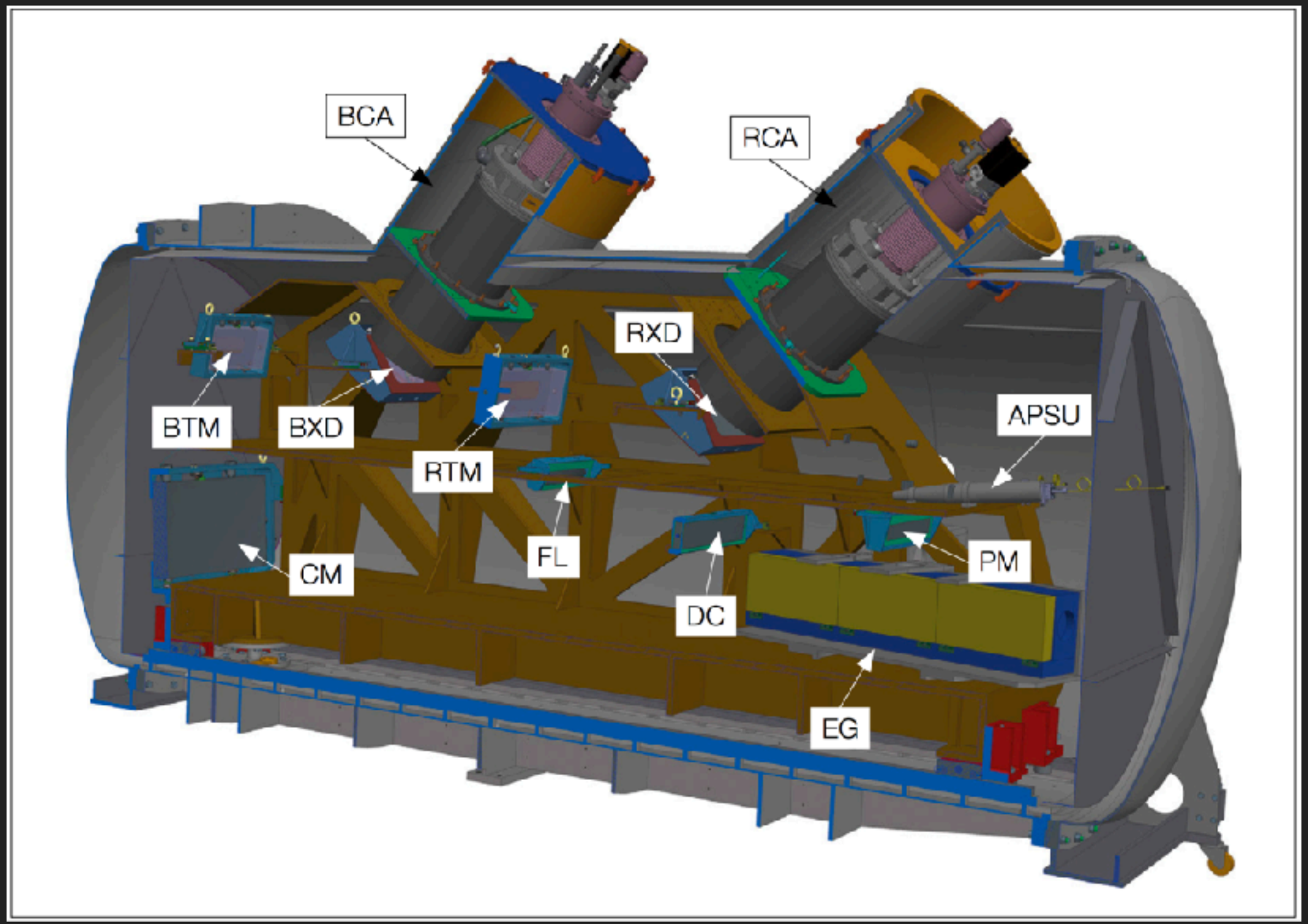
EXAMPLE: EXOPLANET DISCOVERY AND CHARACTERIZATION



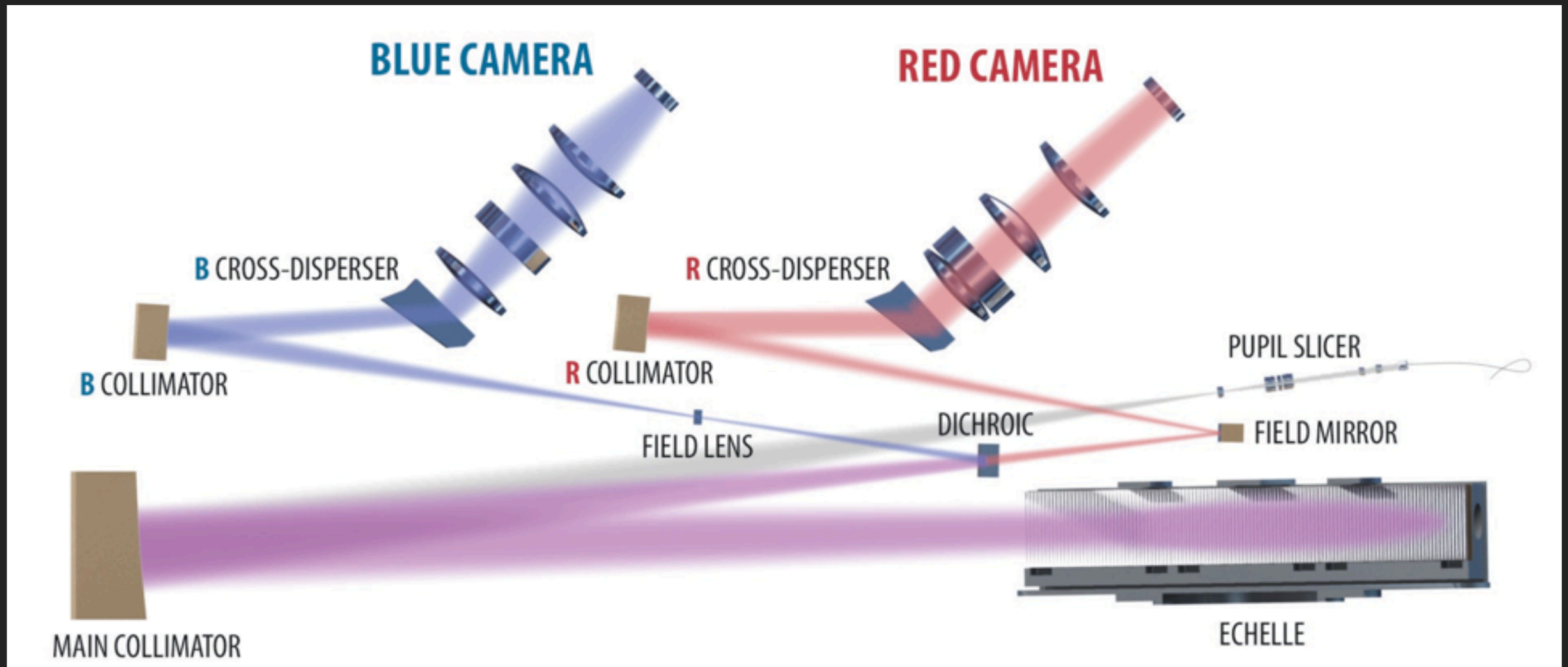
ESPRESSO, Source: eso.org



ESPRESSO



EXAMPLE: EXOPLANET DISCOVERY AND CHARACTERIZATION



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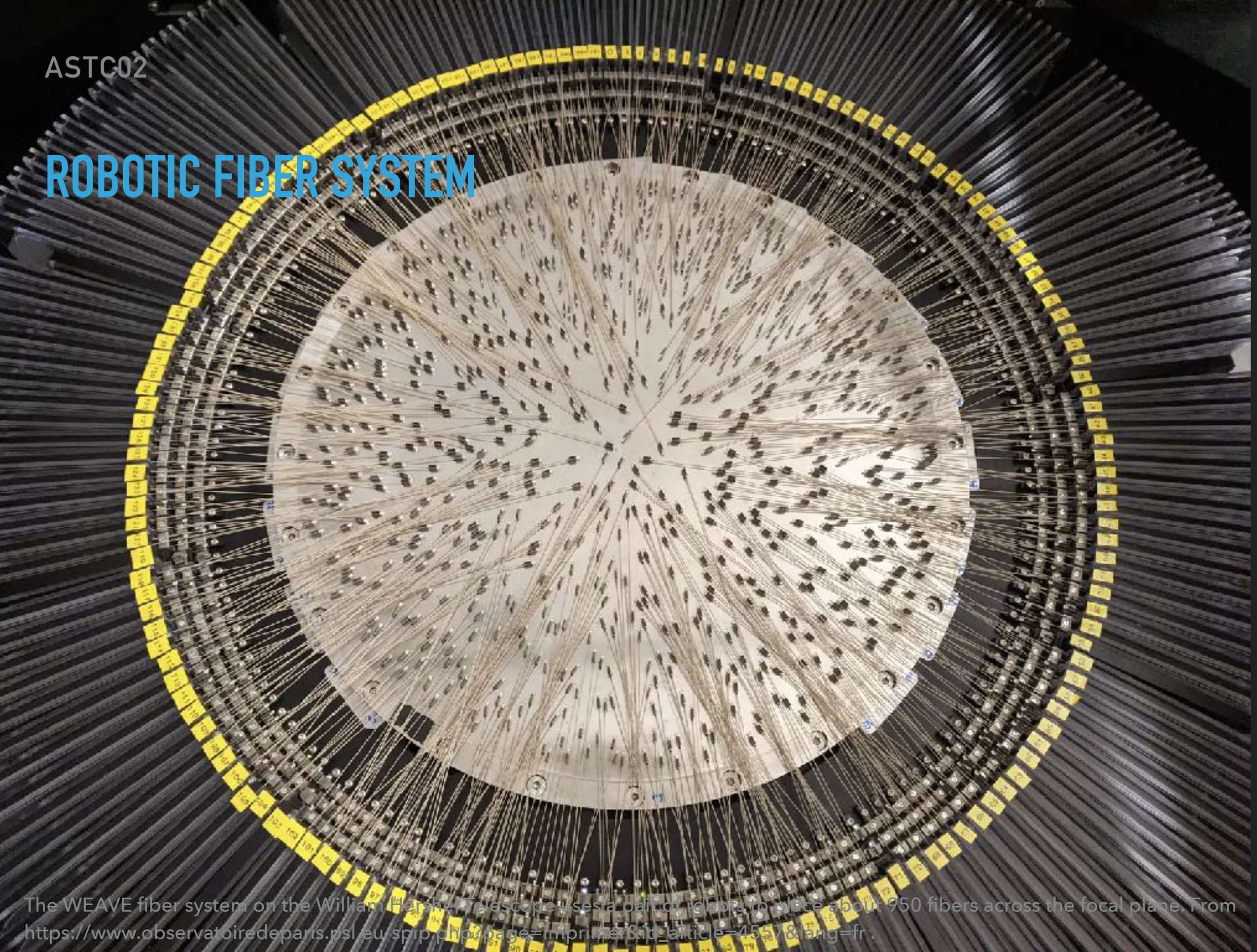
ROBOTIC FIBER SYSTEM



The WEAVE fiber system on the William Herschel Telescope uses a pair of robots to place about 950 fibers across the focal plane. From https://www.observatoiredeparis.psl.eu/spip.php?page=imprimer&id_article=4557&lang=fr .

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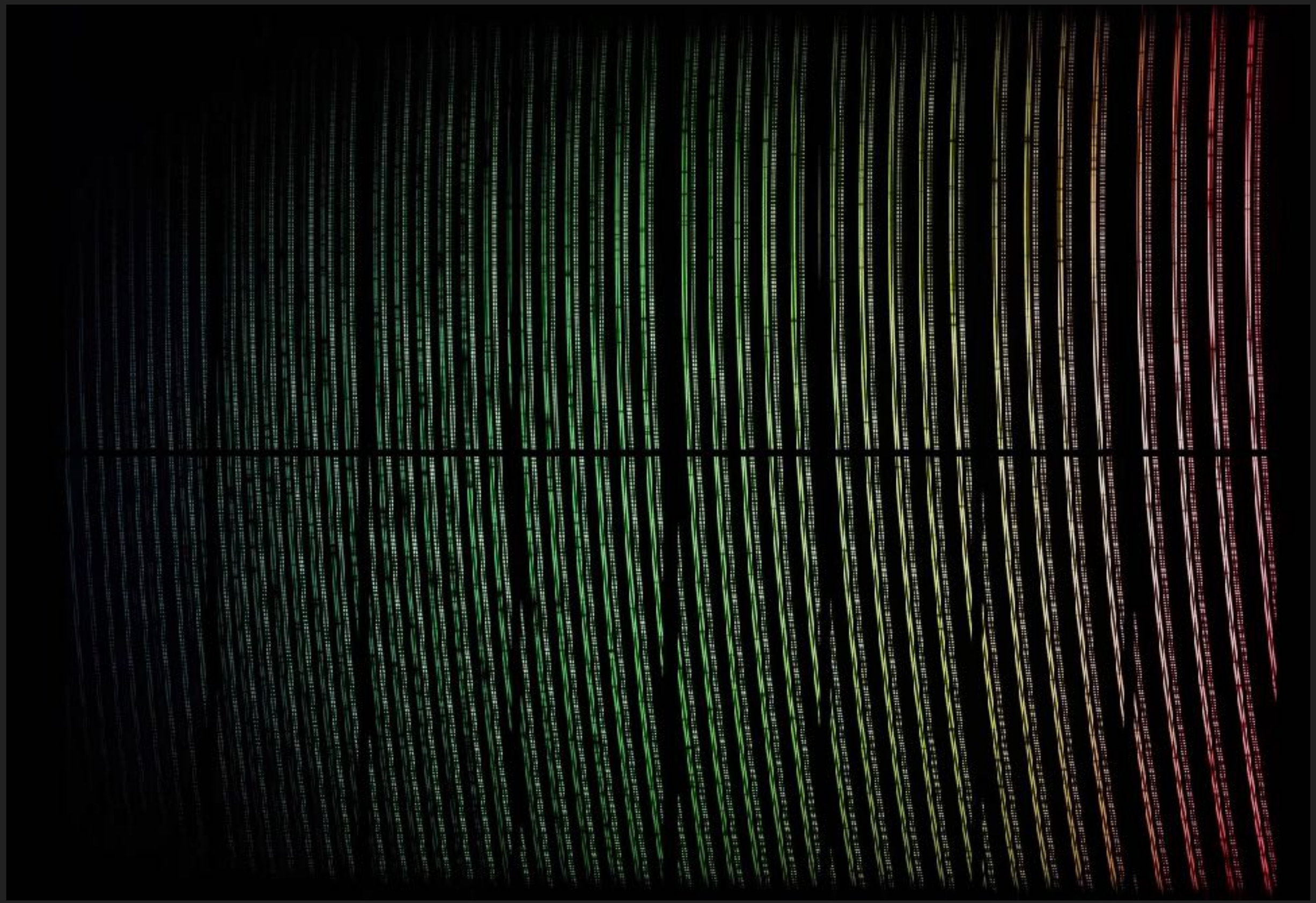


SPECTRAL RESOLUTION

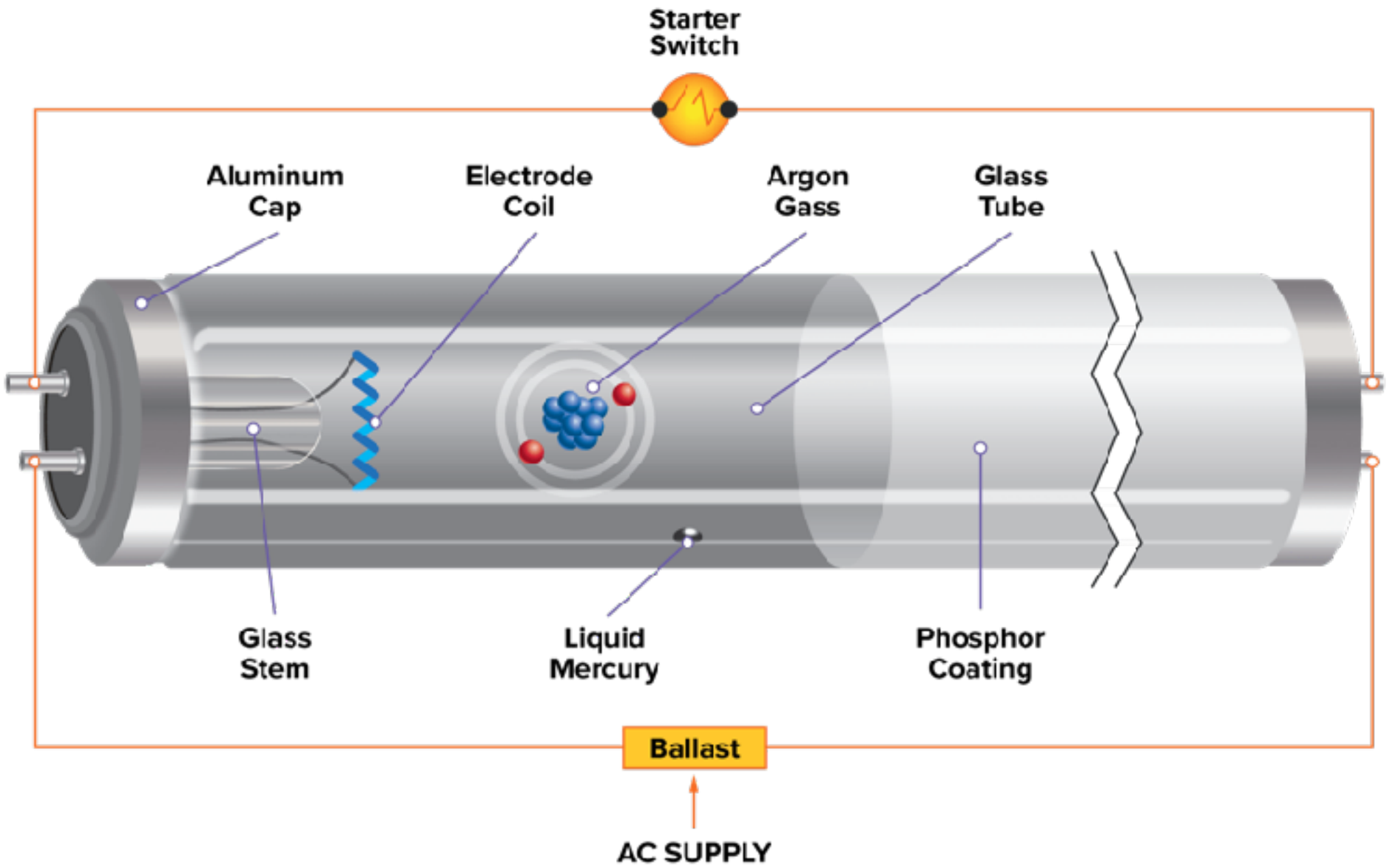
- Ability to resolve features in the spectrum
- High resolution spectrograph, CRIRES+ at ESO's VLT (see Michael's talk):
  ~100,000 - 200,000
- Goal for exoplanet detection: sub m/s

$$R = \frac{\lambda}{\Delta\lambda}$$

GAS DISCHARGE LAMPS

Source: Wikipedia

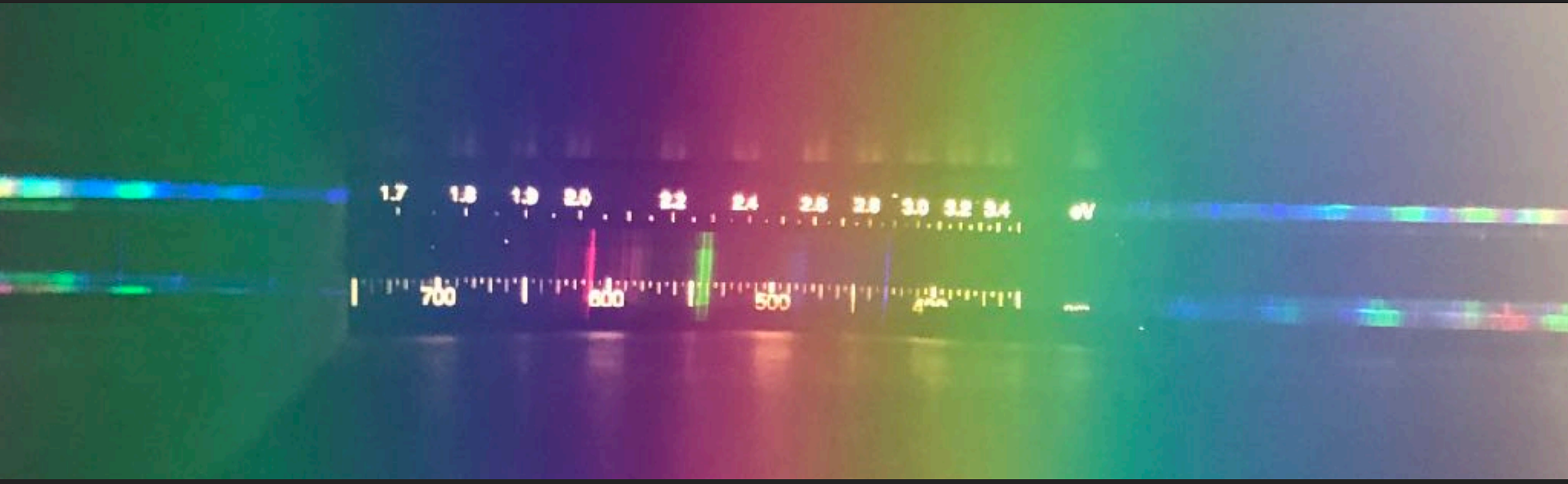
Fluorescent Lamp Diagram



Source: Regencysupply.com

TASK:

- Get a spectrometer.
- Calibrate it by looking at a fluorescent light bulb
- Look at the 6 mystery lamps. Try to determine the elements that drives the emission spectra.
- Bonus points for the final exam if you get it right.

TASK:

- You can either look through the spectrometer by eye, or try to use your phone.