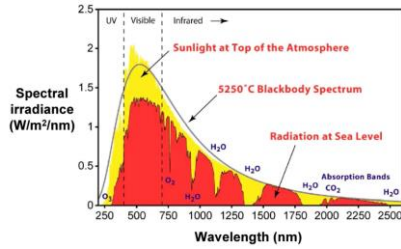


Today's Class: Space Telescopes – Imagers and Spectrographs

- Reading: Section 6.3 in Cosmic Perspective.
- Homework #3 due on Monday.



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1

Last Class

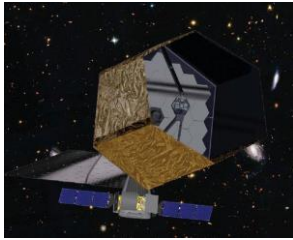
- **Refraction**
 - Focusing light
 - Image formation
- **Fundamental Properties of Telescopes**
 - Light Collection Area
 - Angular Resolution
- **Designs of Telescopes**
 - Refracting telescope
 - Reflecting telescope

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2

Class Exercise: The Next Large Space Telescope

You have been tasked to design the next Large Space Telescope to study signs of life in the atmospheres of Earth-like exoplanets. Describe your design & why. What do you require for angular resolution and light collecting area?



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3

Today's Class

- **Astronomical Imaging**
 - Colors
 - What do we learn from images?
- **Spectroscopy**
 - Design of spectrographs
 - What do we learn from spectra?

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4

Telescopic Images



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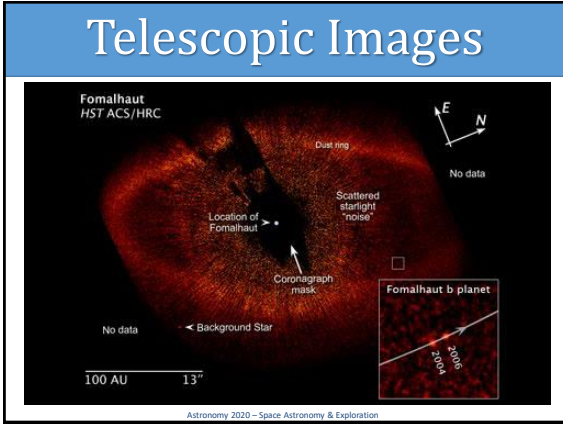
5

Telescopic Images



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6



7



8

Imaging

The actual light collected

Blue filter
Green filter
Red filter

...is combined to show a full-color image

- An image is an array, or a matrix, of square pixels (picture elements) arranged in columns and rows.
- Astronomical detectors generally record only one color of light at a time.
- Several images must be combined to make full-color pictures.

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9

Imaging

- Astronomical detectors can record forms of light our eyes can't see.
- Color is sometimes used to represent different energies of non-visible light.

lowest-energy X rays (red)
medium-energy X rays (green)
highest-energy X rays (blue)

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10

Colors

Stars of different temperature will put differing amounts of light in the different filters, allowing a temperature measurement of stars by comparing their bright nesses in various filters.

UBV Passbands

Relative Intensity
Wavelength (nm)

hot star
cool star

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11

Spectroscopy

Spectroscopy is breaking light up and measuring how much light comes at each wavelength

White Light
Prism
Dispersion Angle

Red
Orange
Yellow
Green
Blue
Indigo
Violet

This can tell us a lot about the nature of object emitting the light

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12

Each Element has a unique spectrum due to its atomic structure

Spectra of H, He, and C

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13

Spectrograph

- A spectrograph separates the different wavelengths of light before they hit the detector.

1. Slit: Allows only the light from the object of interest to pass through.
 2. Collimating mirror: Makes all the reflected rays parallel.
 3. Diffraction grating: Disperses reflected light into a spectrum.
 4. Camera mirror: Focuses the spectrum onto a detector.
 5. Detector: Records an image of the spectrum.

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15

Spectroscopy

- Plotting relative brightness of light at each wavelength shows the details in a spectrum.

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16

Spectrum from HST Cosmic Origin Spectrograph (COS)

HE2347-4342

Flux ($10^{-15} \text{ erg cm}^{-2} \text{ s}^{-1} \text{ \AA}^{-1}$)

Wavelength (Å)

Unique, sub-1150Å capability

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17

What did we learn today?

- **Astronomical Imaging**
 - Colors
 - What do we learn from images?
- **Spectroscopy**
 - Design of spectrographs
 - What do we learn from spectra?

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18