



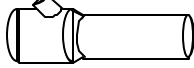

Topic D
“Part 2. Astronomical Detectors”
 (Web Version: 08-15-01)

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Web Table 8b
Detectors (UV to IR)

- Human Eye 
- Charged Couple Device (CCD) 
- Photographic Plates or Films 
- Photoelectric Photometer 
- Spectrograph 



Do on own

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Web Table 8b
Human Eye

Sensitivity Range

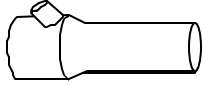

- Visible light (violet to red) only
(About 400 to 700 nm)
- Peak sensitivity?



 Green

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The Spectrograph

An instrument used to produce spectra

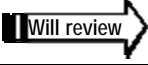

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 (typically from UV through IR)

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Web Table 8b
Three Terms to Learn

- Dispersion *Distribute or separate*
- Refraction
- Diffraction

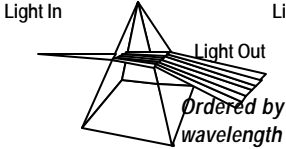
Turn, bend or change direction
 (method different for each)

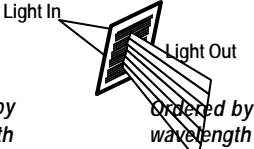


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Web Table 8c
Production of Spectra

Dispersion . . . Separation of light either by refraction (prism) or diffraction (grating)


 Prism
 Ordered by wavelength


 Grating
 Ordered by wavelength

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Web Table 8c

Refraction

Change in direction of waves *when passing from one medium into another*

Amount of bending depends on wavelength

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Web Table 8c

Diffraction

Change in direction of waves *after passing an obstacle*

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Web Table 8b

Modern Astro Spectrographs

- Reflection Optics
 - Mirrors
 - Reflection Grating
- Reflections = Confusing

Instead will illustrate with prisms & lenses (simpler)
(Study Guide Fig. 5)

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Web Table 8c

“S Word” Terminology!

- Spectrograph — instrument
- Spectrum — what produced
- Spectrogram — resulting *image*
- Spectroscopy — study of spectra
- Spectroscopist — person studying spectra

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Web Table 8c

“S Word” Terminology!

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Fig. 5

Disperse the Light

(Prism or Grating)

Example shows only three wavelengths — other might be present

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Fig. 5

Light Must Enter Parallel

Light from Telescope

But light from telescope *not parallel!*
(since telescope brings light to a *focus*)

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Fig. 5

Light Not Parallel?

Dispersive Element

If non-parallel light enters, common rays leaving not parallel

(Prism or Grating)

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Fig. 5

Now Disperse the Light

Light from Telescope

Parallel light enters

Dispersive Element

Dispersed light leaves with common wavelengths parallel

(Prism or Grating)

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Fig. 5

Record the Spectrum

Light from Telescope

Collimator Optics

Dispersive Element

Camera Optics

Detector

(Prism or Grating)

Photographic Plate or CCD

Modern instruments use electronic detectors (CCDs)

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The Problem

Pretend Photographing the Sun

Image without prism (ordinary photo)

Image with prism (spectrogram)

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Fig. 5

Solution — Entrance Slit

Light from Telescope

Entrance Slit (edge-on)

Collimator Optics

Dispersive Element

Camera Optics

Detector

(Prism or Grating)

Photographic Plate or CCD

Use a narrow *entrance slit* — a narrow window

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Fig. 5
(middle)

Slit Face On

Sun's image shining on slit

Slit "jaws" →

Slit opening →

Most of sun's image does *not* get into spectrograph

Only sunlight passing through slit gets in

(Looking *into* spectrograph)

[See middle of *Study Guide* Fig. 5]

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Slit Face On

Slit needed for stars too

Star image smaller but ...

Image "swells" due to turbulence in Earth's atmosphere

(Looking *into* spectrograph)

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Fig. 5
(bottom)

Result Using Slit

Get Images of Slit Illuminated by Sunlight

One image

Image *without* prism
(ordinary photo)

Multiple Slit Images

Image with prism
(spectrogram)

[See bottom of Fig. 5]

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Fig. 5
(bottom)

The Spectrogram*

Each *spectral line* an . . .

image of the slit
(illuminated by sunlight)

Result — one image for *each wavelength*

spectral lines

*Example shows only three of many possible wavelengths

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Fig. 5

The Complete Spectrograph

Entrance Slit

Collimator Optics

Dispersive Element

Camera Optics

Detector

Light from Telescope (edge-on)

(Prism or Grating)

Photographic Plate or CCD

Study Guide Fig. 5

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