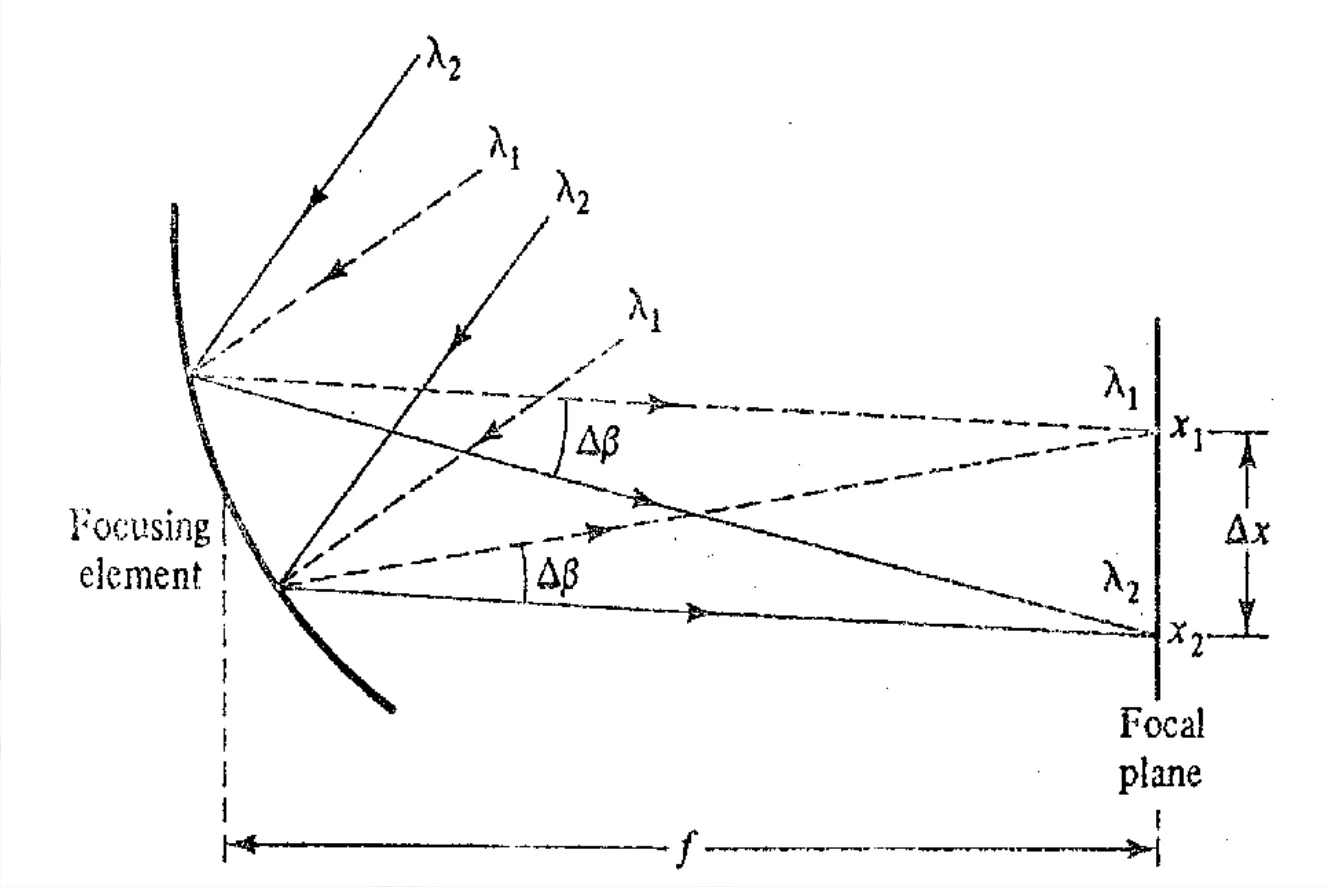
Dispersive Charactristics

The linear dispersion, $D_l = dx/d\lambda$



$\lambda_2 - \lambda_1 = 1$ nm

The linear distance between dispersed wavelengths with 1nm difference mm/nm rad/nm

the linear dispersion is given by

$$D_l = fD_a$$

where f is the focal length

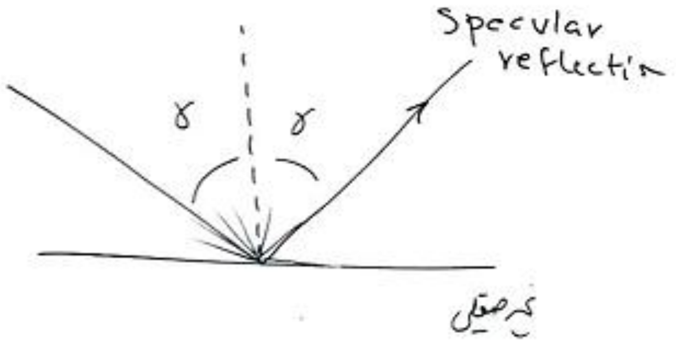
reciprocal linear dispersion R_d

$$R_d = D_l^{-1} = (fD_a)^{-1} = \frac{d\lambda}{dx}$$

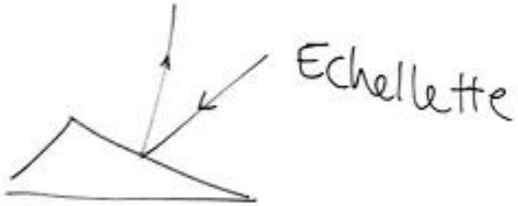
$$R_d = (D_a f)^{-1} = d\,\frac{\cos\beta}{f|m|}$$

$$R_d = \frac{\lambda\cos\beta}{f(\sin\alpha + \sin\beta)}$$

D2 Spect Introd 971024 mon



Blazed condition



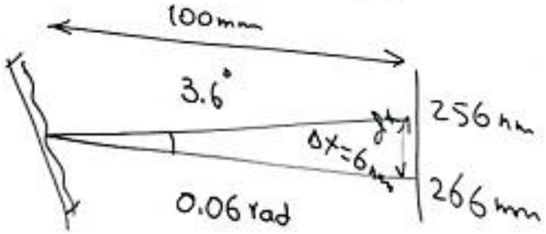
Angular dispersion

$$D_a = \frac{d\beta}{d\lambda}$$

Linear dispersion

$$D_l = f D_a = \frac{dx}{d\lambda} \quad \frac{mm}{nm}$$

f → focal length



$$D_a = \frac{0.06}{266-256} = 0.006 \frac{rad}{nm}$$

$$D_l = f D_a$$

(mm/nm; f → Focal length, mm/rad; D_a → rad/nm)

= 100 × 0.006 rad

= 0.6 mm/nm

distance between 256 and 266

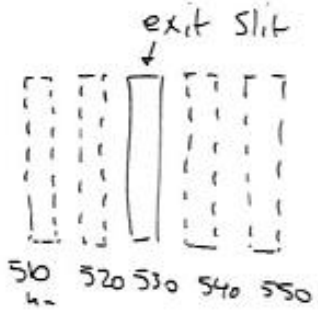
0.6 × 10 = 6 mm

Using Mirror → f ↑

Unit of f ? $\frac{mm}{rad}$?

reciprocal lin dispersion

$$R_d = \frac{1}{D_l} = \frac{1}{fD_a}$$

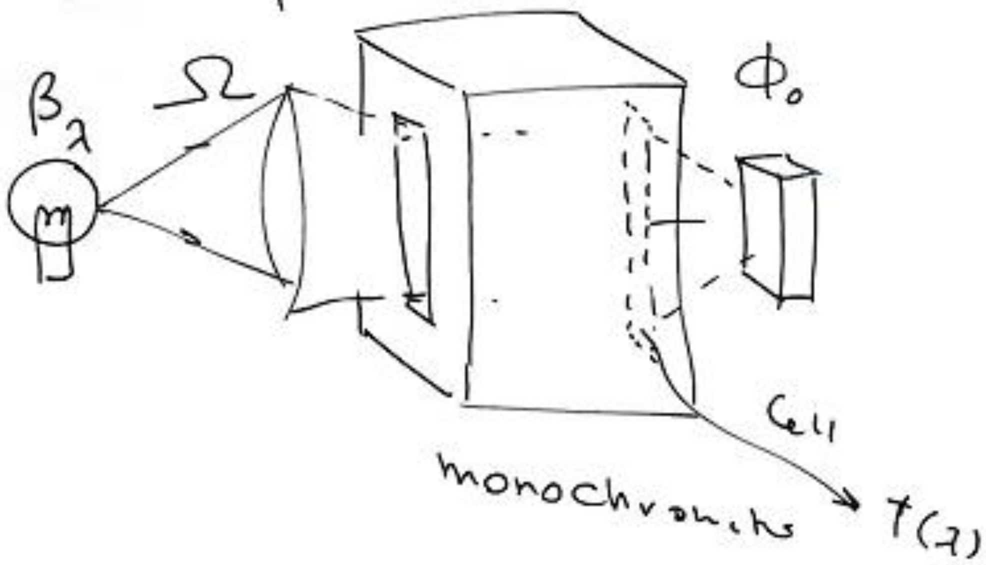


$$R_d = \frac{S_g}{W} = \frac{8nm}{2mm}$$

W → Slit width

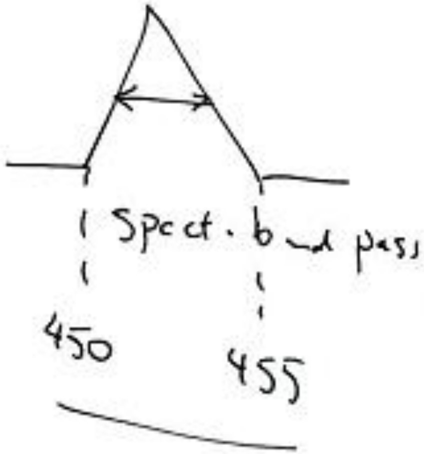
$$R_d = 4 \frac{nm}{mm}$$

D2 Spect Introd 971024 mon



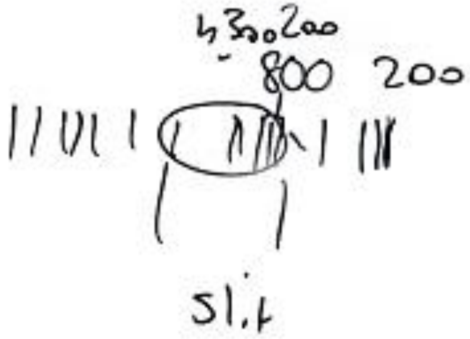
$T_{opt} = 0.7$

$t(\lambda)$

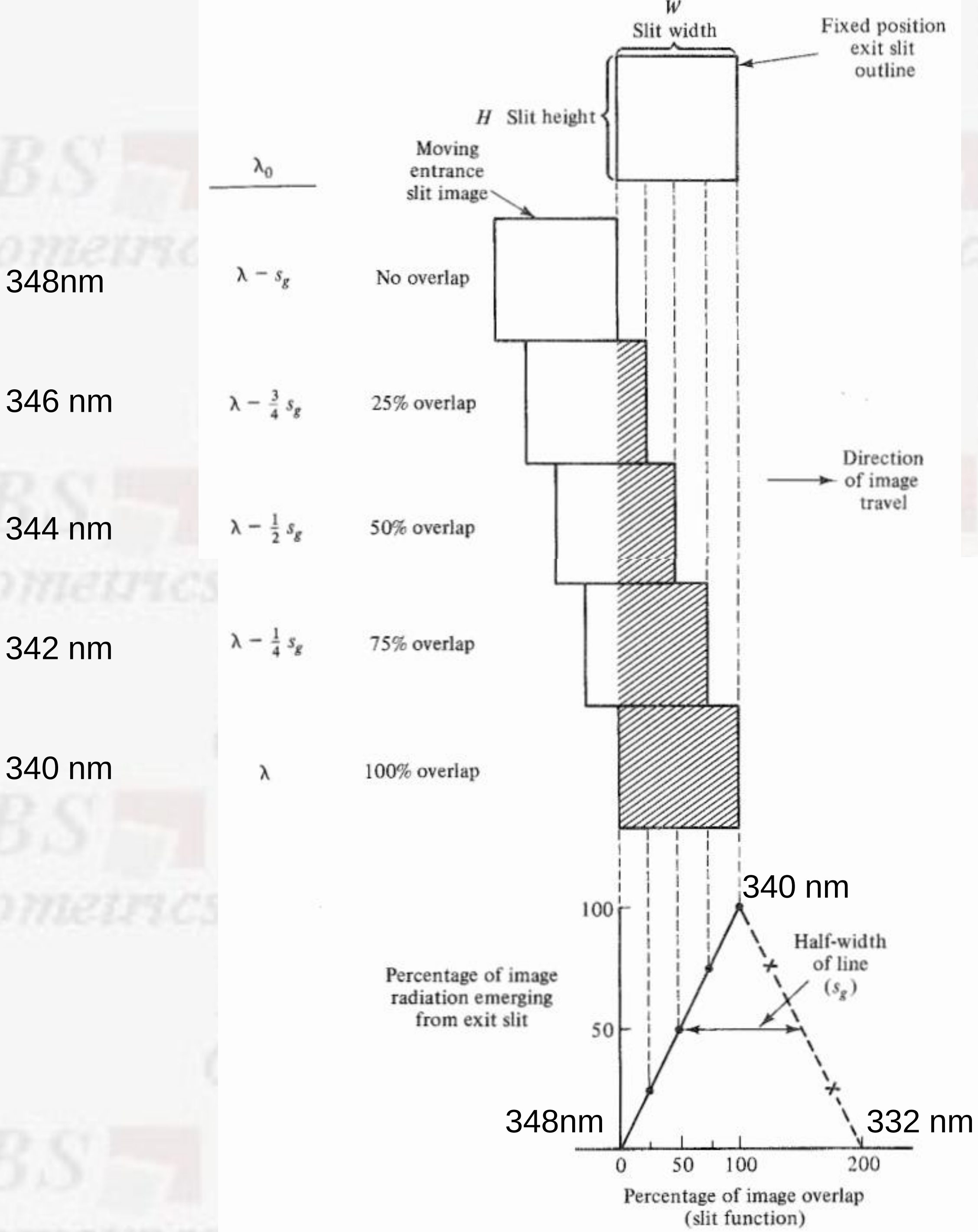


520 !! Stray rad

only grating



Grating + prism

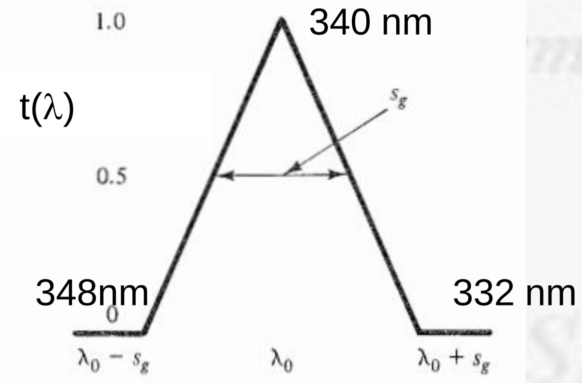


$$\int_{332}^{348} t(\lambda)\, d\lambda = s_g = R_d W$$

Spectral band pass

=(348-332) / 2= 8 nm

Wavelengths passing exit slit with intensities >50%



$R_d = s_g / W$= 8nm/2mm

=4 nm/mm

Effective width of grating *cos β

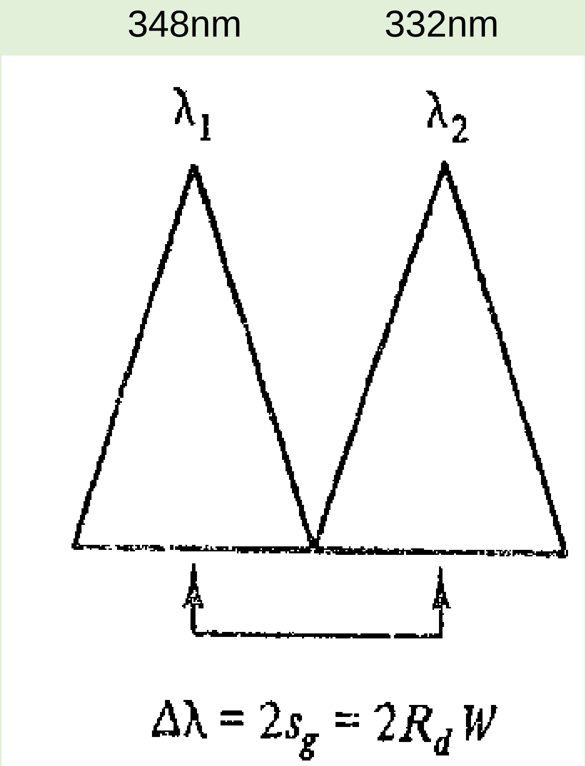
$$R_{th} = W'_D D_a$$

$$R_{th} = \frac{W'_D |m|}{d \cos \beta}$$

$$R_{th} = \frac{W_G |m|}{d} = |m| N$$

$$N = W_G / d$$

$$R_{th} = \frac{d(\sin\alpha + \sin\beta)N}{\lambda} = \frac{W_G(\sin\alpha + \sin\beta)}{\lambda}$$



Completely resolved

$R_{th} = \lambda_{aver}/\Delta\lambda$ $= 340/16 = 21.25$

Theoretical resolution

Throughpot factors

Output spectral radiance into cell $(\Phi_\lambda)_o$

$$\Phi_o = \int_0^\infty (\Phi_\lambda)_o \, d\lambda = WH\Omega \int_0^\infty B_\lambda T_{op} t(\lambda) \, d\lambda$$

$$\Phi_o = B_\lambda W H \Omega T_{op} \int_0^\infty t(\lambda) \, d\lambda = W^2 B_\lambda H \Omega T_{opt} R_d$$

$= R_d W$

B_λ : Source spectral radiance
W : Slit width
H : Slit height
Ω : Solid angle into monochromator
T_{opt} : Optical transmittance
R_d : Reciprocal linear dispersion

Stray Radiation.

Stray radiation or stray light in a monochromator is considered to be any radiation passed that is outside the interval $\lambda_0 \pm s$

Were λ_0 is the wavelength setting and **S** is the spectral bandpass.

- Leaked room light
- Reflecting walls
- Dust
- Fluorescence
- Grating order overlap
- Grating imperfectness
- Slit edge diffraction

$$\% \text{ stray radiation} = \frac{\Phi_{SR}}{\Phi_o} \times 100 \qquad (3\text{-}75)$$

Solution:
-Holographic Gr.
- Double Monochr

Φ_{SR} is the stray radiant power

Φ_o is the **Source radiant power passed by the monochromatorover** $\lambda_0 \pm s$

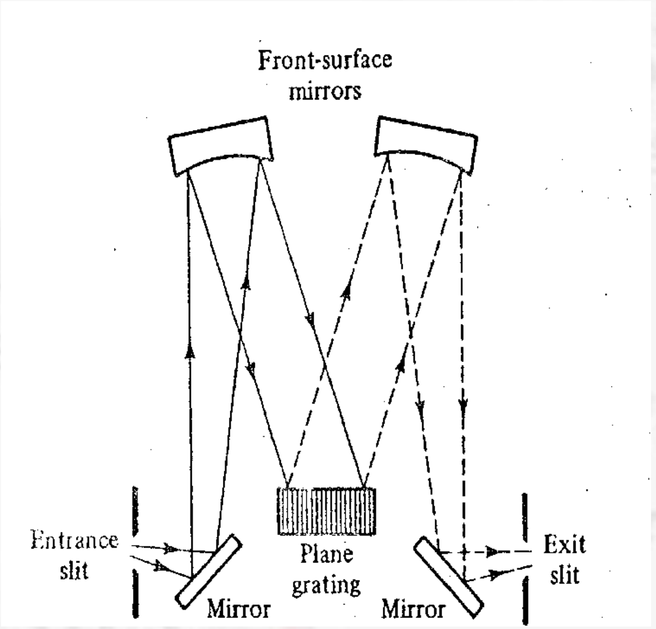
Optical aberations:

- Mirror → No chromatic aberration,
- Parabolic shape → No spherical aberration,
- $\alpha \approx \beta$ → Low Coma
- High N → high throughput, high resolution, but astigmation

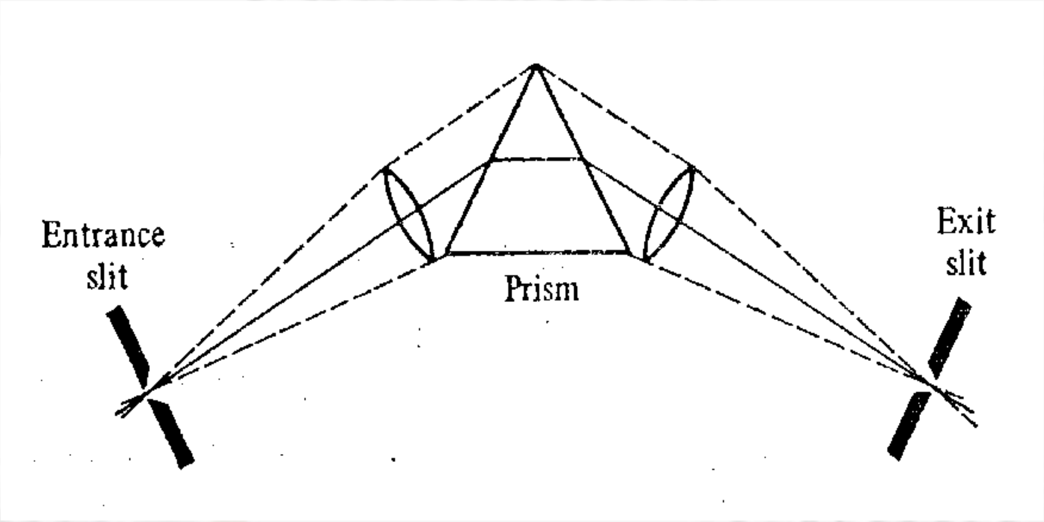
(number of grooves)

Monochromator Types.

Czerny-turner monochromator(grating design)

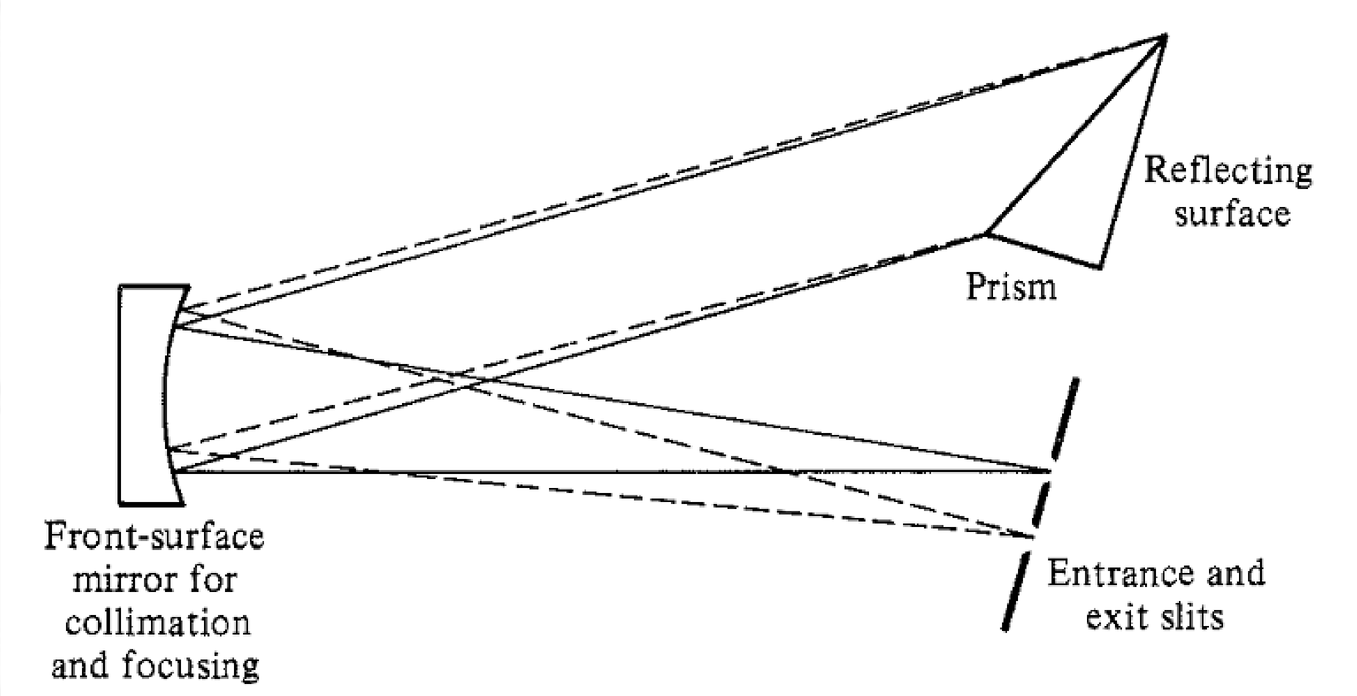


Bunsen design (prism)



Monochromator Types.

Littrow Monochromator design

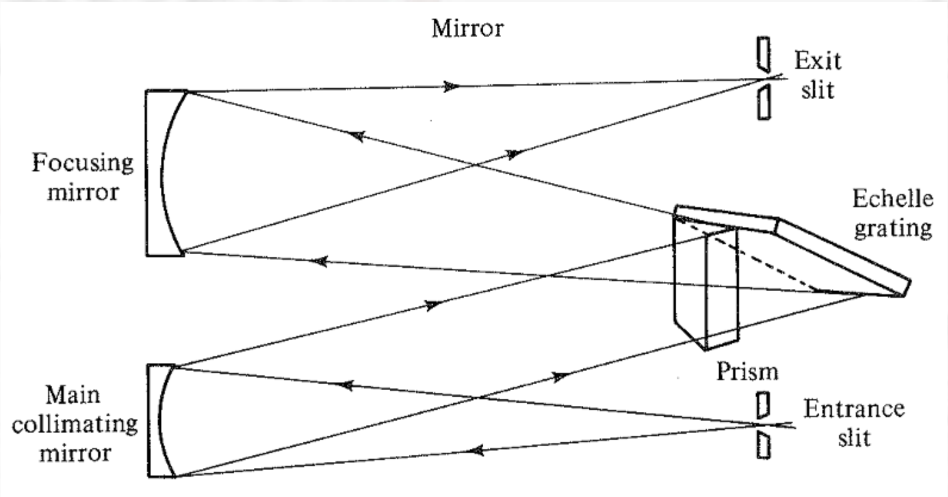


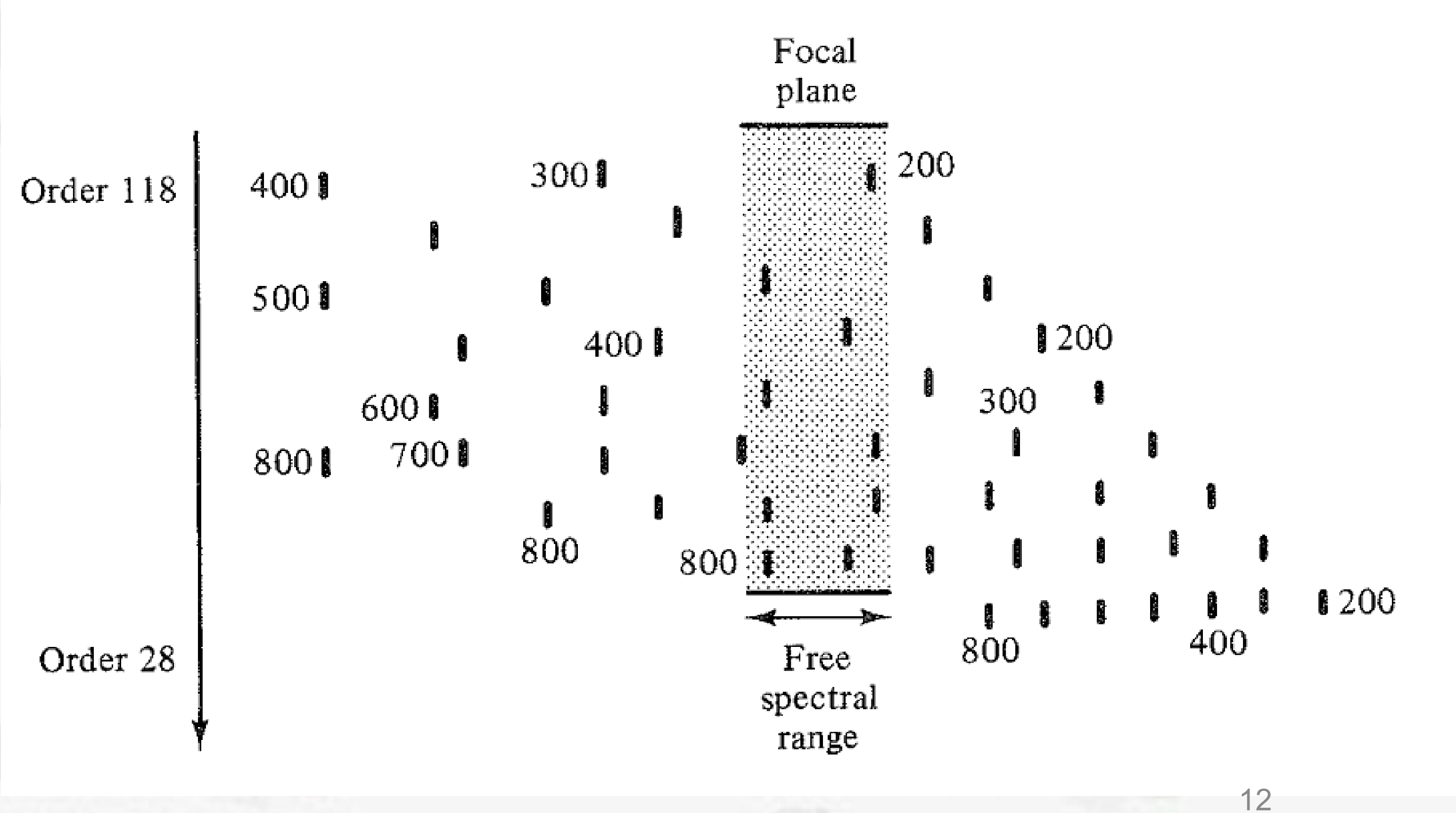
Echelle Monochromator

A prism prior to grating serves as an order sorter.

It disperses the spectrum perpendicular to diffraction direction,
Which gives rise to 2D spectrum.

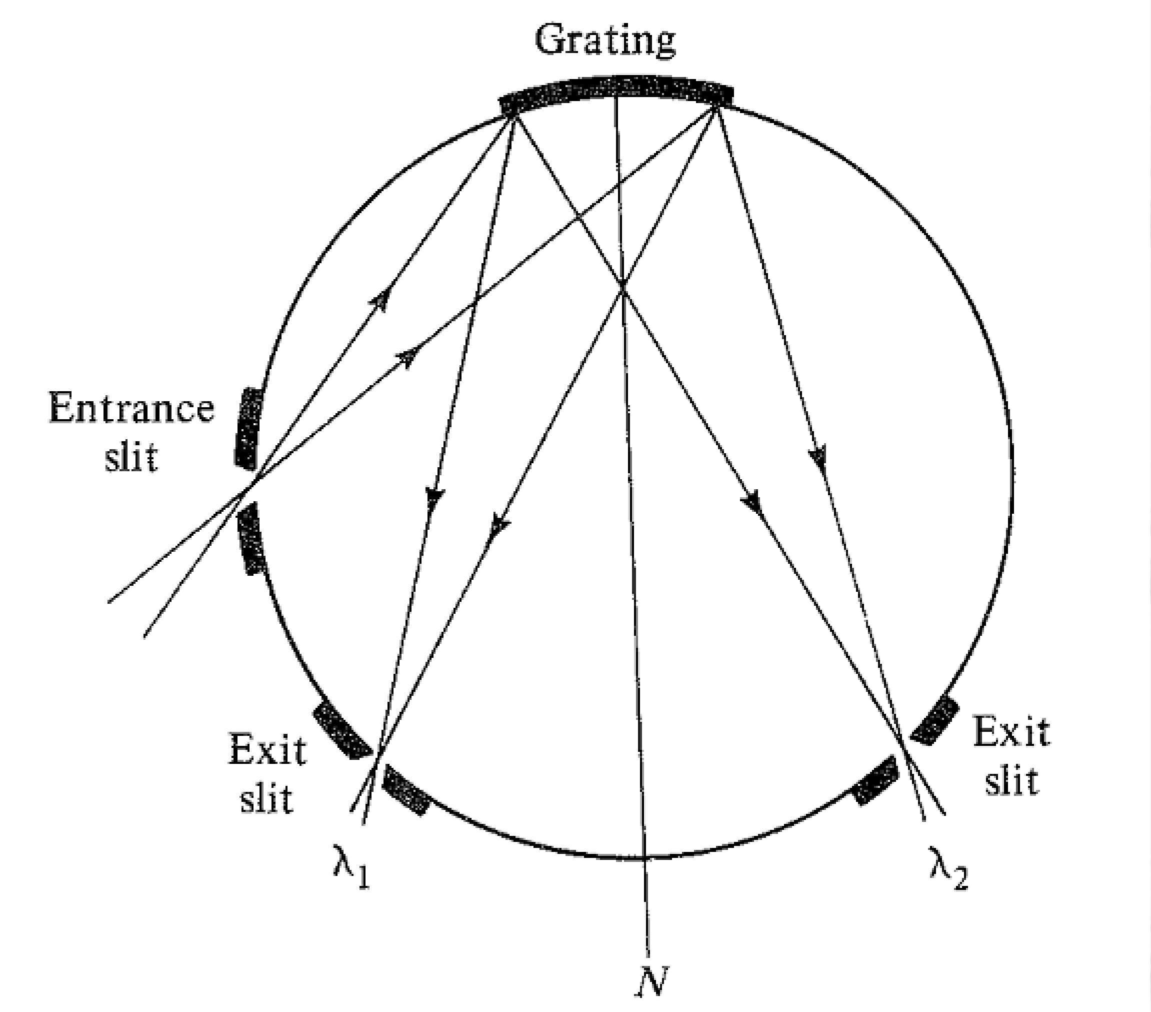
Central wavelength region of different orders are considered.





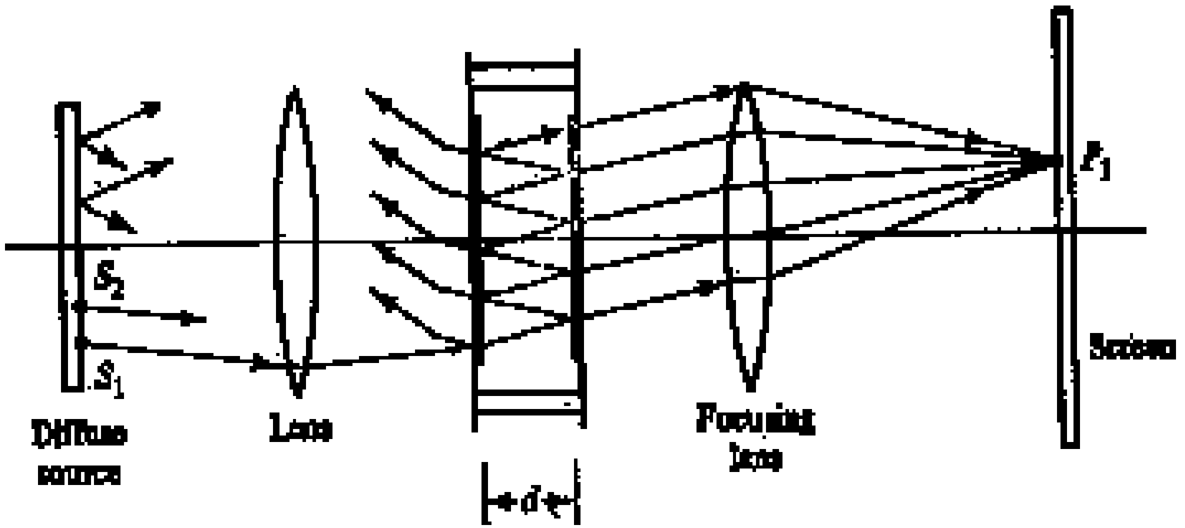
Rowland circle

Polychromator or spectrograph



3-7 NONDISPERSIVE SYSTEMS

Fabry–Perot Interferometer



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