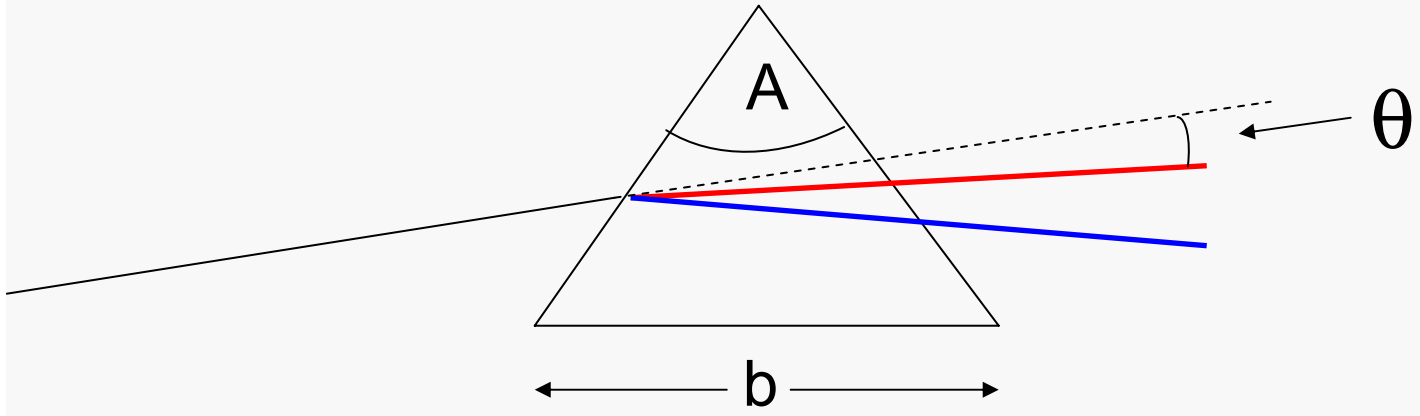
Dispersion Devices

1) Prisms

A = apical angle
b = base length



Light bends due to η $\eta = f(\lambda)$

function of prism design (i.e. angle A)

$$\underline{\text{Angular Dispersion}} = \frac{d\theta}{d\lambda} = \frac{d\theta}{d\eta} \times \frac{d\eta}{d\lambda}$$

function of prism material

Angle changes with λ → the larger the better

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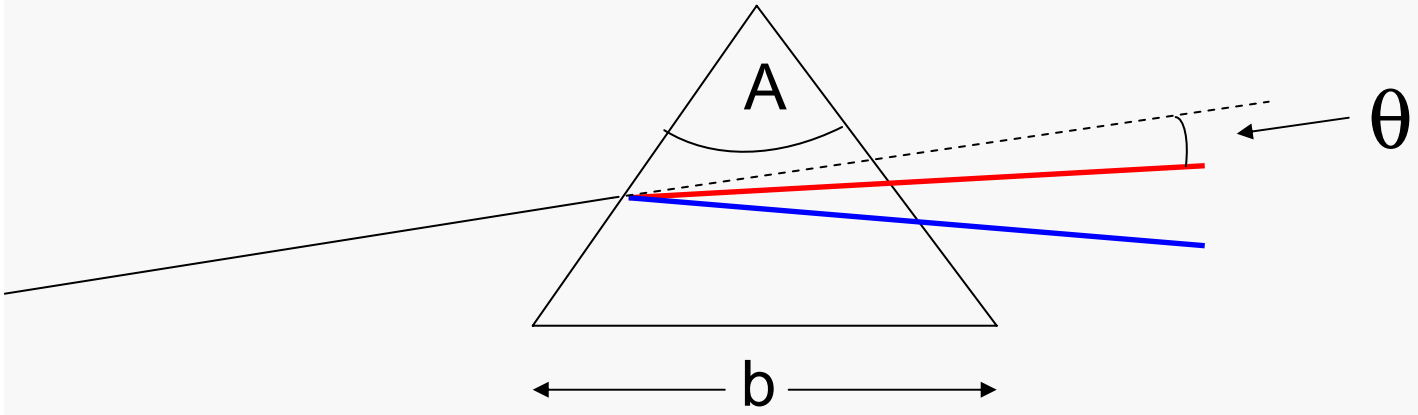

Increasing A → $\frac{d\theta}{d\eta}$ increases but internal reflection is also greater (typical A value is 60^{o})

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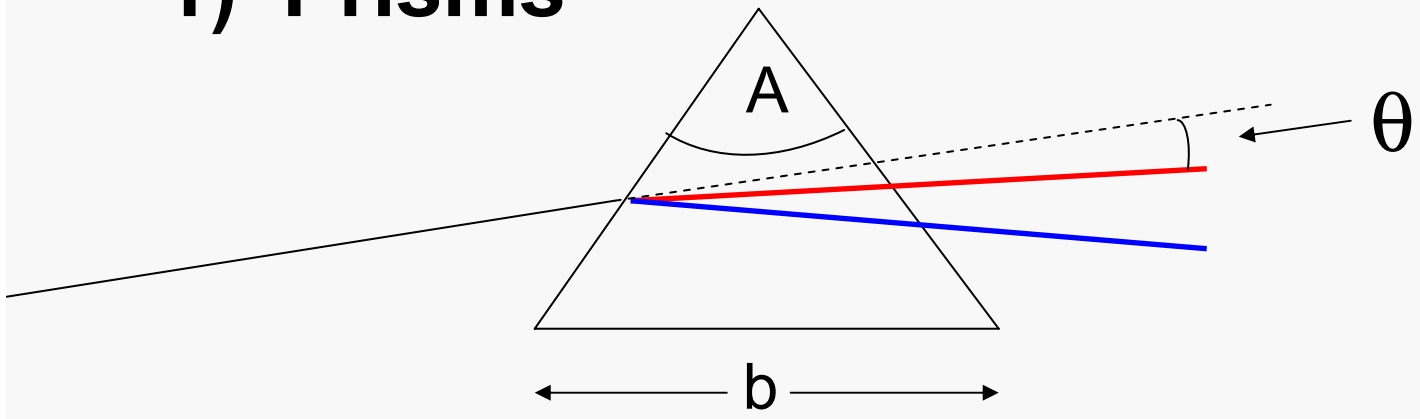
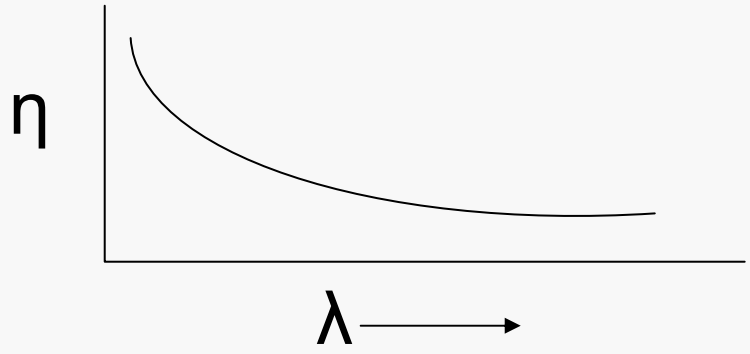
1) Prisms



$\frac{d\eta}{d\lambda}$ depends on material, $\frac{d\eta}{d\lambda}$ greatest at shorter λ



$$\underline{\text{Linear Dispersion}} \quad \left(\frac{\text{mm}}{\text{nm}}\right) = f\,\frac{d\theta}{d\lambda}$$

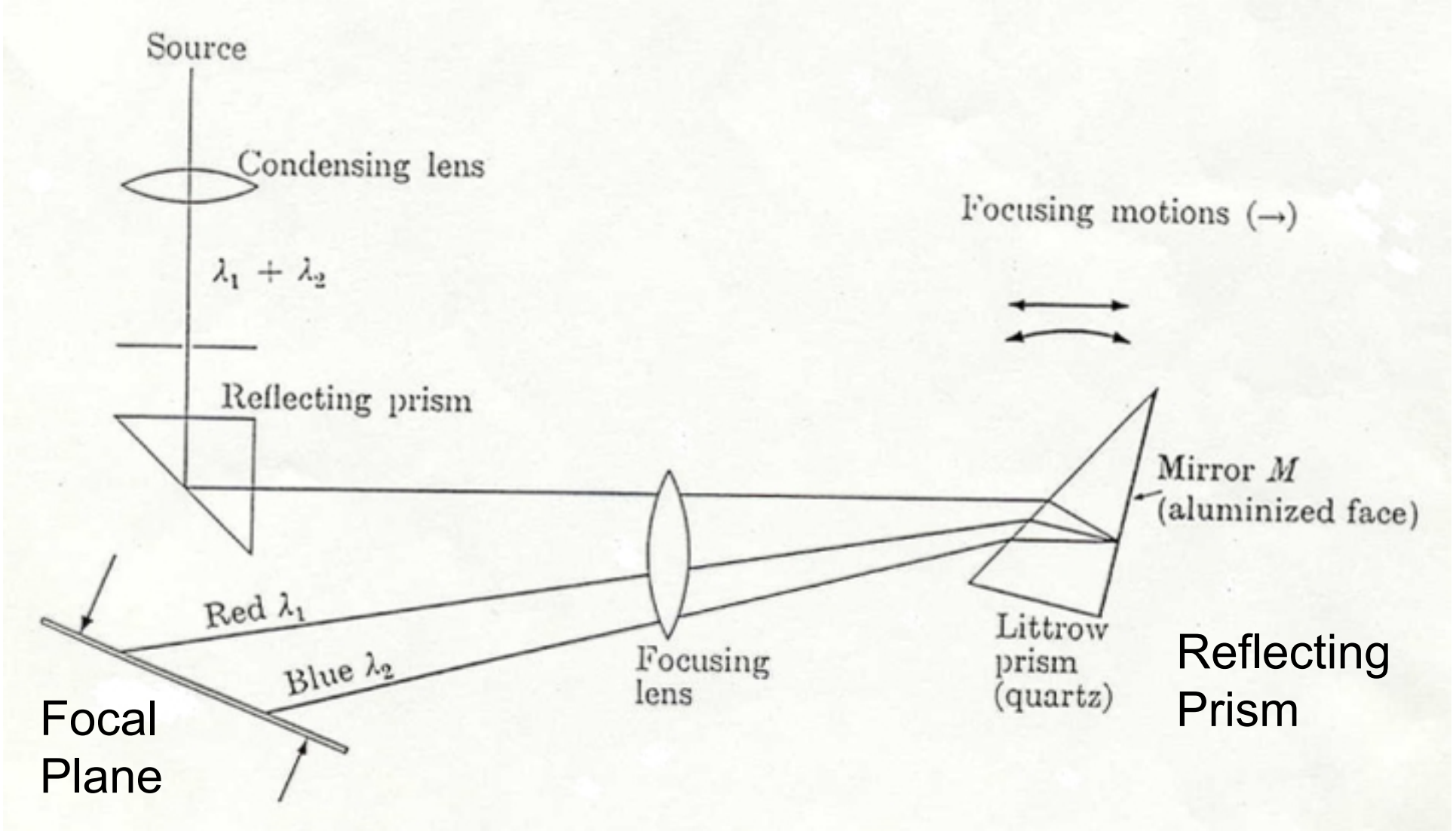
Depends on angular dispersion and focal length

For constant bandwidth, slit widths must be varied with λ to compensate for variations in dη/ dλ

Stated another way, linear dispersion changes in different regions of the spectrum

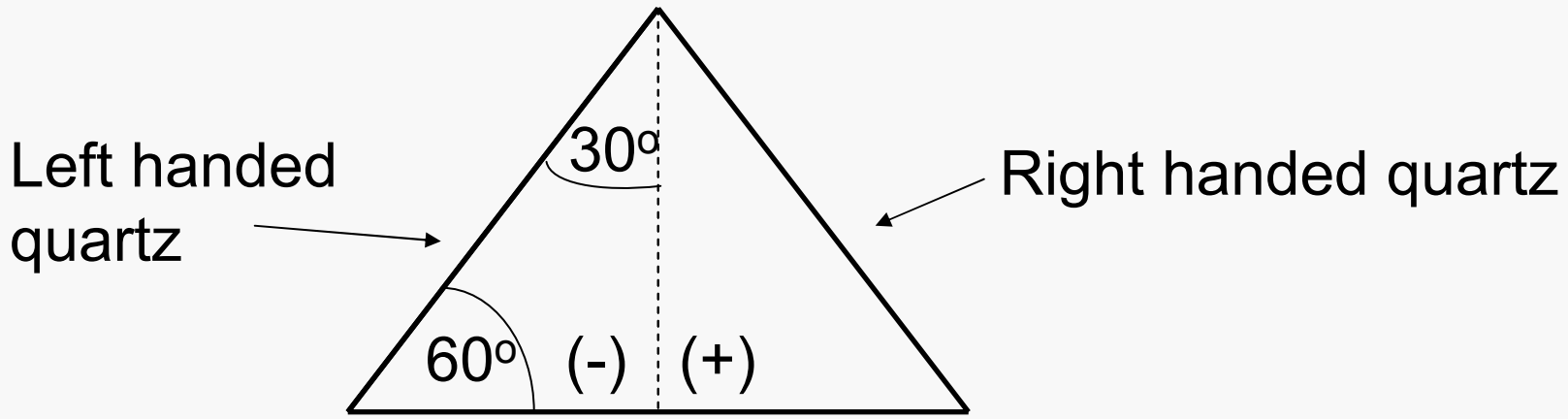
Kinds of Prisms

Littrow Prism & Mounting – compact design



Problem with quartz prisms is that quartz is optically active (optically anisotropic). With the Littrow prism or any reflecting prism, the light travels essentially the same path in both directions and this effect is eliminated.

Cornu Prism



f/ of a monochromator is important if have a weak source. For lenses in series, the smallest f/ sets the overall f/ for the system.

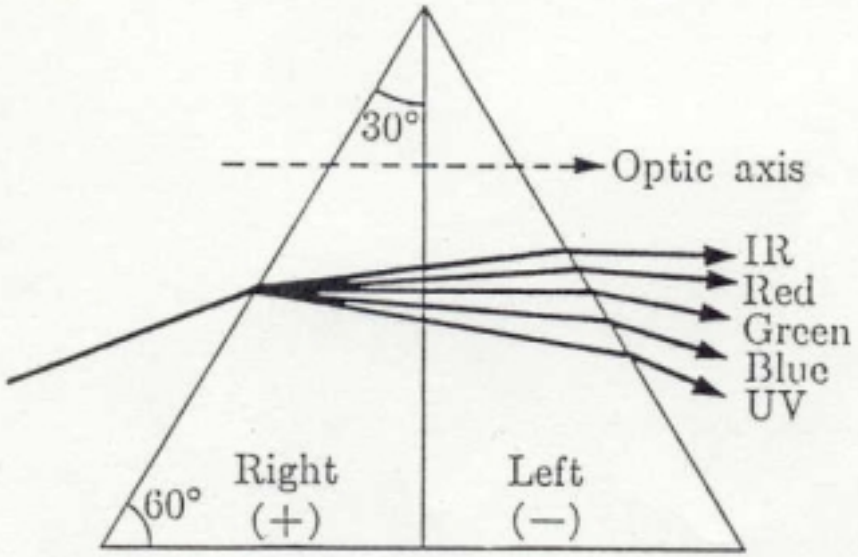
Lens Summary:

1) rugged, easy to use, inexpensive

2) can have chromatic aberrations = focal length depends on η which varies with λ – solution is to fabricate lenses out of a composite glasses so η is constant with λ. This increases cost

3) Each lens results in some light loss due to reflection

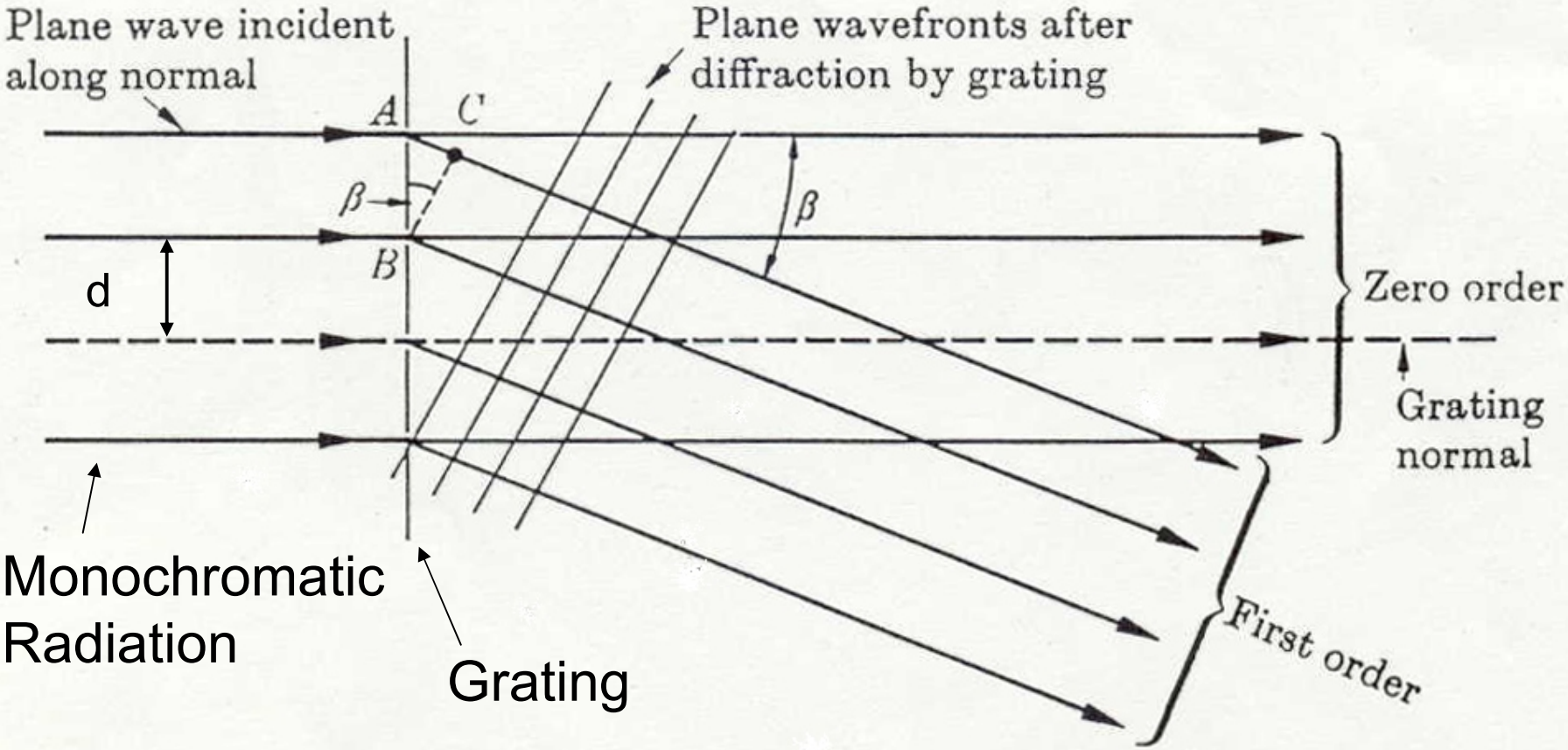
Another view of a Cornu prism



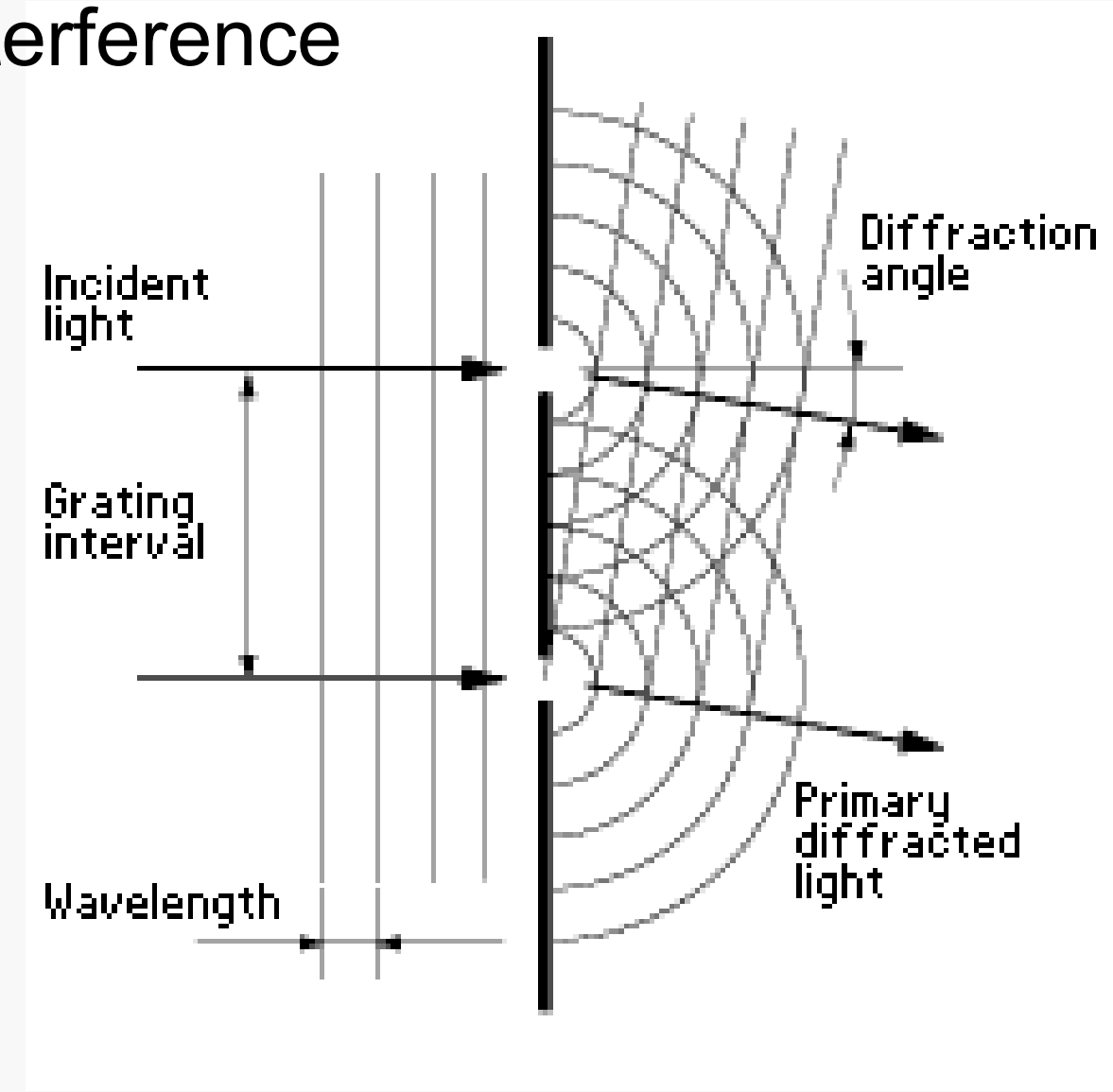
Cornu prism of quartz. The circular double refraction (not shown) produced by the first half is just offset by the equal and opposite effect in the second half. Two overlapping spectra would result if the prism were all of one kind of crystalline quartz.

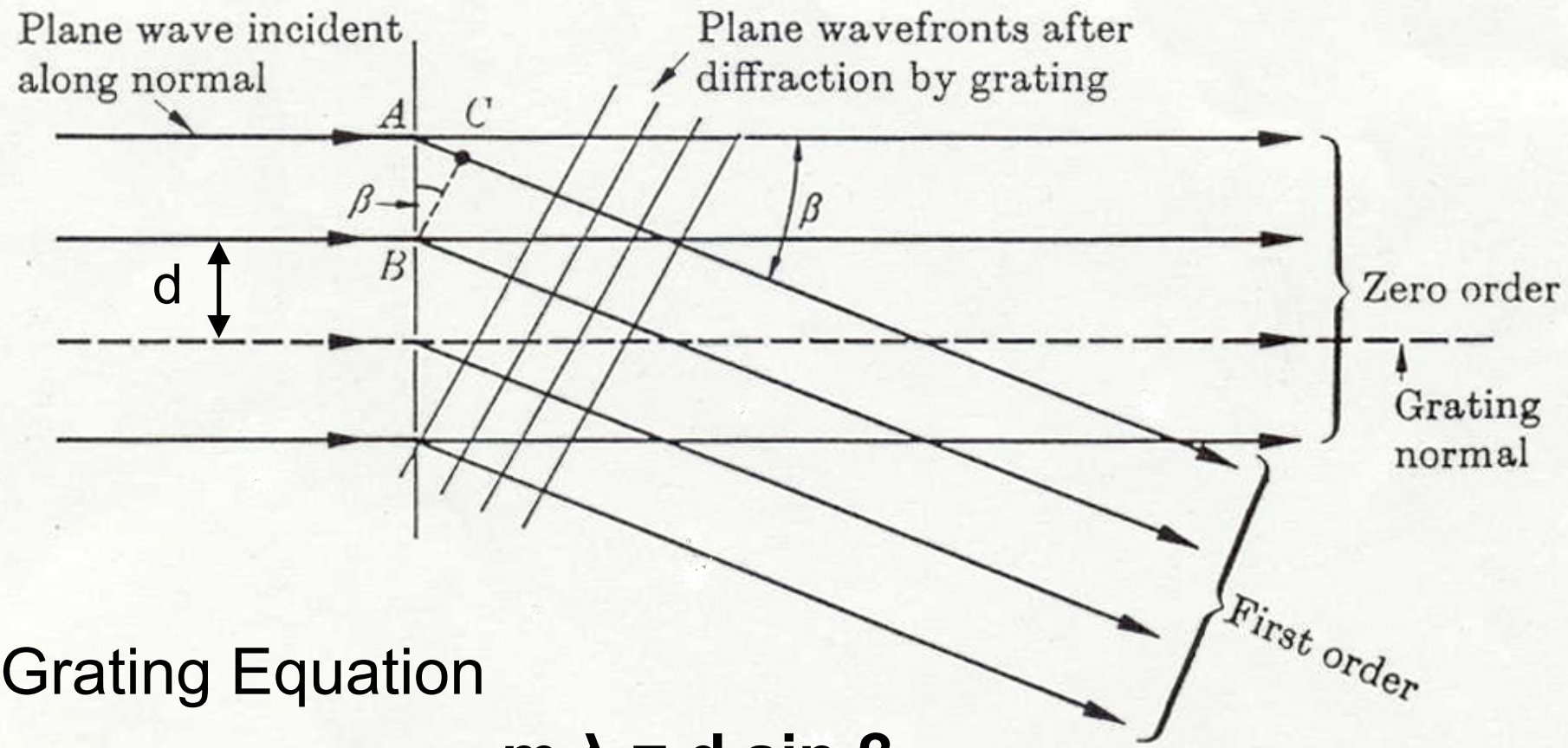
Gratings – based on diffraction & interference

Transmission Gratings & Reflection Gratings consist of a series of grooves in glass or quartz or a mirror (usual kind)



Gratings work on the principles of diffraction & interference





Grating Equation

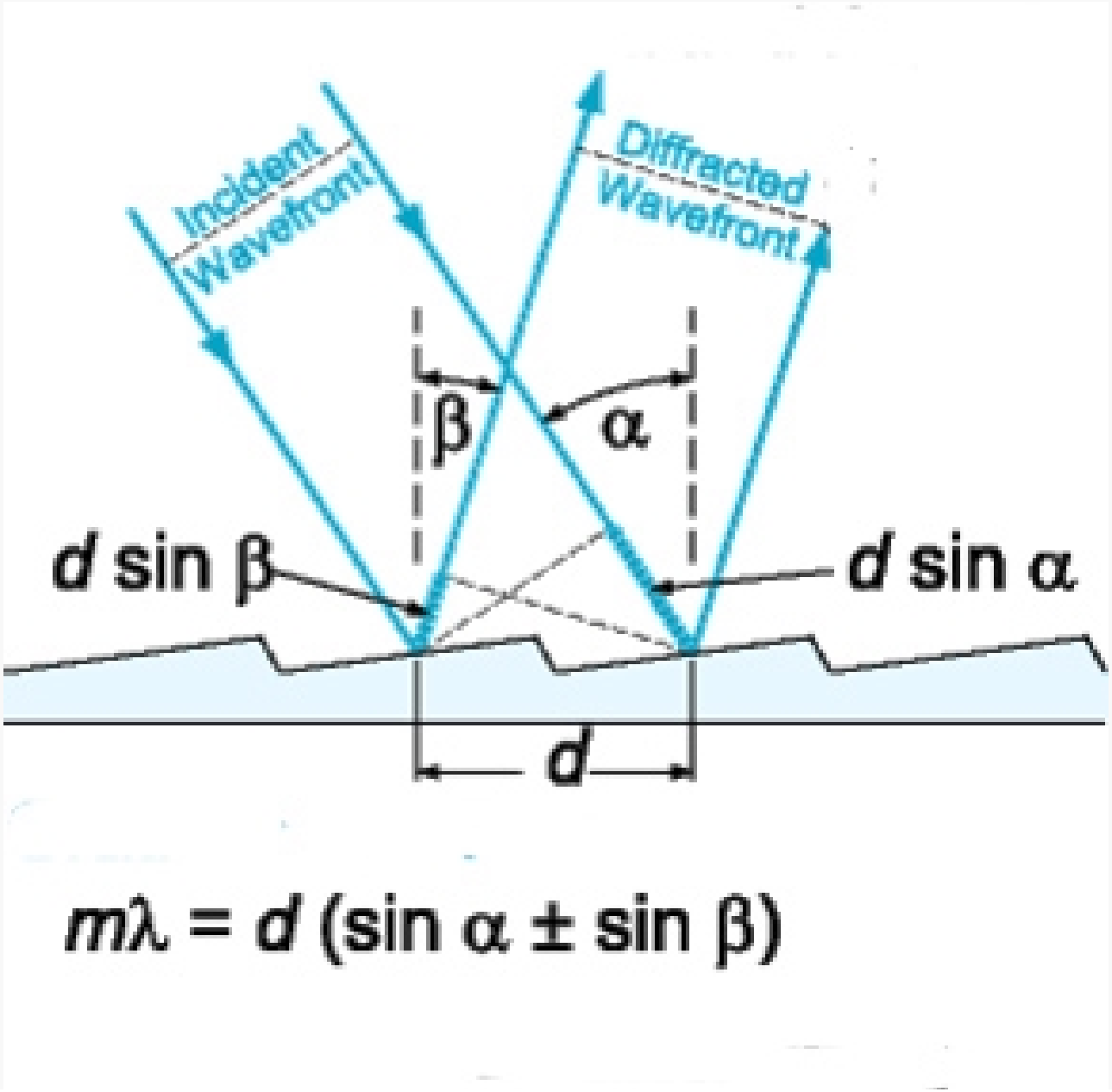
$$m \lambda = d \sin \beta$$

Condition for constructive interference

AC = extra distance light travels for first order = d sin β

For higher orders the distance gets longer

Reflection grating with non-normal incidence



$$m\lambda = d\,(\sin\alpha \pm \sin\beta)$$