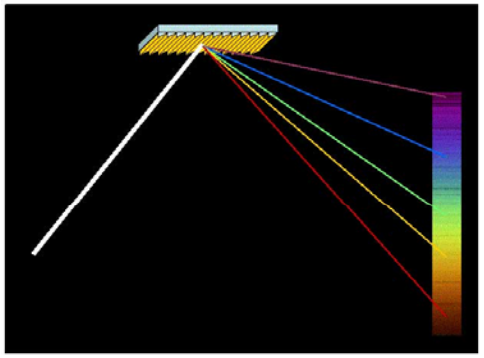
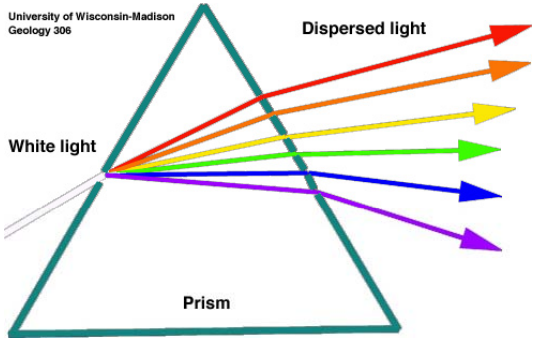
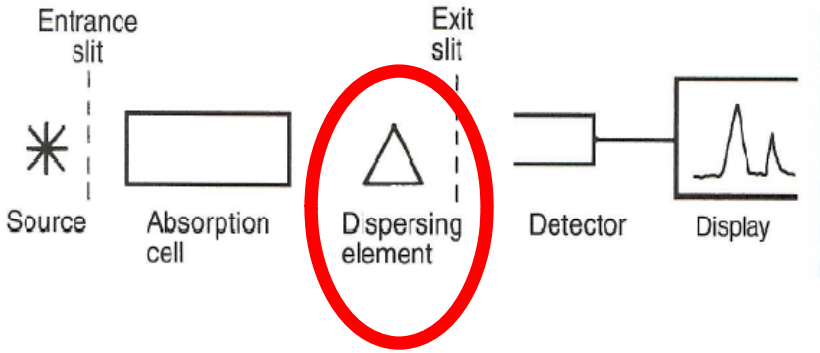
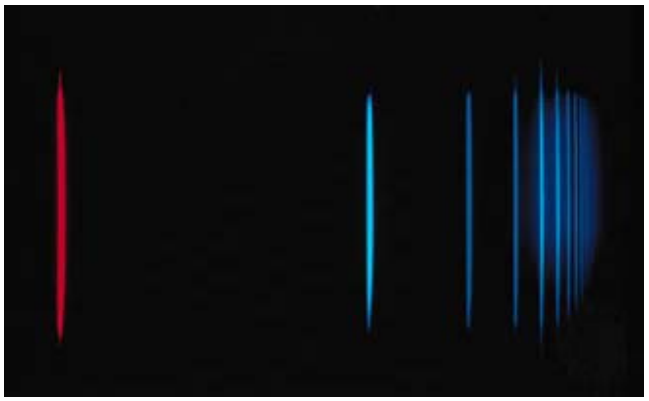
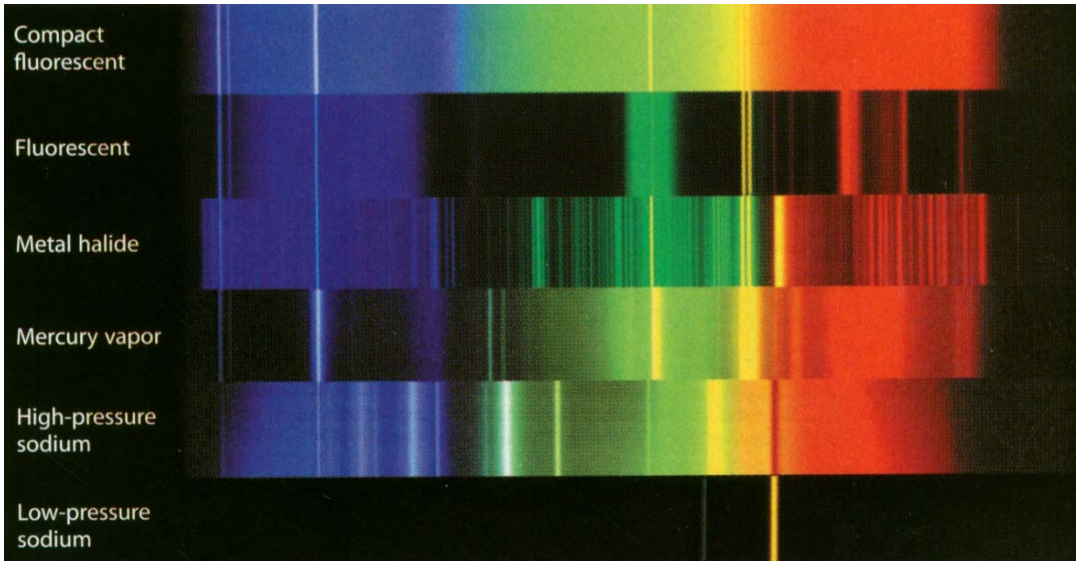


Light dispersion









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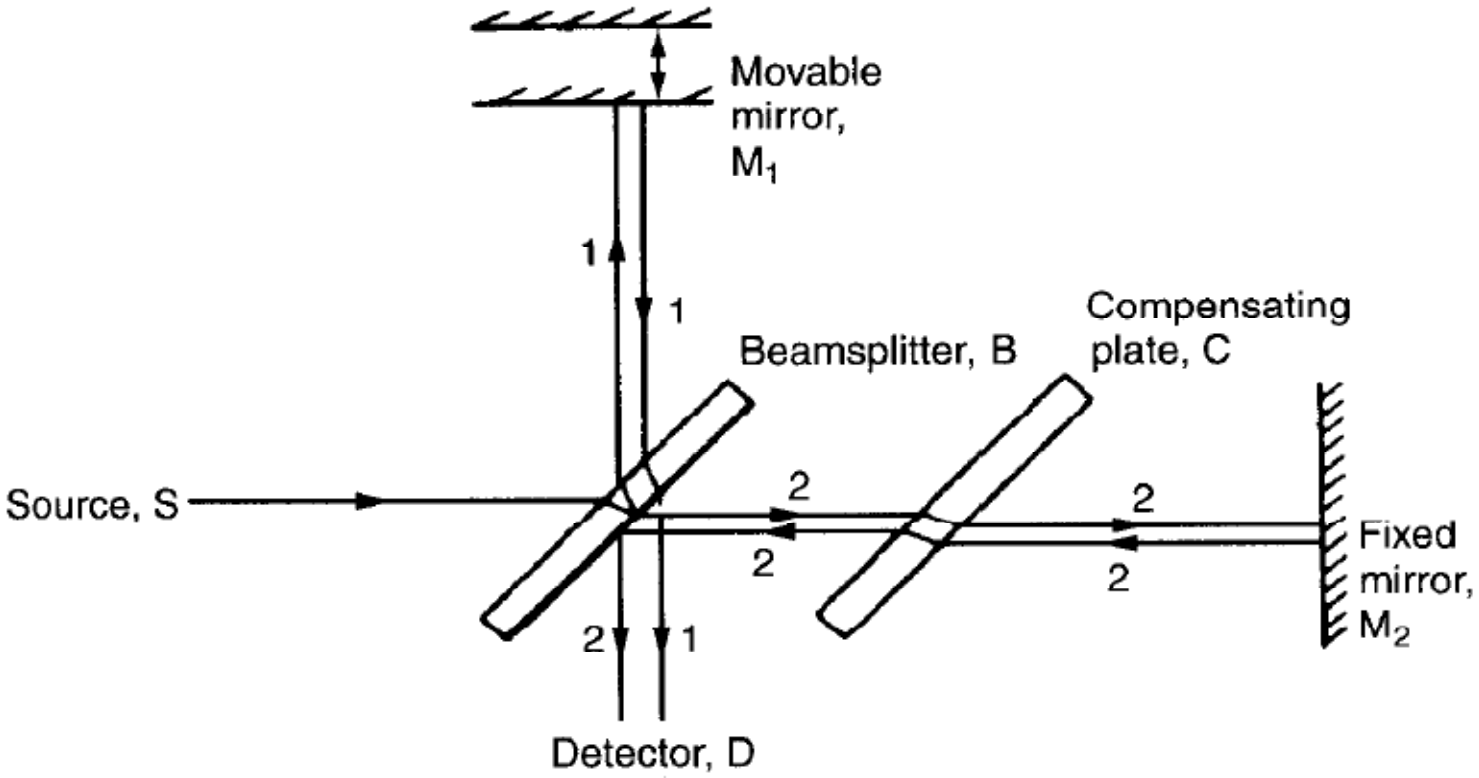
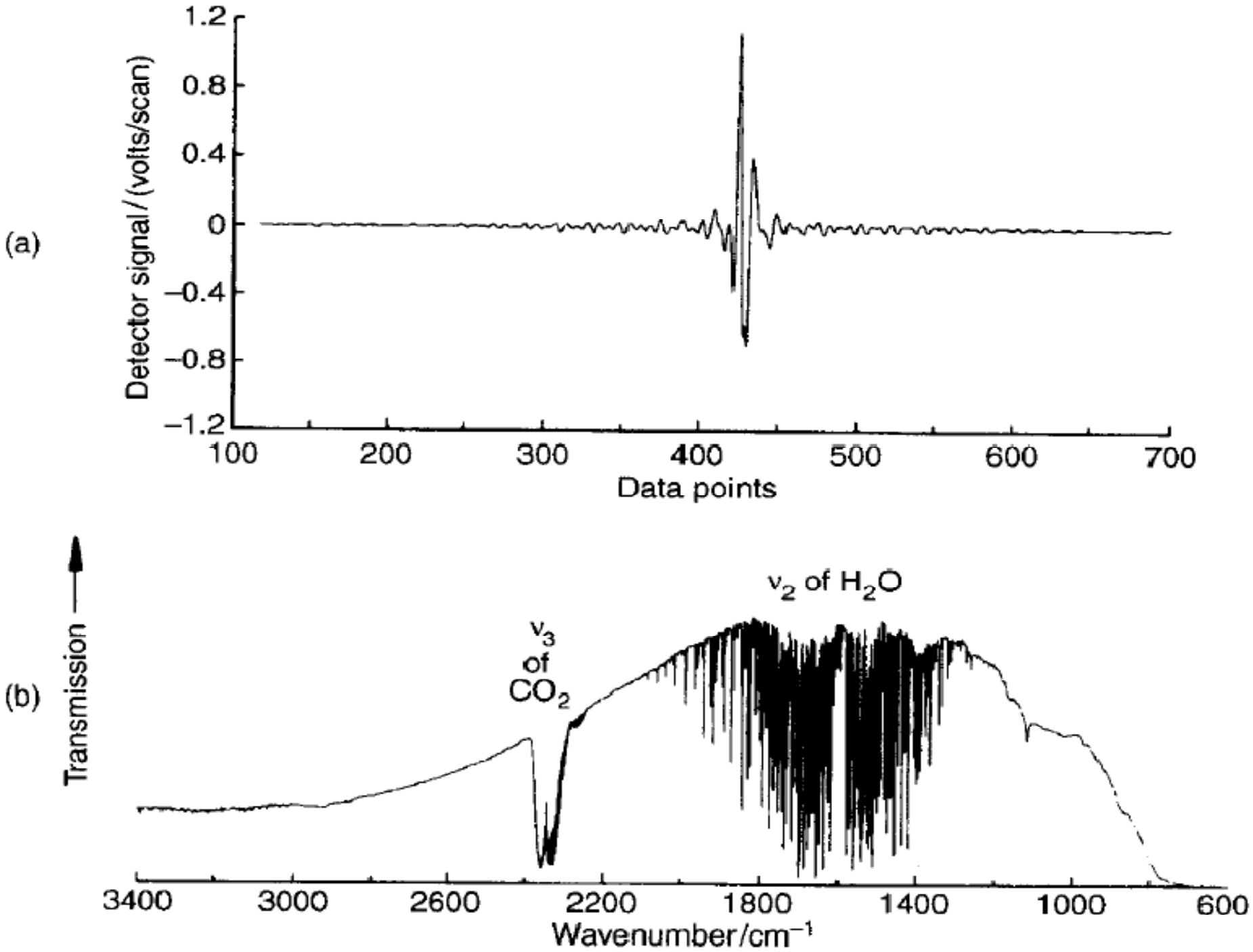
Interferometer

- Resolving power: $R = \tilde{\nu} * \delta_{max}$



http://www.chem.uoa.gr/Applets/AppletFourAnal/Appl_FourAnal2.html


(a)
Detector signal/(volts/scan)
1.2
0.8
0.4
0
−0.4
−0.8
−1.2
100
200
300
400
500
600
700
Data points
(b)
Transmission
ν_2 of H_2O
ν_3 of CO_2
3400
3000
2600
2200
1800
1400
1000
600
Wavenumber/cm^{-1}

Felgett (multiplex) advantage

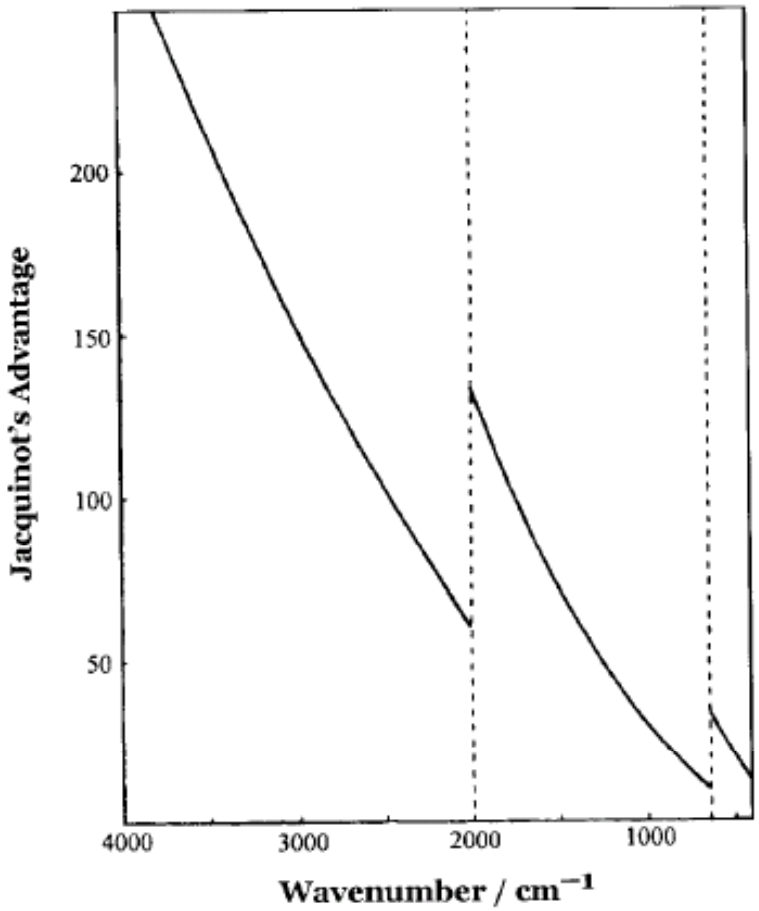
- For spectra measured in the same time at the same resolution, optical throughput and efficiencey, the SNR of the FTIR spectrometer exceeds the SNR of a grating spectrometer by the square root of the number of resolution elements in the spectrum.
  - All wavelengths observed simultaneously
  - Transient species are observable

Jacquinot (throughput) advantage

- Apperture effect:

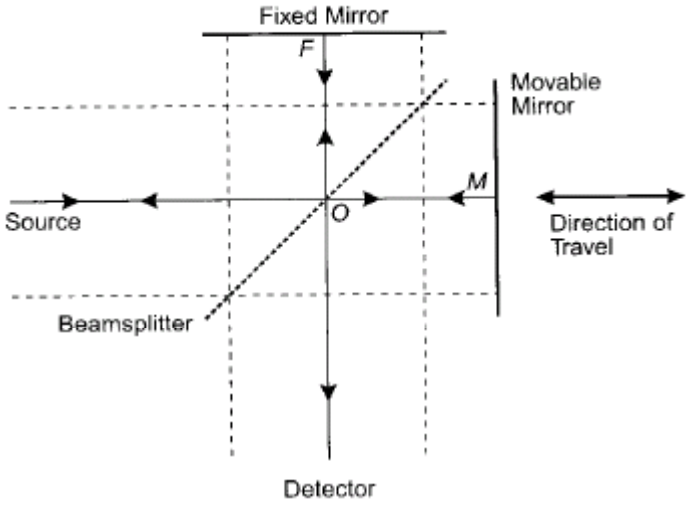
$$\frac{\Theta_I}{\Theta_G} = \frac{2\pi A_M f a \tilde{\nu}^2}{A_G h \tilde{\nu}_{\max}}$$

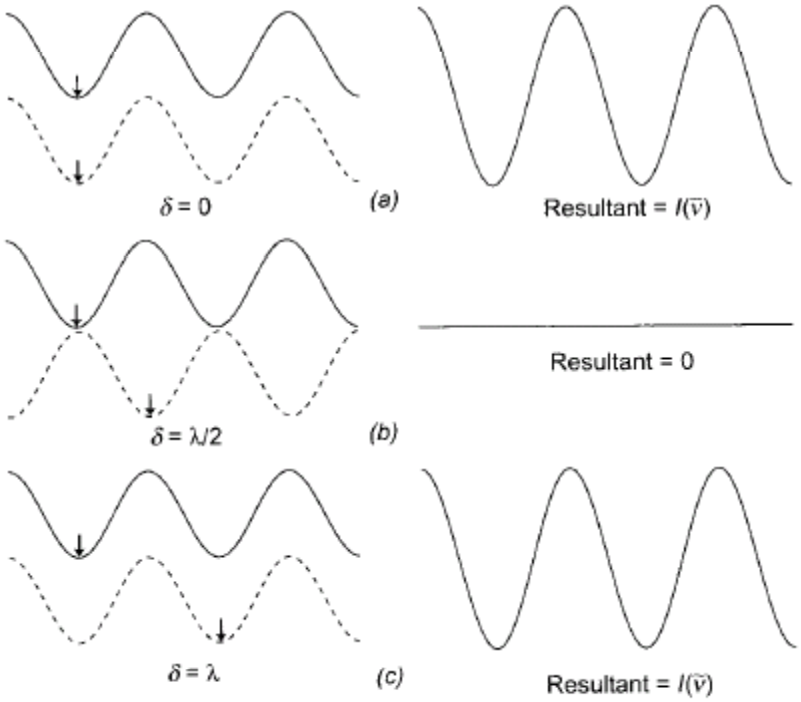
A_m = mirror area
A_g = grating area
f = numerical aperture
a = grating constant



igure 7.3. Calculated variation of Jacquinot's advantage between a Digilab FTS-14 FT-IR spectrometer d a Beckman Model 4240 grating spectrometer, both operating at 2 cm^{-1} resolution. The dashed lines dicate the grating changes for the monochromator. (Reproduced from [9], by permission of the Society r Applied Spectroscopy; copyright © 1977.)

Emission interferogram





- For monochromatic radiation

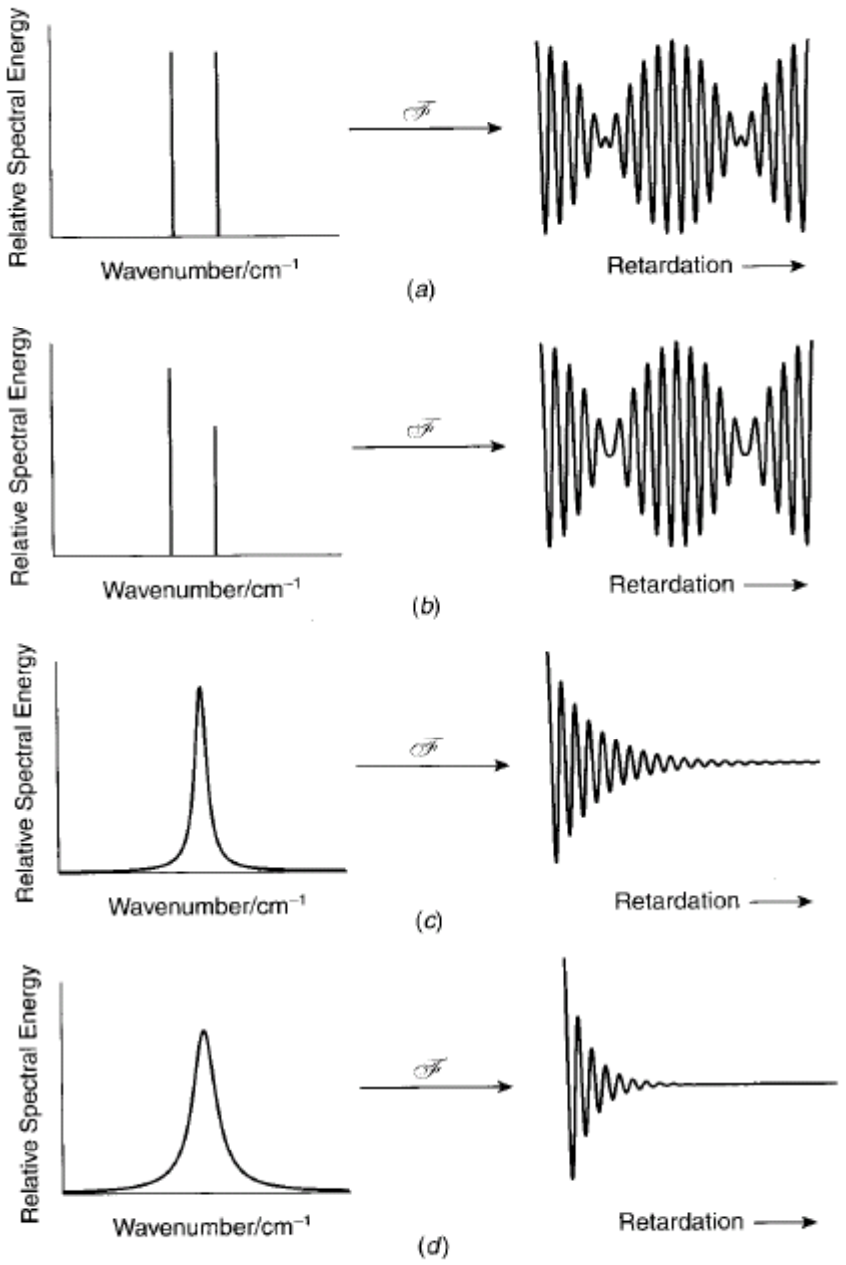
Interferograms cont.

- Source a continuum:

$$S(\delta) = \int_{-\infty}^{+\infty} B(\tilde{\nu}) \cos 2\pi\tilde{\nu}\delta \, d\tilde{\nu}$$

- Fourier Transform:

$$B(\tilde{\nu}) = 2 \int_{0}^{+\infty} S(\delta) \cos 2\pi\tilde{\nu}\delta \, d\delta$$



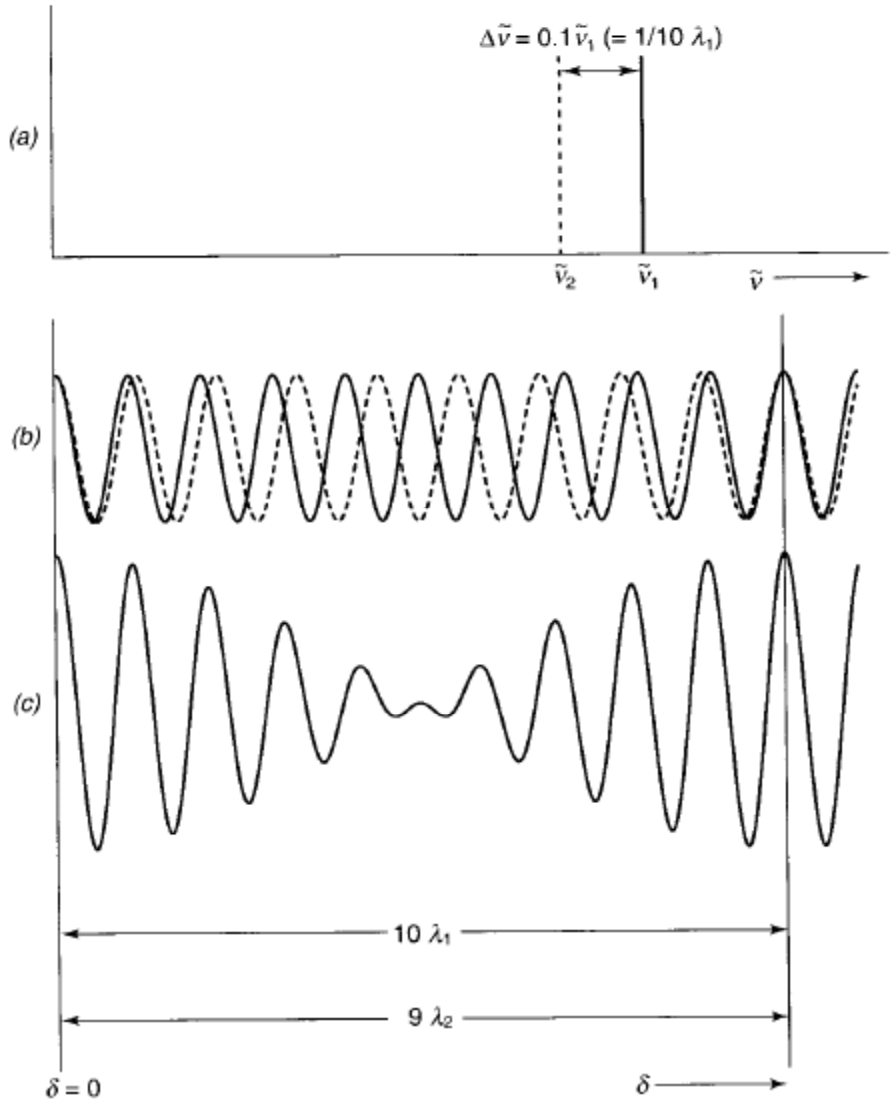


Figure 2.4. (*a*) Spectrum of two lines of equal intensity at wavenumbers $\tilde{\nu}_1$ (solid line) and $\tilde{\nu}_2$ (dashed line) separated by $0.1\tilde{\nu}_1$; (*b*) interferogram for each spectral line shown individually as solid and dashed lines, respectively; (*c*) resulting interferogram with the first maximum of the beat signal at $10/\tilde{\nu}_1$; to resolve these two spectral lines, it is necessary to generate an optical retardation of at least this value.

Finite Resolution

$$(\Delta\tilde{\nu}) = (\Delta_{\max})^{-1}$$

- Apodization:

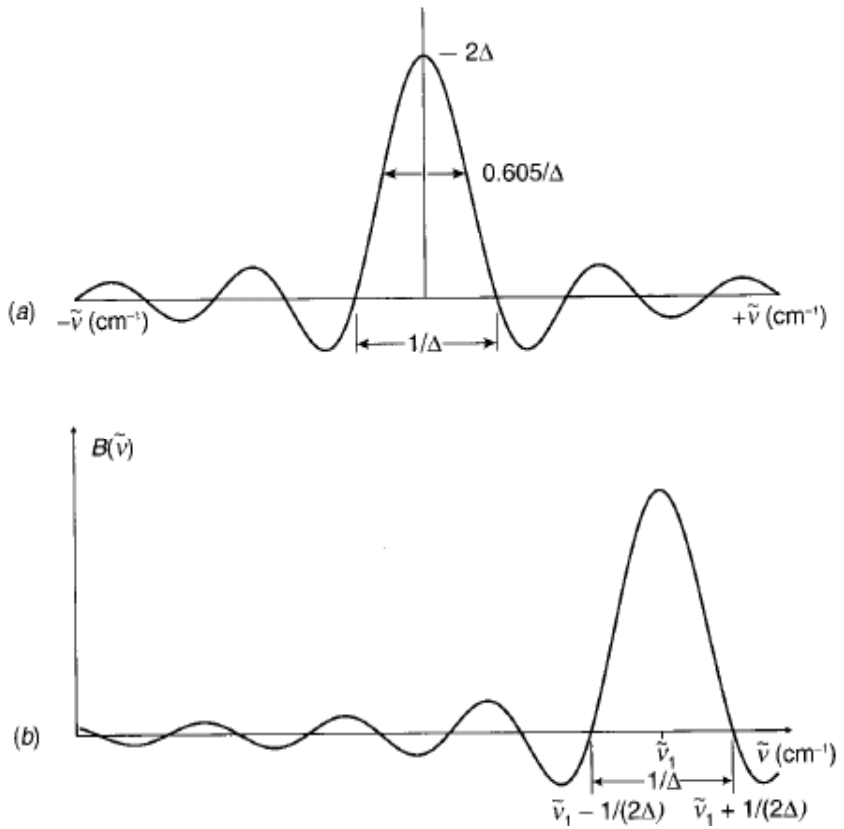
$$D(\delta) = \begin{cases} 1 & \text{if } -\Delta \le \delta \le +\Delta \\ 0 & \text{if } \Delta > |\Delta| \end{cases}$$

$$B(\tilde{\nu}) = \int_{-\infty}^{+\infty} S(\delta) D(\delta) \cos 2\pi\tilde{\nu}\delta \, d\delta$$

Instrument line shape function is the Fourier transform of the truncation function.

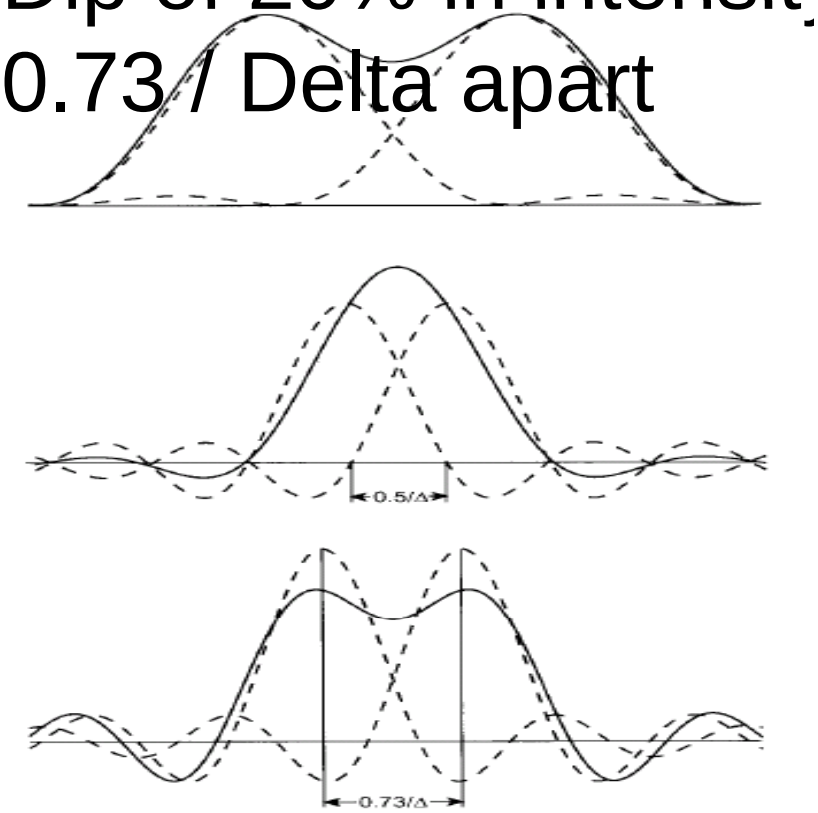
Instrument line shape function

- Boxcar truncation
  -> sinc function

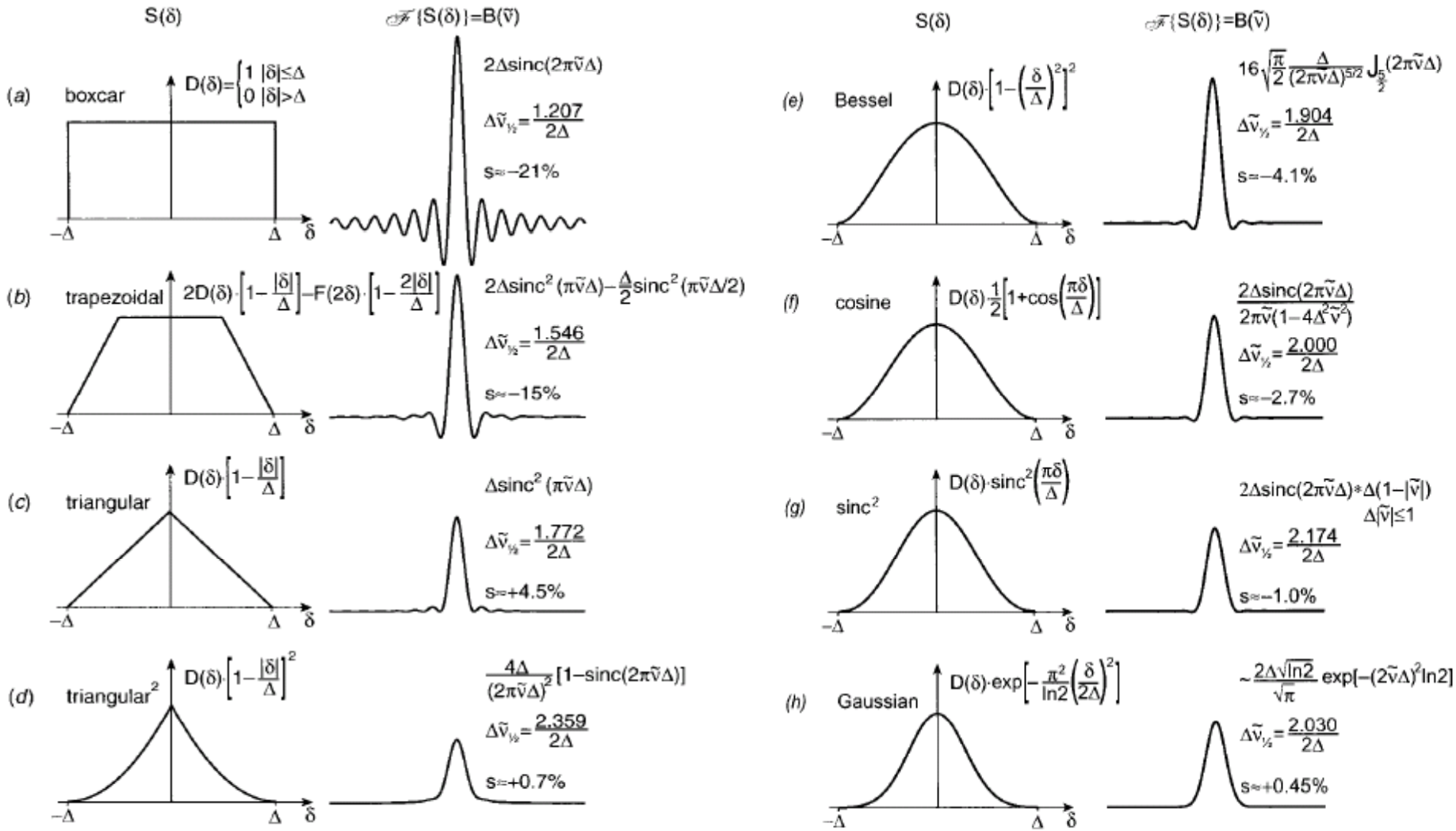


Rayleigh criterion
for resolution:

Dip of 20% in intensity
0.73 / Delta apart



ILS cont


S(δ)
ℱ{S(δ)}=B(ν̃)
(a) boxcar
D(δ)=1 |δ|≤Δ, 0 |δ|>Δ
2Δsinc(2πν̃Δ)
Δν̃½=1.207/2Δ
s≈−21%
(b) trapezoidal
2D(δ)·[1−|δ|/Δ]−F(2δ)·[1−2|δ|/Δ]
2Δsinc²(πν̃Δ)−(Δ/2)sinc²(πν̃Δ/2)
Δν̃½=1.546/2Δ
s≈−15%
(c) triangular
D(δ)·[1−|δ|/Δ]
Δsinc²(πν̃Δ)
Δν̃½=1.772/2Δ
s≈+4.5%
(d) triangular²
D(δ)·[1−|δ|/Δ]²
4Δ/(2πν̃Δ)²[1−sinc(2πν̃Δ)]
Δν̃½=2.359/2Δ
s≈+0.7%
S(δ)
ℱ{S(δ)}=B(ν̃)
(e) Bessel
D(δ)·[1−(δ/Δ)²]²
16√(π/2)·Δ/(2πν̃Δ)^5/2 J5/2(2πν̃Δ)
Δν̃½=1.904/2Δ
s≈−4.1%
(f) cosine
D(δ)·½[1+cos(πδ/Δ)]
2Δsinc(2πν̃Δ)/2πν̃(1−4Δ²ν̃²)
Δν̃½=2.000/2Δ
s≈−2.7%
(g) sinc²
D(δ)·sinc²(πδ/Δ)
2Δsinc(2πν̃Δ)*Δ(1−|ν̃|) Δ|ν̃|≤1
Δν̃½=2.174/2Δ
s≈−1.0%
(h) Gaussian
D(δ)·exp[−π²/ln2·(δ/2Δ)²]
~2Δ√ln2/√π exp[−(2ν̃Δ)²ln2]
Δν̃½=2.030/2Δ
s≈+0.45%