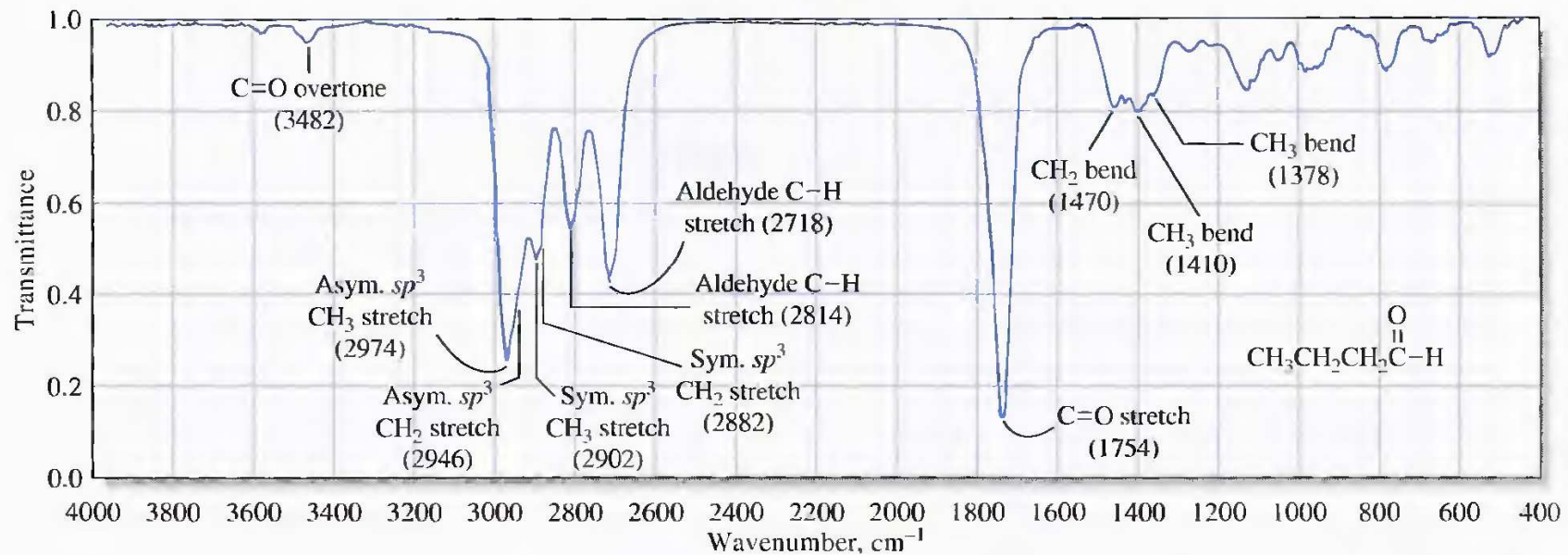
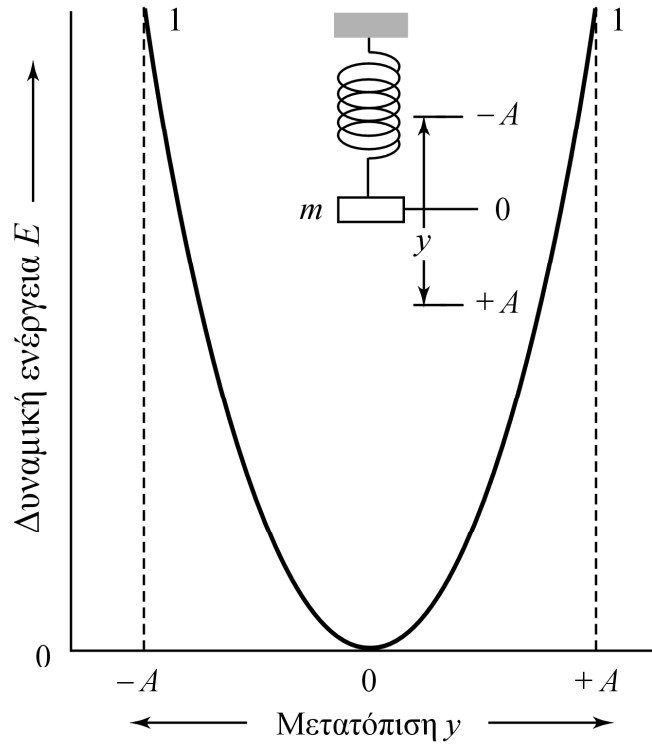


# Φασματοσκοπία Υπερύθρου, IR

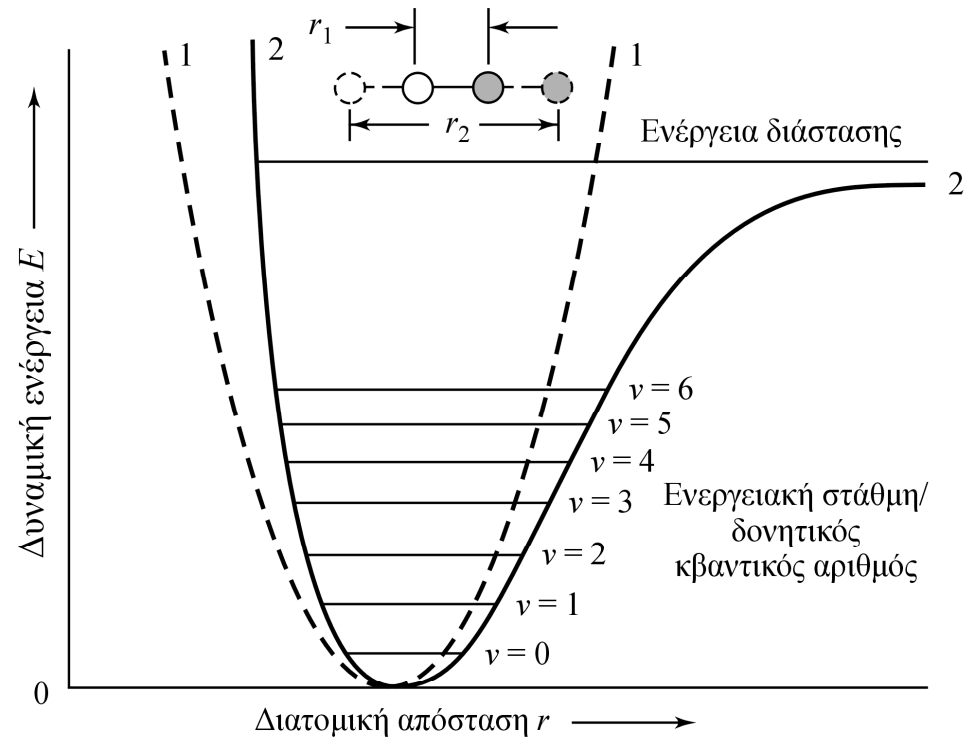
	Near IR.	Mid IR.	Far IR.
Wavenumber	13,000–4,000 $\text{cm}^{-1}$	4,000–200 $\text{cm}^{-1}$	200–10 $\text{cm}^{-1}$
Wavelength	0.78–2.5 $\mu\text{m}$	2.5–50 $\mu\text{m}$	50–1,000 $\mu\text{m}$



# Φασματοσκοπία Υπερύθρου, IR

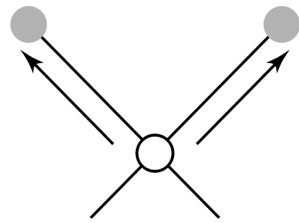


(α)

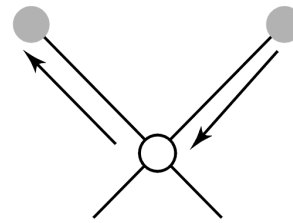


(β)

# Φασματοσκοπία Υπερύθρου, IR



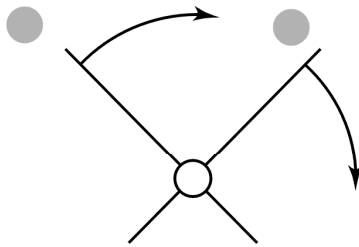
Συμμετρική



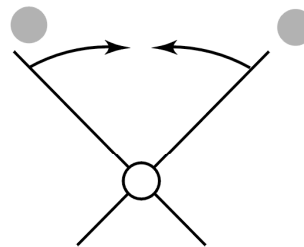
Ασύμμετρη

(α) Δονήσεις έκτασης

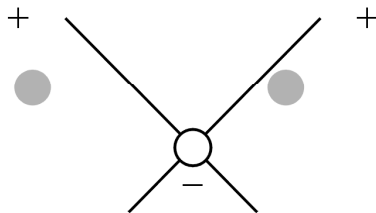
Αριθμός δονήσεων =  $3N-6$   
Γραμμικά:  $3N-5$



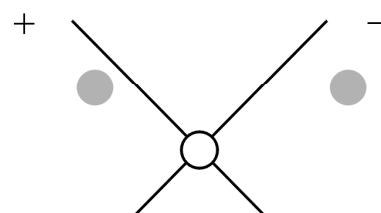
Λικνιζόμενη (στο ίδιο επίπεδο)



Ψαλιδοειδής (στο ίδιο επίπεδο)



Παλλόμενη (εκτός επιπέδου)



Συστρεφόμενη (εκτός επιπέδου)

(β) Δονήσεις κάμψης

# Φασματοσκοπία Υπερύθρου, IR

**TABLE 26-5**

**Some Characteristic Infrared Absorption Peaks**

	Functional Group	Absorption Peaks	
		Wavenumber, $\text{cm}^{-1}$	Wavelength, $\mu\text{m}$
O—H	Aliphatic and aromatic	3600–3000	2.8–3.3
NH <sub>2</sub>	Also secondary and tertiary	3600–3100	2.8–3.2
C—H	Aromatic	3150–3000	3.2–3.3
C—H	Aliphatic	3000–2850	3.3–3.5
C≡N	Nitrile	2400–2200	4.2–4.6
C≡C—	Alkyne	2260–2100	4.4–4.8
COOR	Ester	1750–1700	5.7–5.9
COOH	Carboxylic acid	1740–1670	5.7–6.0
C=O	Aldehydes and ketones	1740–1660	5.7–6.0
CONH <sub>2</sub>	Amides	1720–1640	5.8–6.1
C=C—	Alkene	1670–1610	6.0–6.2
$\phi$ —O—R	Aromatic	1300–1180	7.7–8.5
R—O—R	Aliphatic	1160–1060	8.6–9.4

# Φασματοσκοπία Υπερύθρου, IR

**TABLE 26-6**

**Examples of Infrared Vapor Analysis for OSHA Compliance\***

<b>Compound</b>	<b>Allowable Exposure, ppm†</b>	<b>Wavelength, <math>\mu\text{m}</math></b>	<b>Minimum Detectable Concentration, ppm‡</b>
Carbon disulfide	4	4.54	0.5
Chloroprene	10	11.4	4
Diborane	0.1	3.9	0.05
Ethylenediamine	10	13.0	0.4
Hydrogen cyanide	4.7§	3.04	0.4
Methyl mercaptan	0.5	3.38	0.4
Nitrobenzene	1	11.8	0.2
Pyridine	5	14.2	0.2
Sulfur dioxide	2	8.6	0.5
Vinyl chloride	1	10.9	0.3

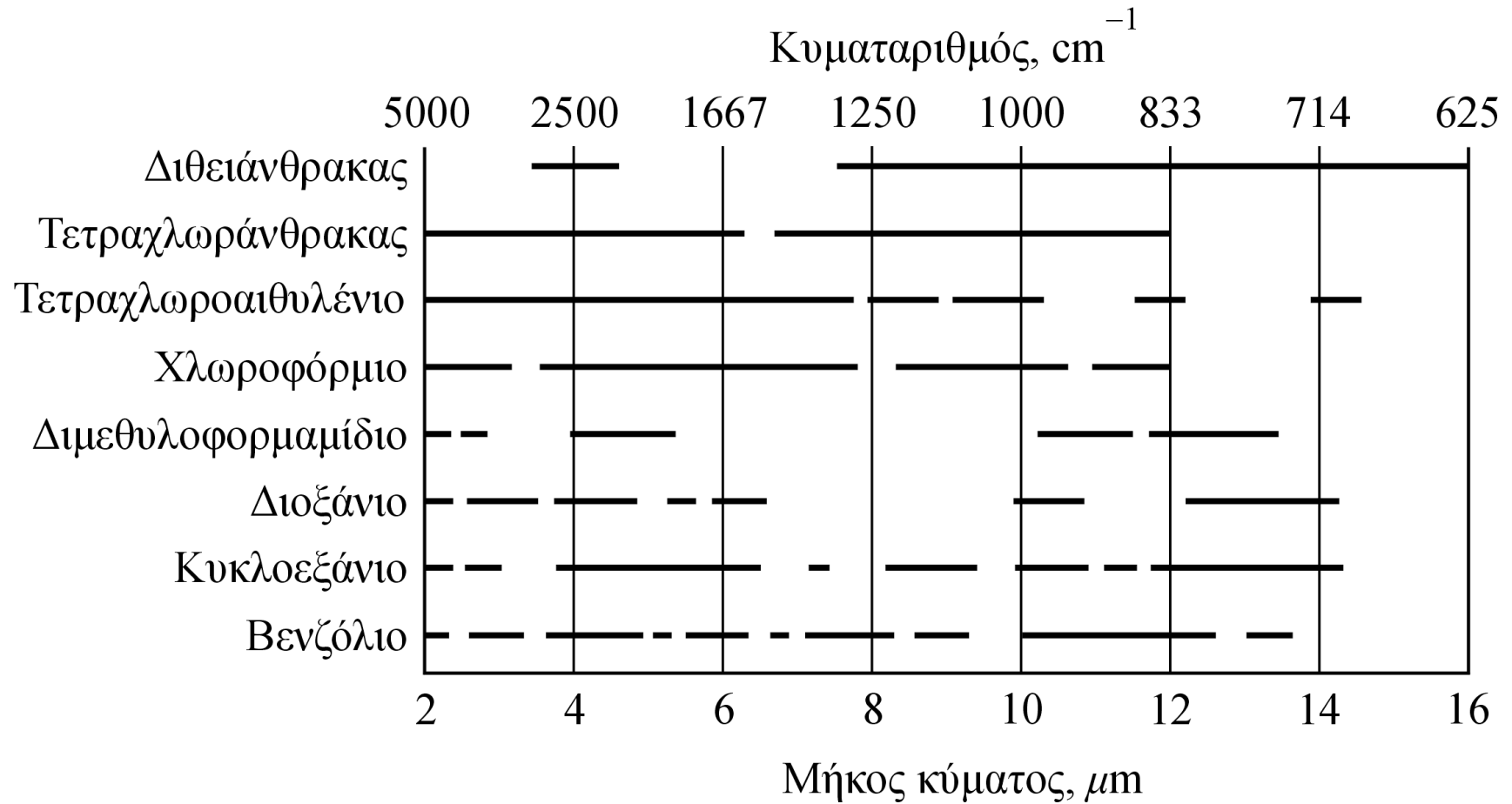
\*Courtesy of The Foxboro Company, Foxboro, MA 02035.

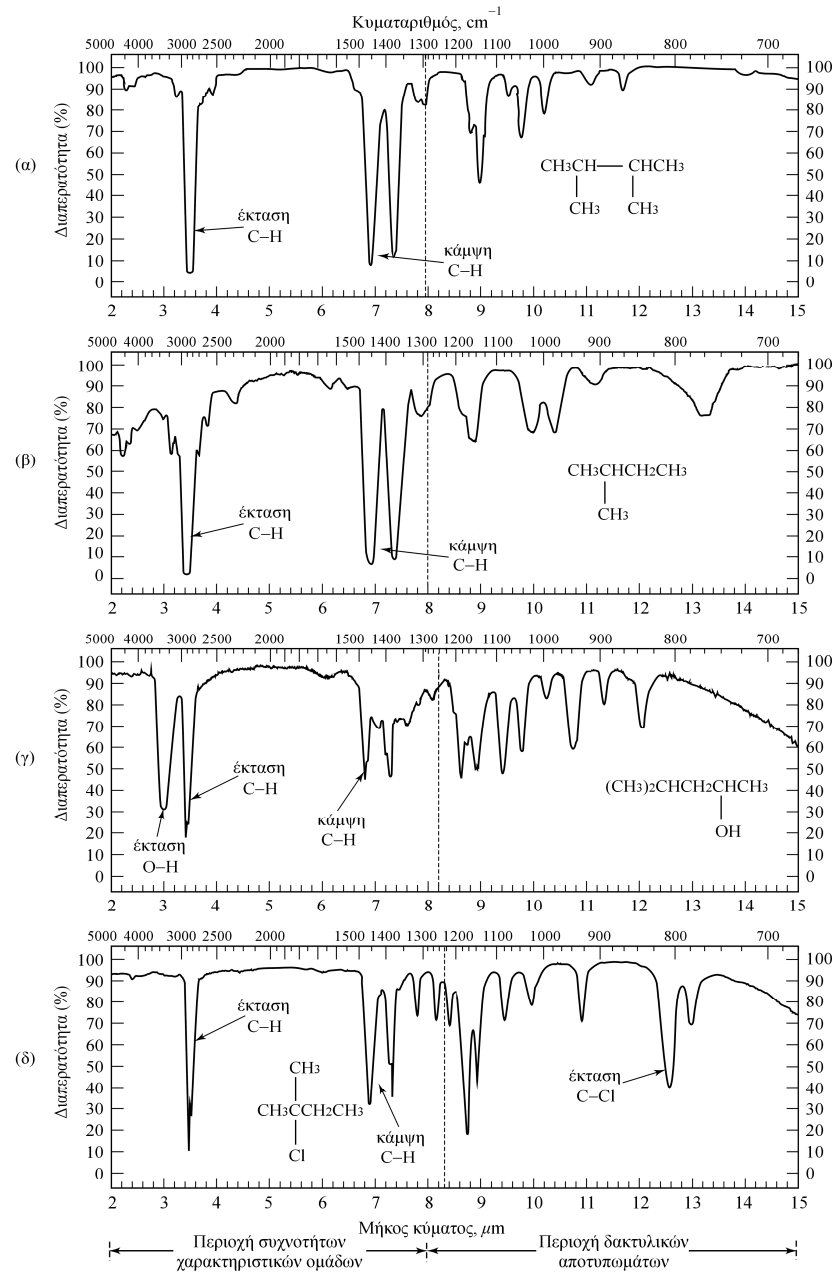
†1992–1993 OSHA exposure limits for 8-hr weighted average.

‡For 20.25-m cell.

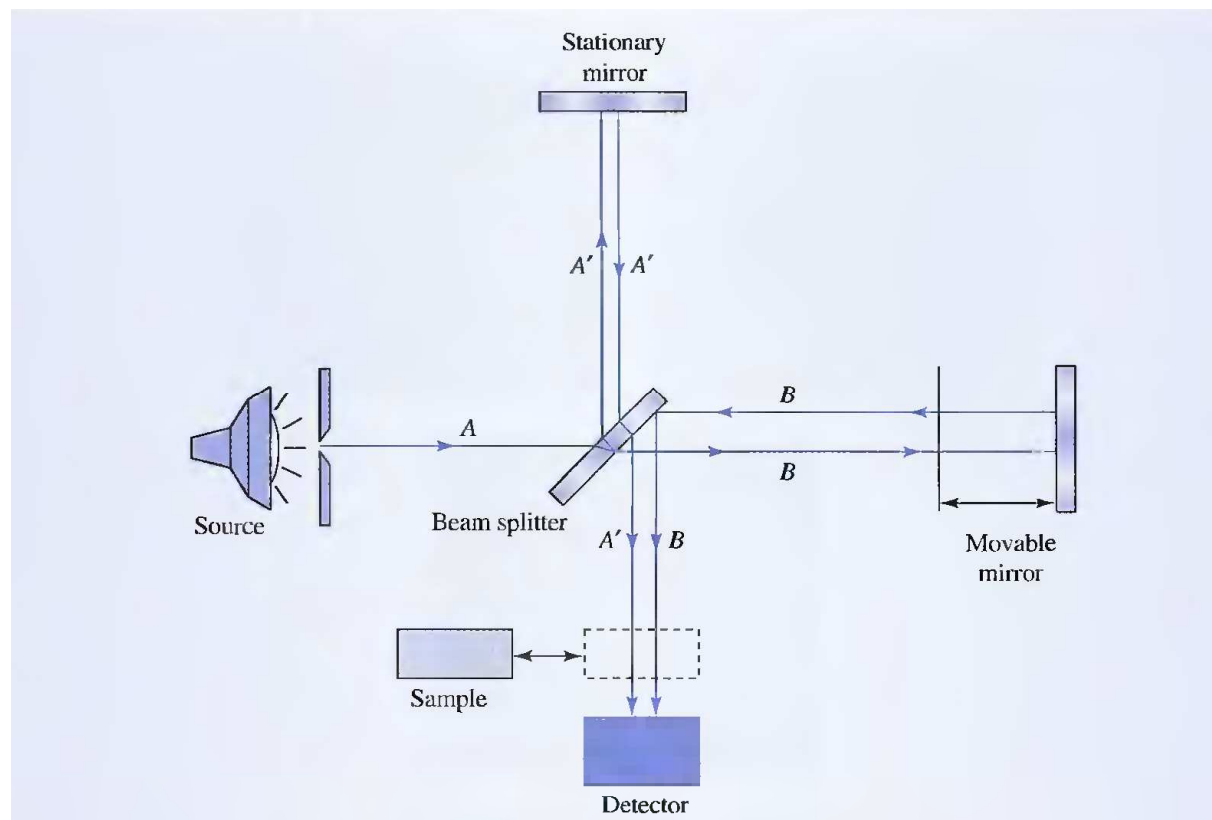
§Short-term exposure limit: 15-min time-weighted average that shall not be exceeded at any time during the work day.

# Φασματοσκοπία Υπερύθρου, IR





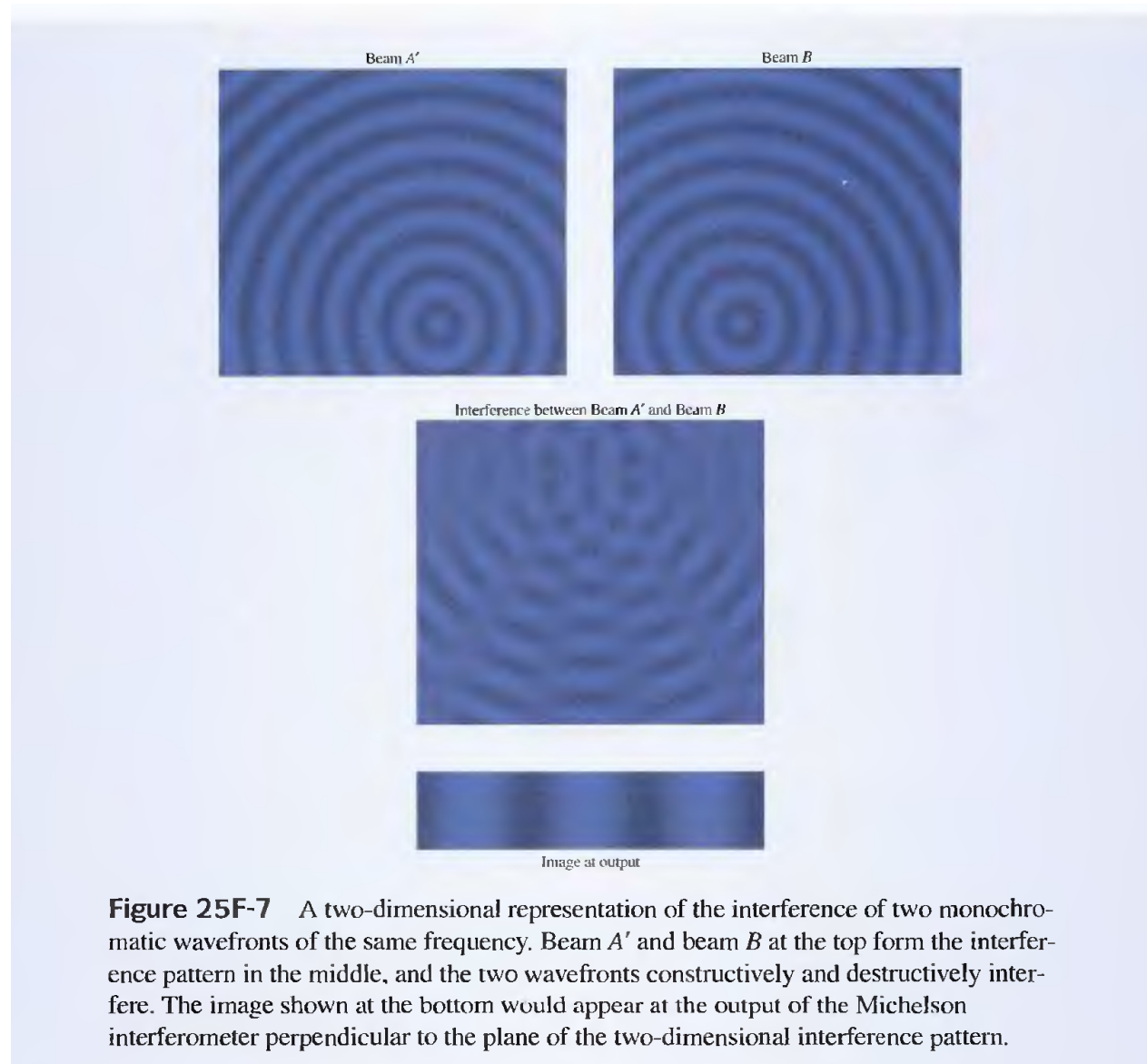
# Michelson interferometer



**Figure 25F-6** Diagram of a Michelson interferometer. A beam from the light source at left is split into two beams by the beam splitter. The two beams travel two separate paths and converge on the detector. The two beams  $A'$  and  $B$  converge in the same region of space and form an interference pattern. As the movable mirror on the right is moved, the interference pattern shifts across the detector and modulates the optical signal. The resulting reference interferogram is recorded and used as a measure of the power of the incident beam at all wavelengths. An absorbing sample is then inserted into the beam, and a sample interferogram is recorded. The two interferograms are used to compute the absorption spectrum of the sample.

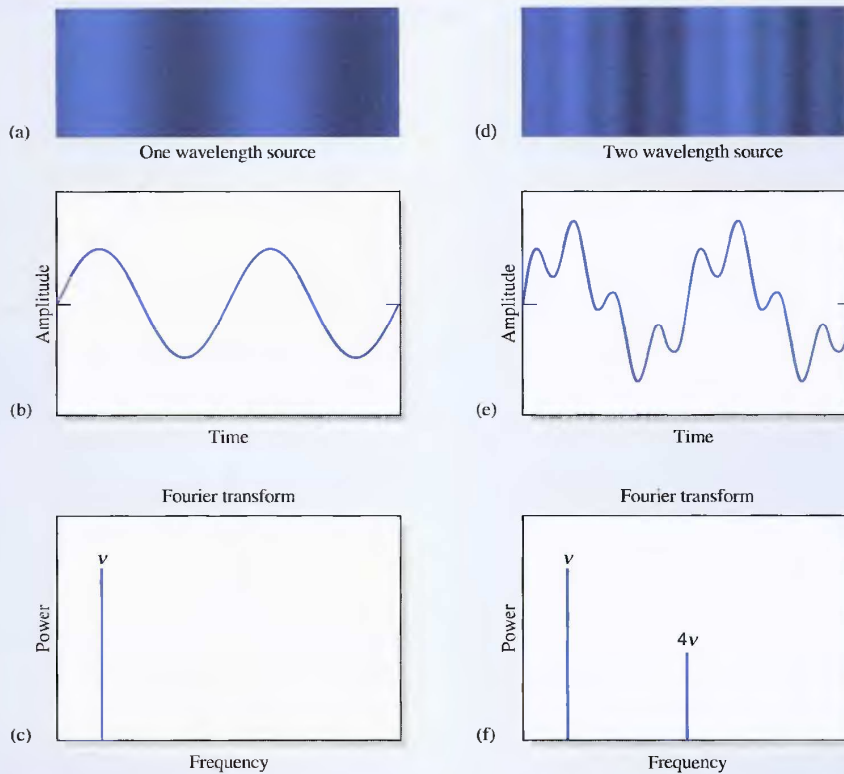


# Φασματοσκοπία Υπερύθρου, IR

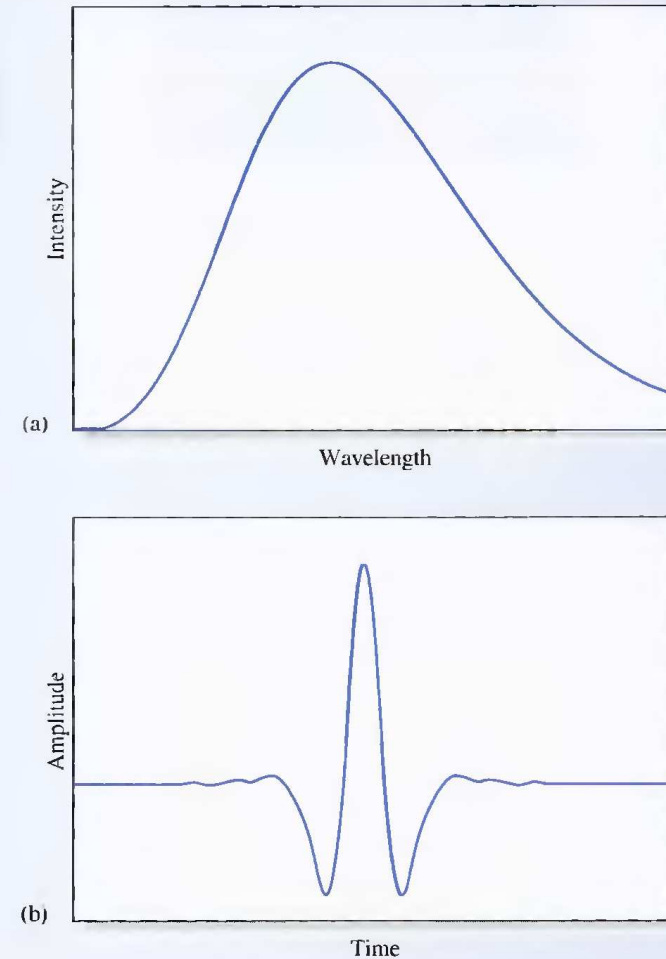


**Figure 25F-7** A two-dimensional representation of the interference of two monochromatic wavefronts of the same frequency. Beam  $A'$  and beam  $B$  at the top form the interference pattern in the middle, and the two wavefronts constructively and destructively interfere. The image shown at the bottom would appear at the output of the Michelson interferometer perpendicular to the plane of the two-dimensional interference pattern.

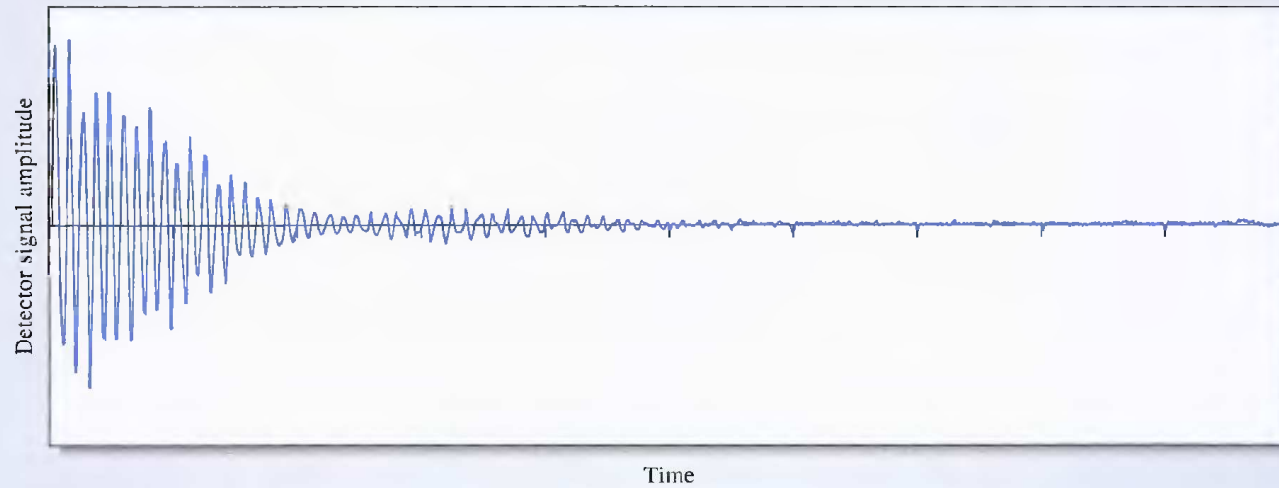
# Φασματοσκοπία Υπερύθρου, IR



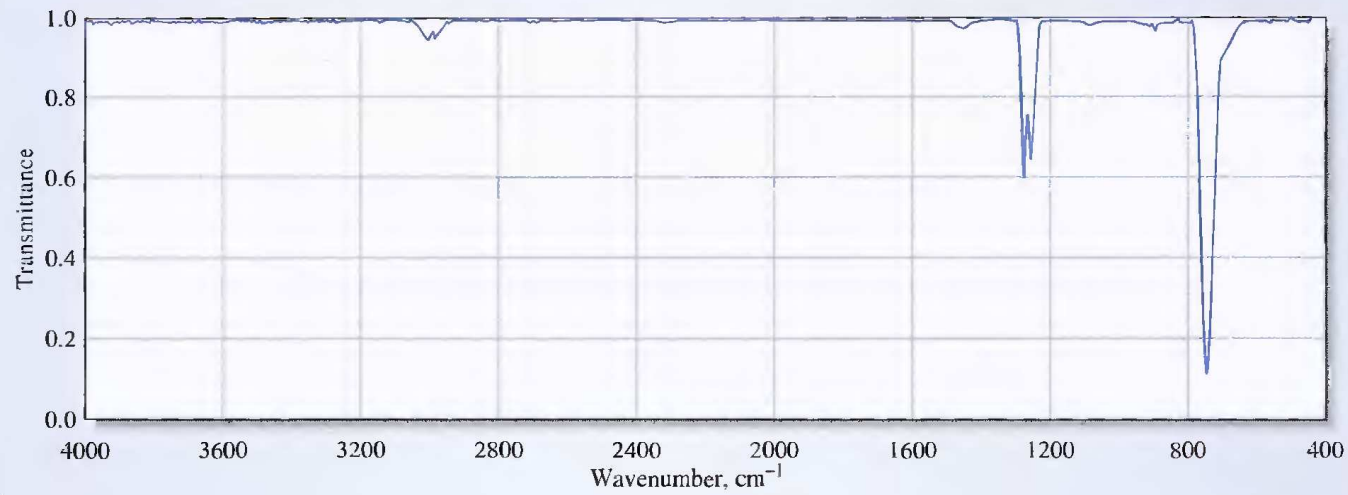
**Figure 25F-8** Formation of interferograms at the output of the Michelson interferometer. (a) Interference pattern at the output of the interferometer resulting from a monochromatic source. (b) Sinusoidally varying signal produced at the detector by the pattern in (a). (c) Frequency spectrum of the monochromatic light source resulting from the Fourier transformation of the signal in (b). (d) Interference pattern at the output of the interferometer resulting from a two-color source. (e) Complex signal produced by the interference pattern of (d) as it falls on the detector. (f) Frequency spectrum of the two-color source.



# Φασματοσκοπία Υπερύθρου, IR

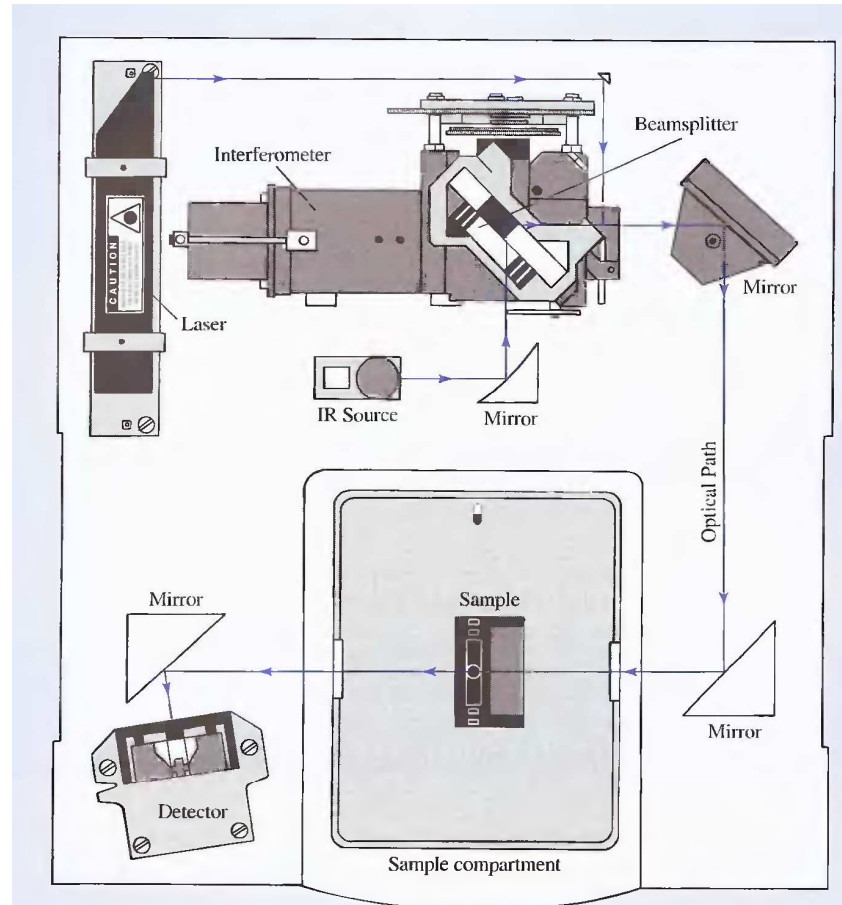


(a)



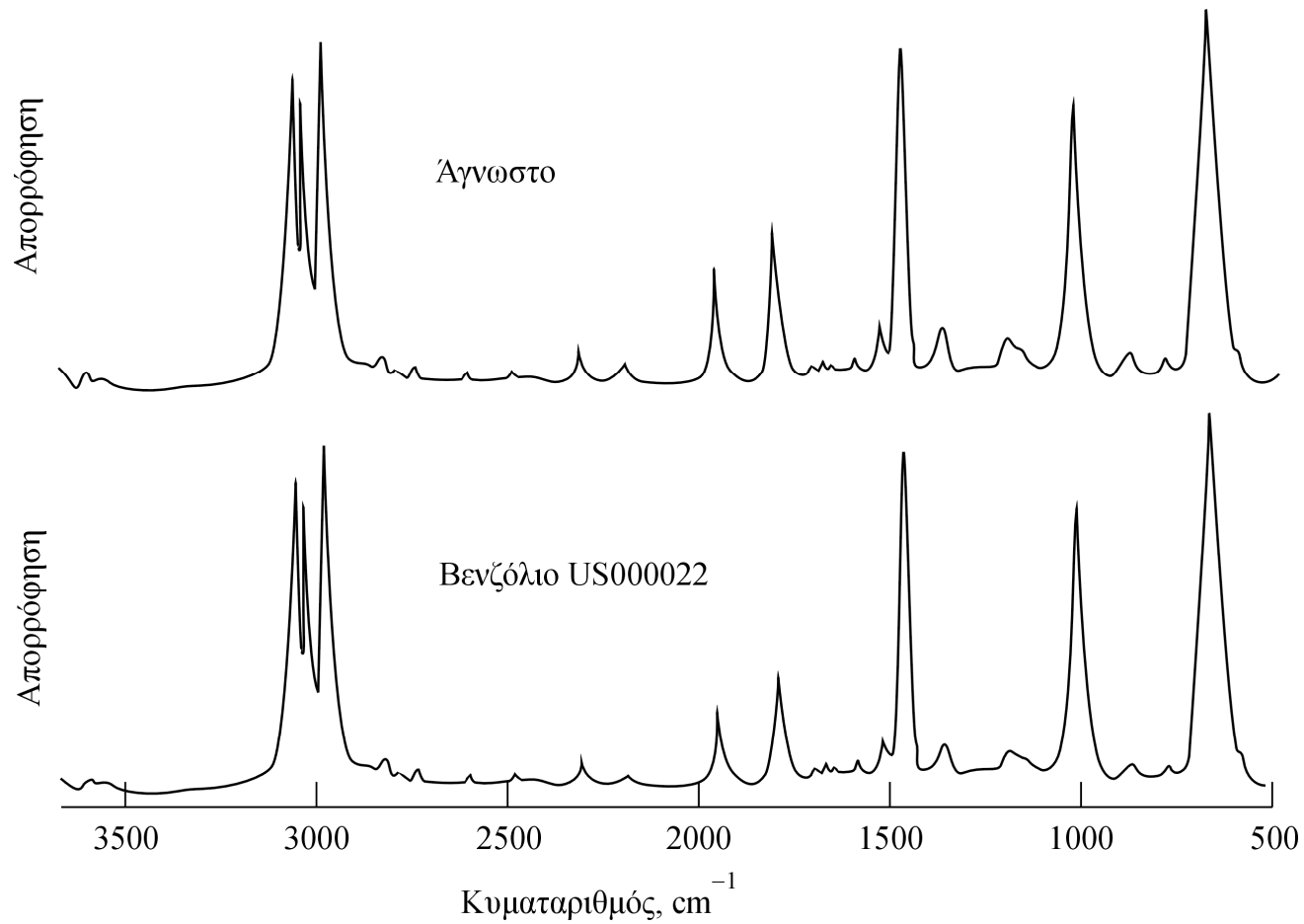
(b)

# Michelson interferometer

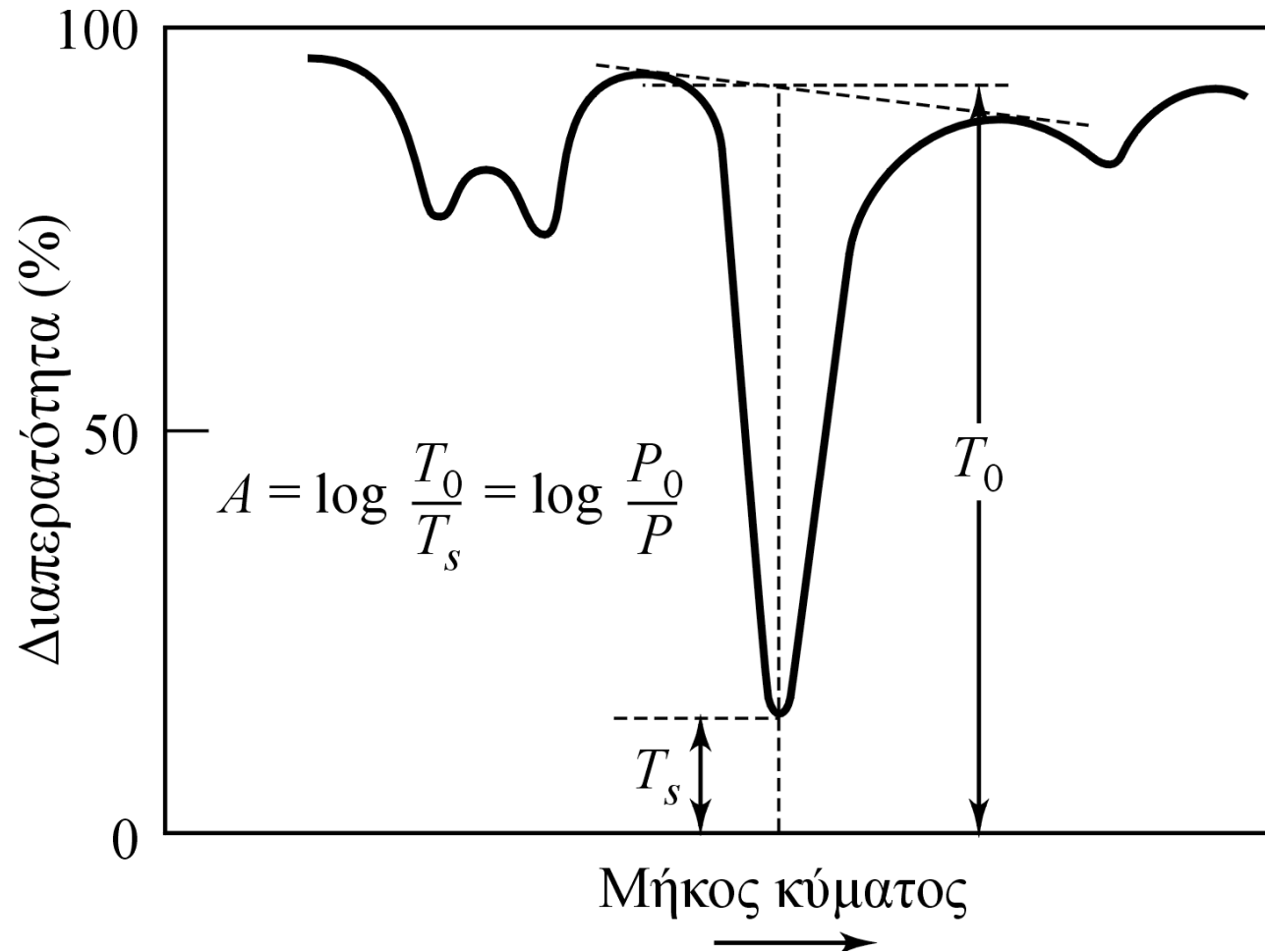


**Figure 26-F1** Instrument diagram for a basic FTIR spectrometer. Radiation of all frequencies from the IR source is reflected into the interferometer where it is modulated by the moving mirror on the left. The modulated radiation is then reflected from the two mirrors on the right through the sample in the compartment at the bottom. After passing through the sample, the radiation falls on the detector. A data acquisition system attached to the detector records the signal and stores it in the memory of a computer as an interferogram. (Courtesy of Thermo Electron Corp., Madison, WI. With permission).

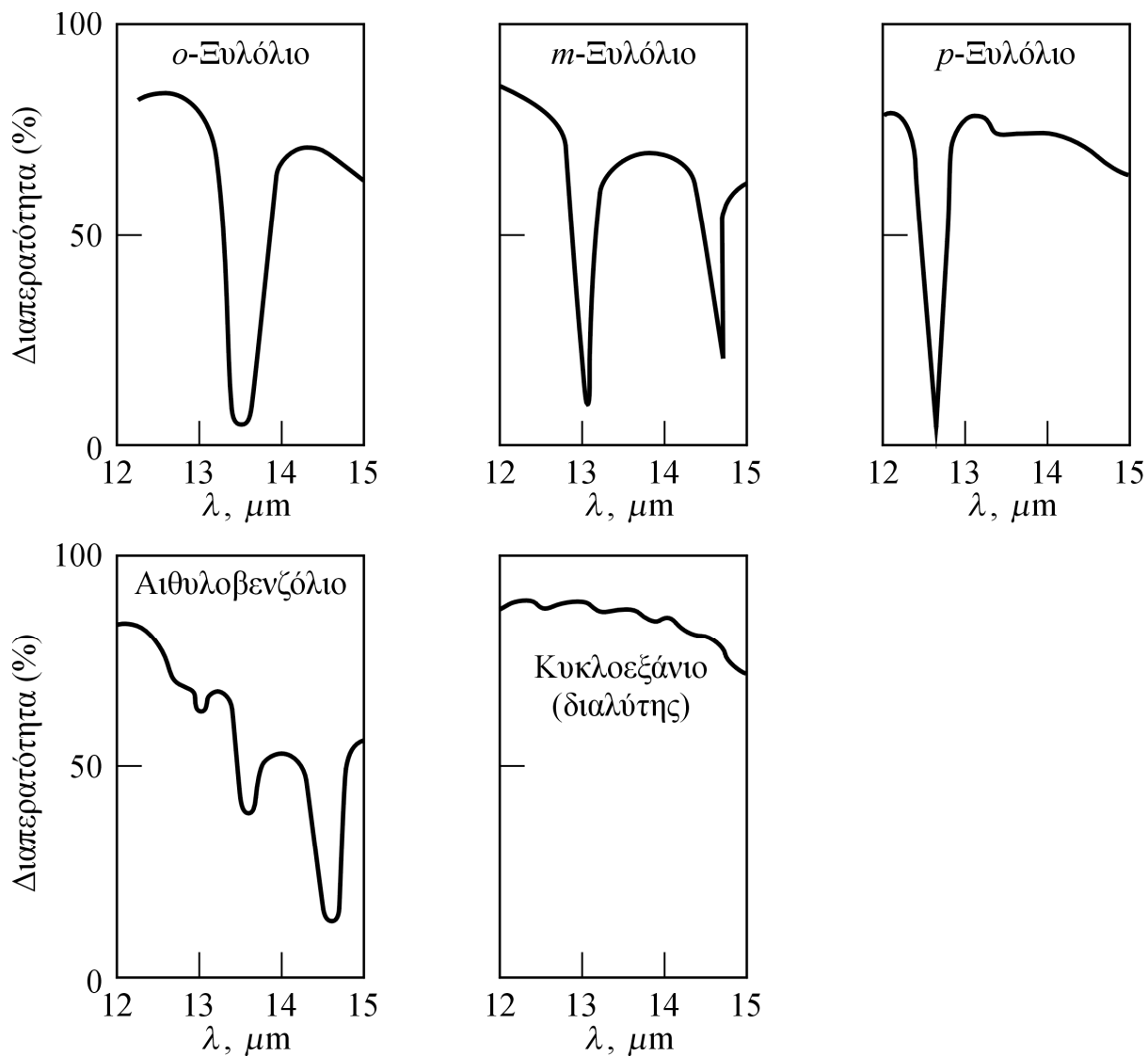
# Ποσοτική φασματοσκοπία IR



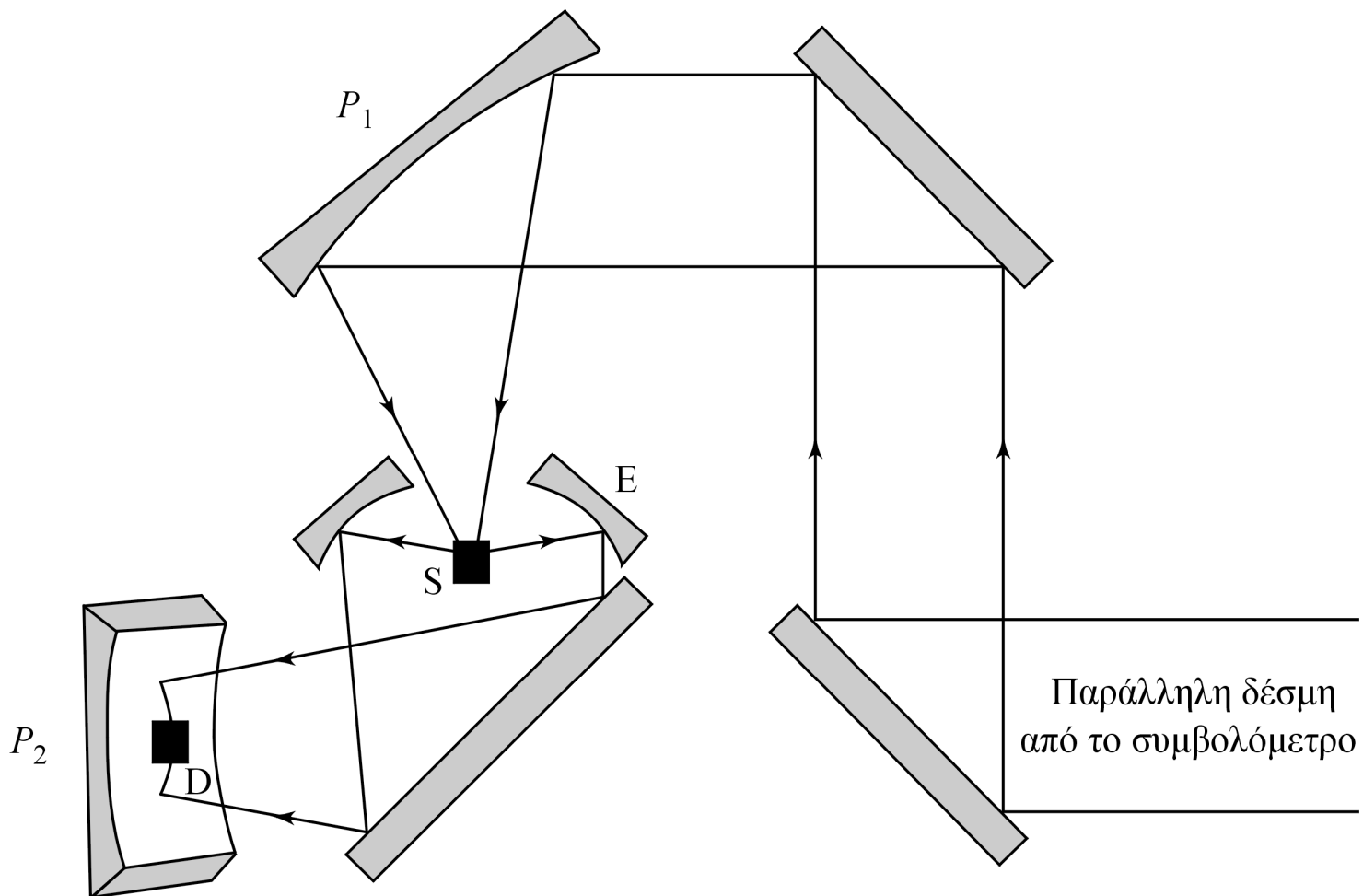
# Γραμμή βάσης (baseline)



# Φάσματα IR ισομερών αρωματικών υδρογονανθράκων

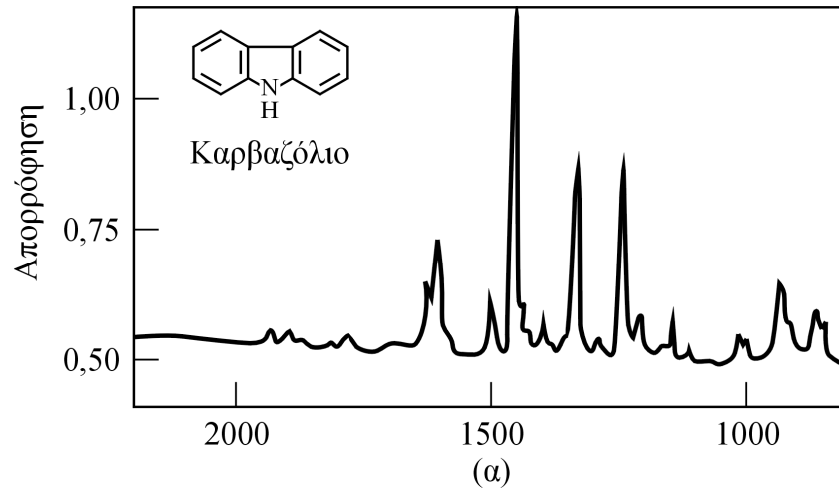


# Φασματοσκοπία IR διάχυτης ανάκλασης

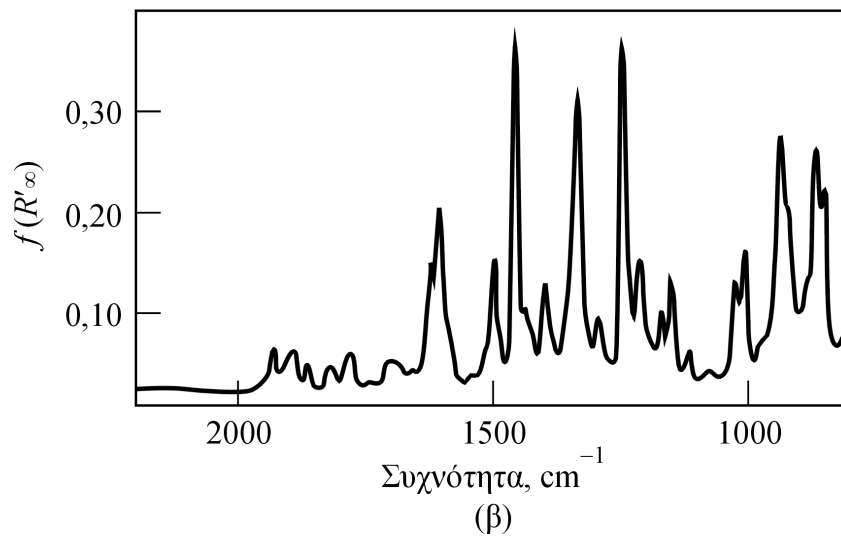




# Φασματοσκοπία Υπερύθρου, IR

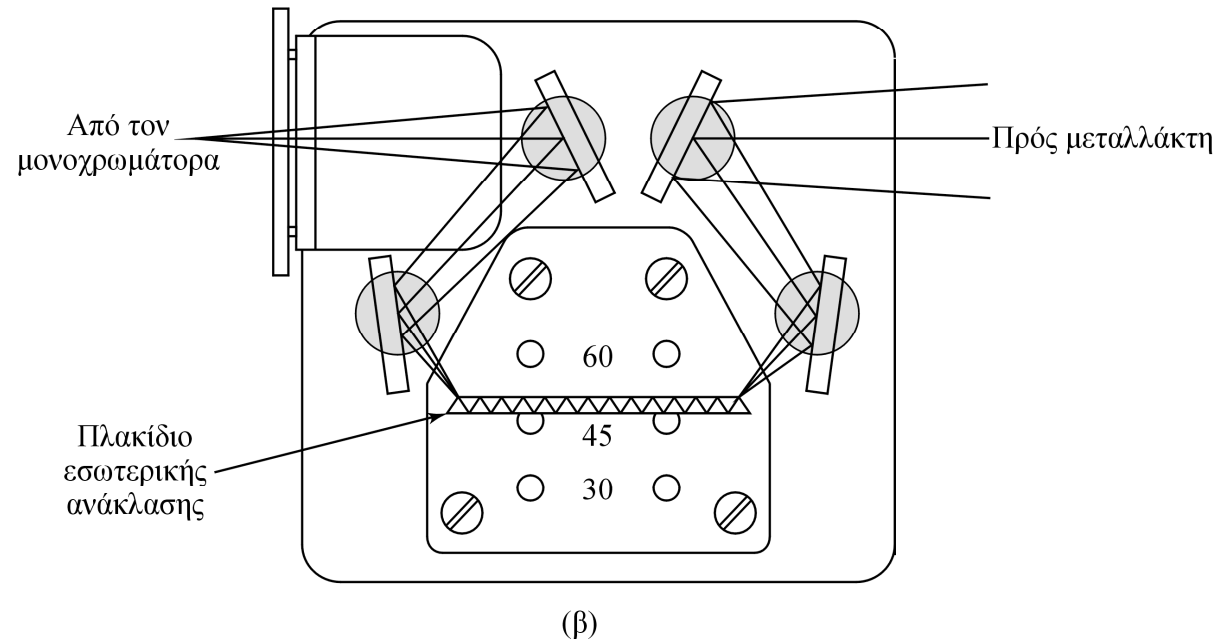
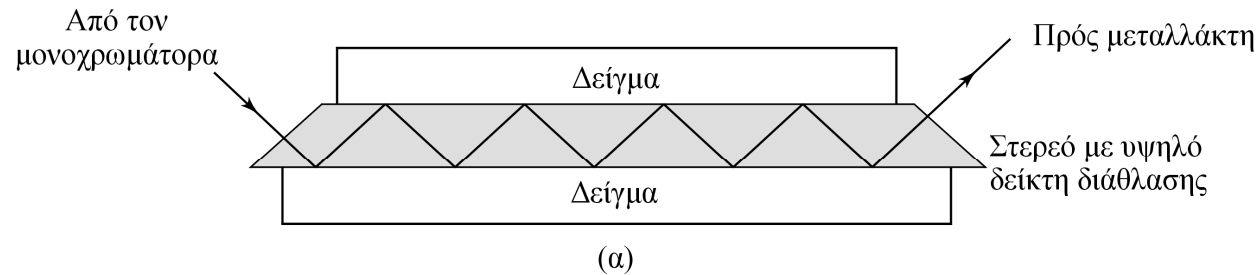


Φάσμα απορρόφησης



Φάσμα διάχυτης ανάκλασης

# Φασματοσκοπία υπερύθρου ATR, εξασθενημένης ολικής ανάκλασης



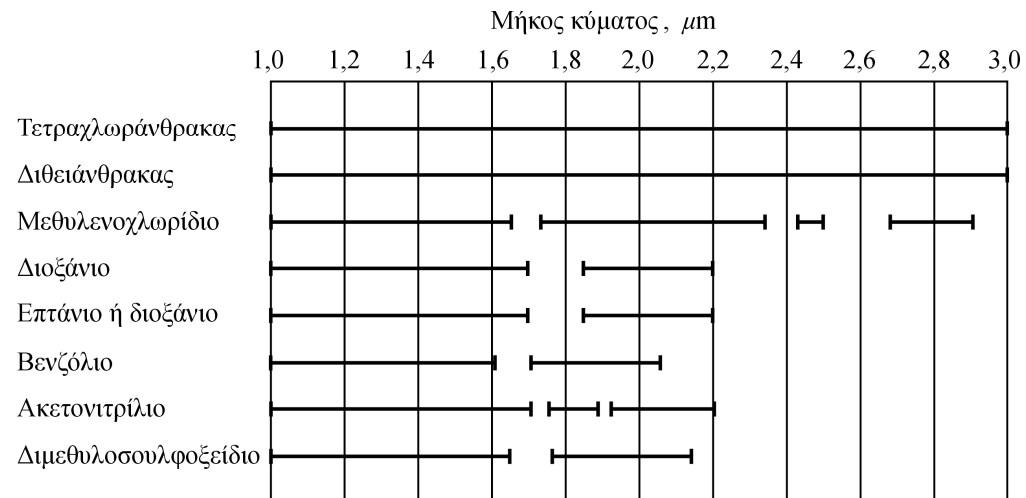
Δύσκολα δείγματα: ίνες, πλαστικά, υφάσματα, πάστες, σκόνες, κλπ.

# Φασματοσκοπία εγγύς υπερύθρου, near-IR

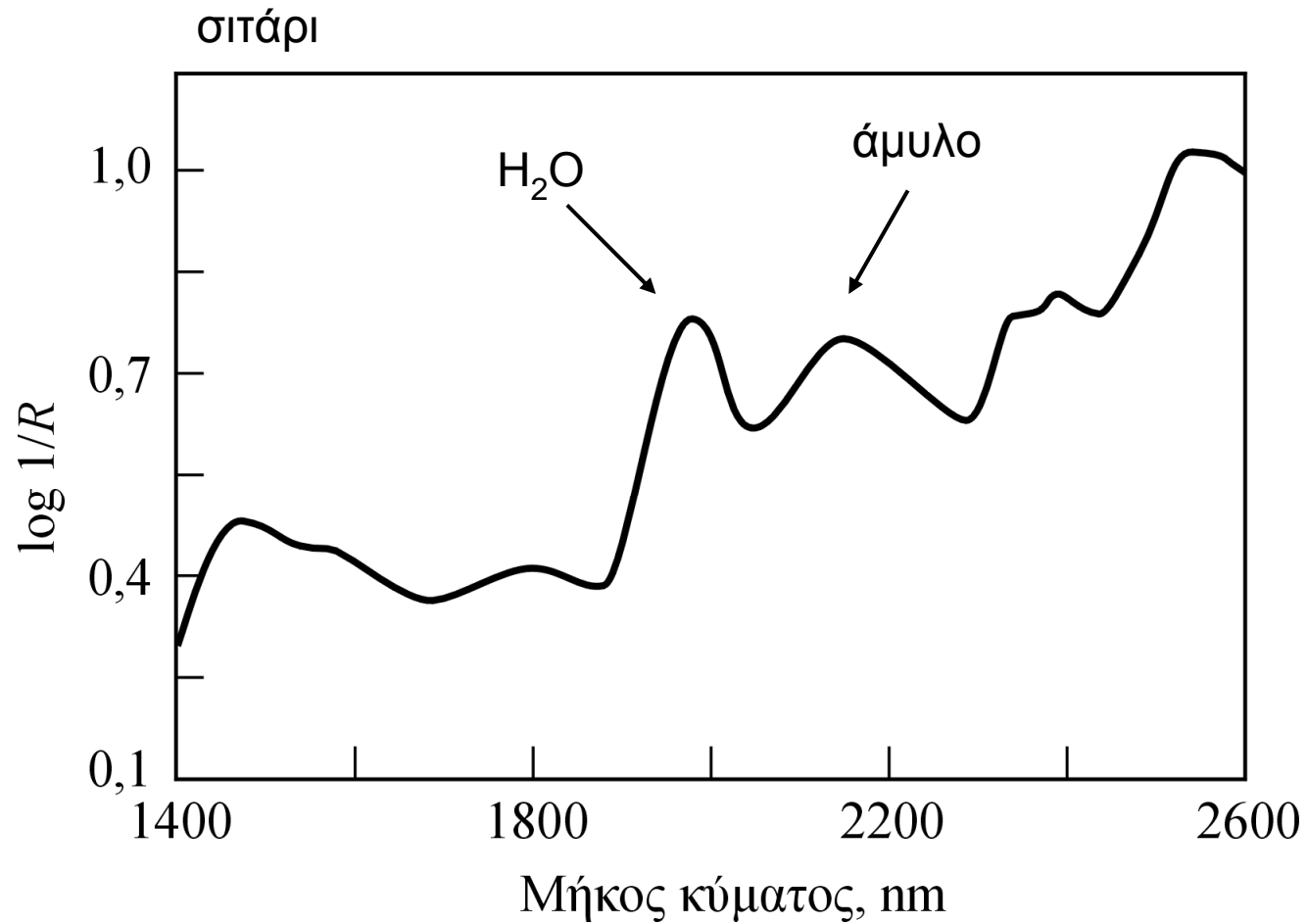
13.000 -4.000  $\text{cm}^{-1}$  : Υπέρτονες ή ταινίες συνδυασμού

C-H, O-H, N-H

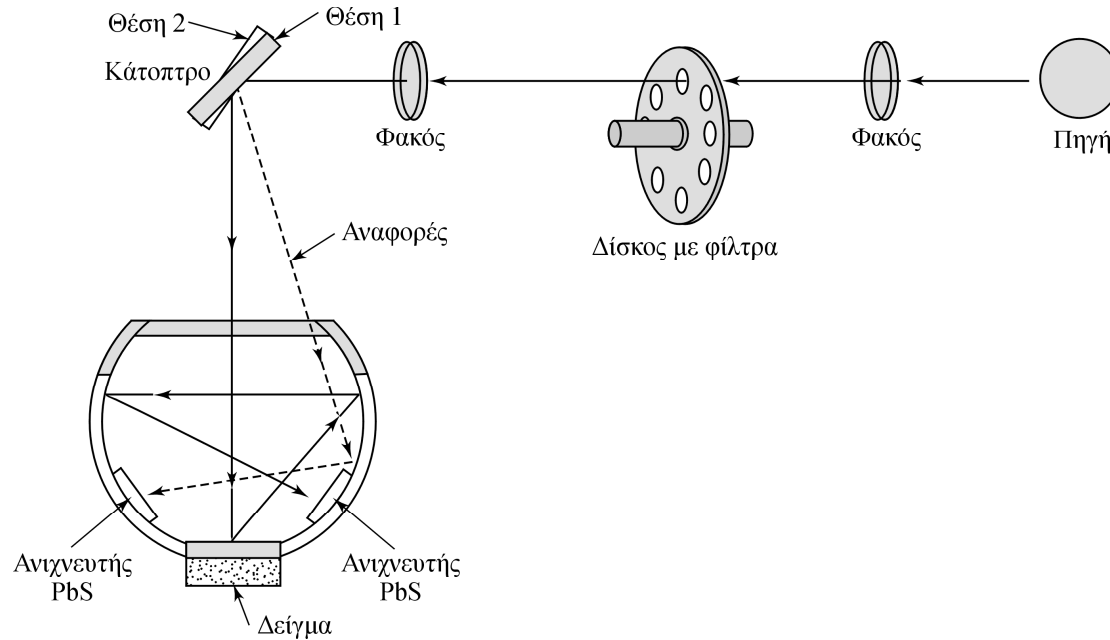
Ποσοτικοί προσδιορισμοί ρουτίνας λιπών, ελαίων, νερού, και πρωτεϊνών στη βιομηχανία τροφίμων και χημικών.



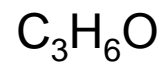
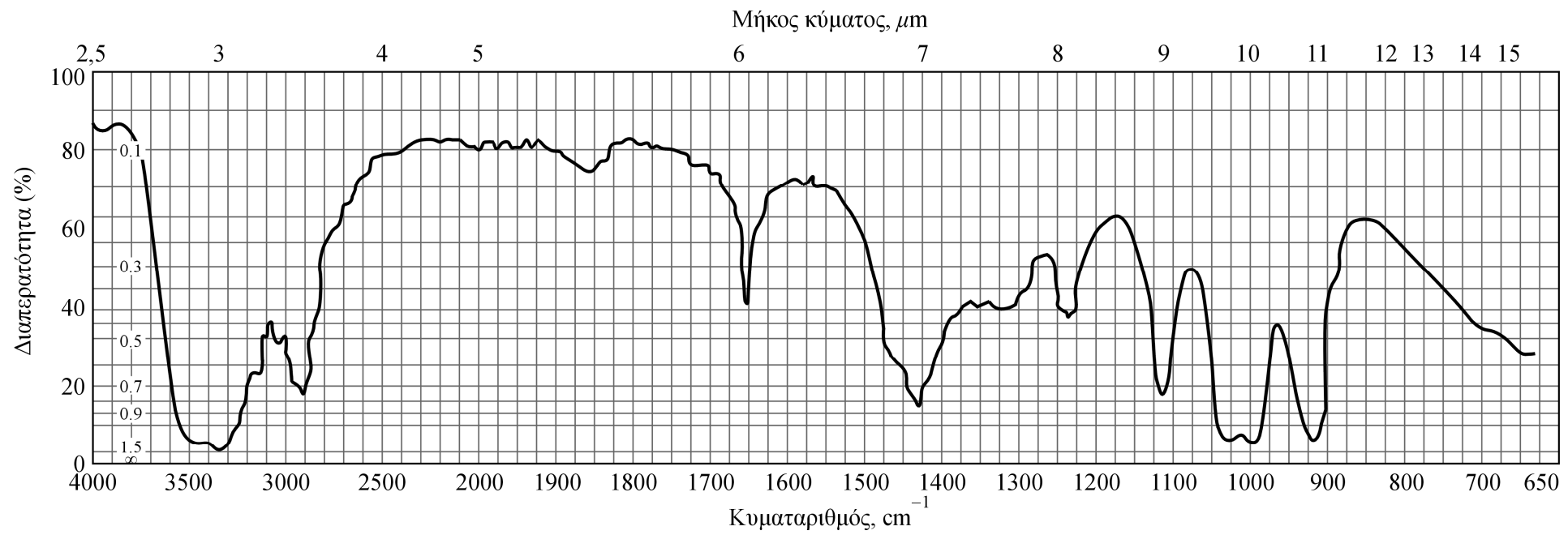
# Φασματοσκοπία εγγύς υπερύθρου



# Φασματοσκοπία εγγύς υπερύθρου, near-IR



Απαιτούνται πολλά πρότυπα δείγματα με διαφορετικές συγκεντρώσεις του αναλύτη



ΠΙΝΑΚΑΣ 17-2 Σύντομος πίνακας συχνοτήτων οργανικών χαρακτηριστικών ομάδων

Δεσμός	Είδος ένωσης	Εύρος συχνοτήτων, cm <sup>-1</sup>	Ένταση
C-H	Αλκάνια	2850-2970	Ισχυρή
		1340-1470	Ισχυρή
C-H	Αλκένια $\left( \begin{array}{c} \diagup \\ \text{C} = \text{C} \begin{array}{l} \diagdown \\ \text{H} \end{array} \end{array} \right)$	3010-3095	Μέτρια
		675-995	Ισχυρή
C-H	Αλκίνια (-C≡C-H)	3300	Ισχυρή
C-H	Αρωματικοί δακτύλιοι	3010-3100	Μέτρια
		690-900	Ισχυρή
O-H	Μονομερείς αλκοόλες, φαινόλες	3590-3650	Κυμαινόμενη
	Αλκοόλες, φαινόλες με δεσμούς υδρογόνου	3200-3600	Κυμαινόμενη, μερικές φορές πλατιά
	Μονομερή καρβοξυλικά οξέα	3500-3650	Μέτρια
	Καρβοξυλικά οξέα με δεσμούς υδρογόνου	2500-2700	Πλατιά
N-H	Αμίνες, αμίδια	3300-3500	Μέτρια
C=C	Αλκένια	1610-1680	Κυμαινόμενη
C=C	Αρωματικοί δακτύλιοι	1500-1600	Κυμαινόμενη
C≡C	Αλκίνια	2100-2260	Κυμαινόμενη
C-N	Αμίνες, αμίδια	1180-1360	Ισχυρή
C≡N	Νιτρίλια	2210-2280	Ισχυρή
C-O	Αλκοόλες, αιθέρες, καρβοξυλικά οξέα, εστέρες	1050-1300	Ισχυρή
C=O	Αλδεΐδες, κετόνες, καρβοξυλικά οξέα, εστέρες	1690-1760	Ισχυρή
NO <sub>2</sub>	Νιτροενώσεις	1500-1570	Ισχυρή
		1300-1370	Ισχυρή