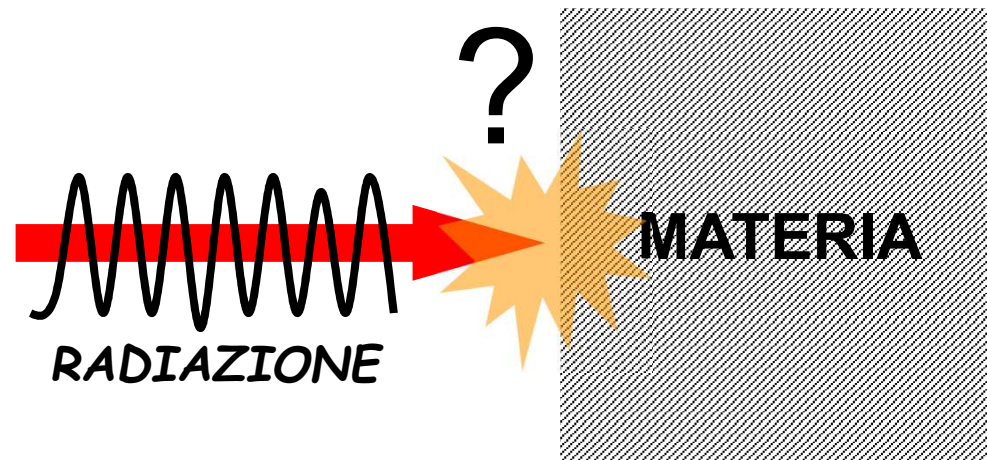


PARTE I

Spettroscopia?

Interazione tra radiazione e materia.



LUCE

La Radiazione Elettromagnetica e le sue proprietà

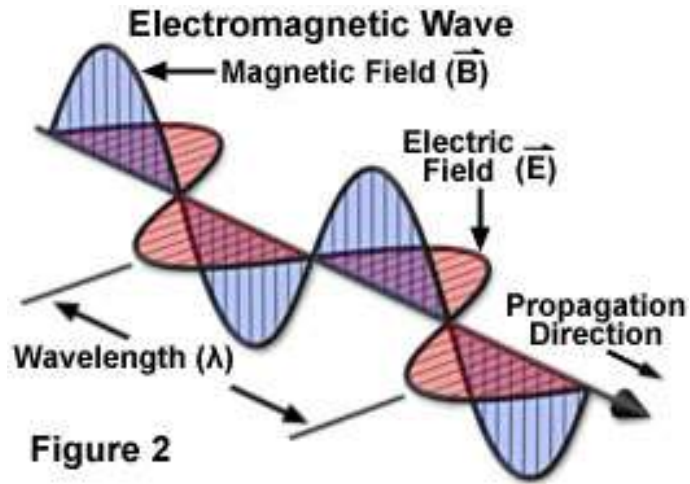
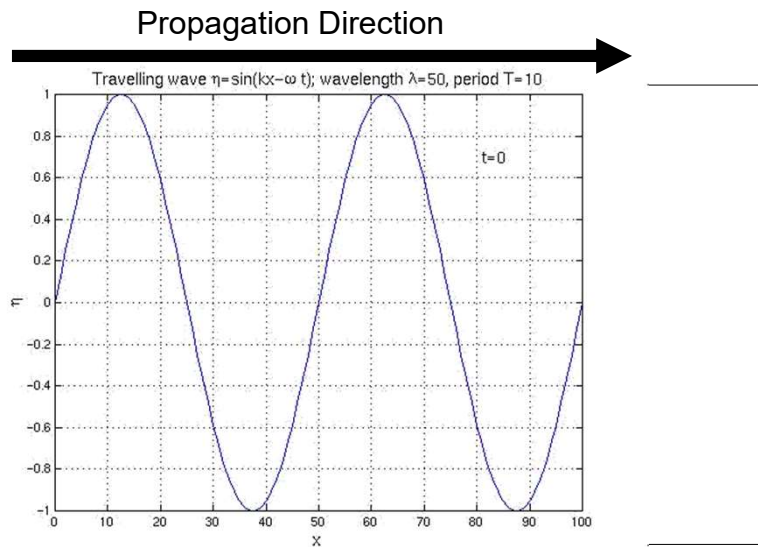
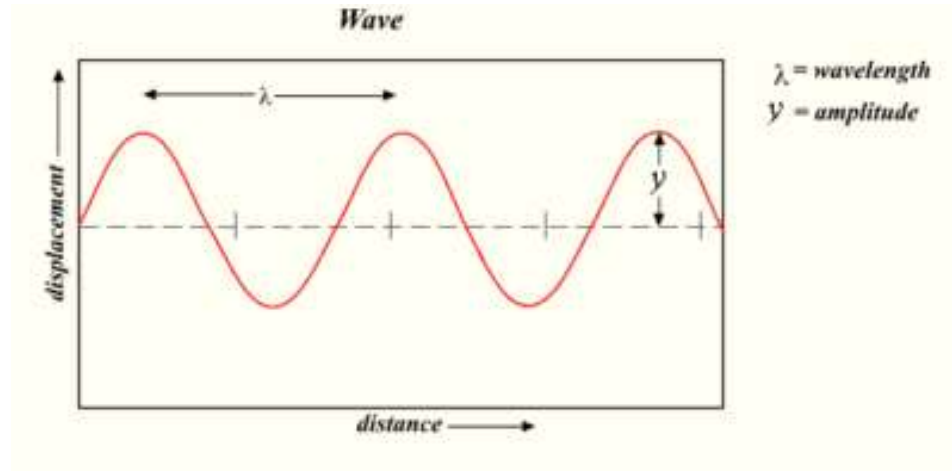


Figure 2



Lunghezza d'onda λ : m, nm (10^{-9} m)

Velocità di propagazione (nel vuoto)

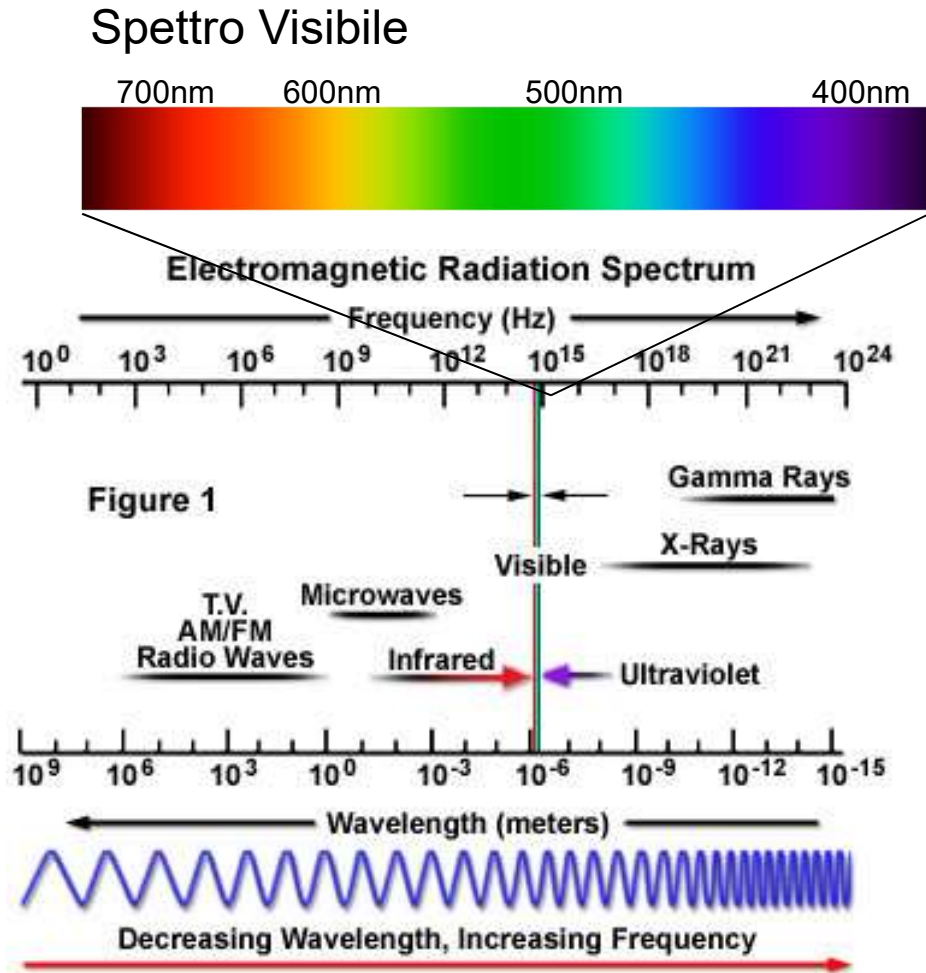
$$c: \sim 3 \times 10^8 \text{ ms}^{-1} \text{ (m/s)}$$

hertz (Hz)

$$\text{Frequenza } \nu = \frac{c}{\lambda} \left(\frac{\frac{m}{s}}{\frac{m}{s}} = \frac{1}{s} = s^{-1} \right)$$

$$\text{Numero d'onda } \tilde{\nu} = \frac{1}{\lambda} \left(\frac{1}{cm} = cm^{-1} \right)$$

La Radiazione Elettromagnetica e le sue proprietà



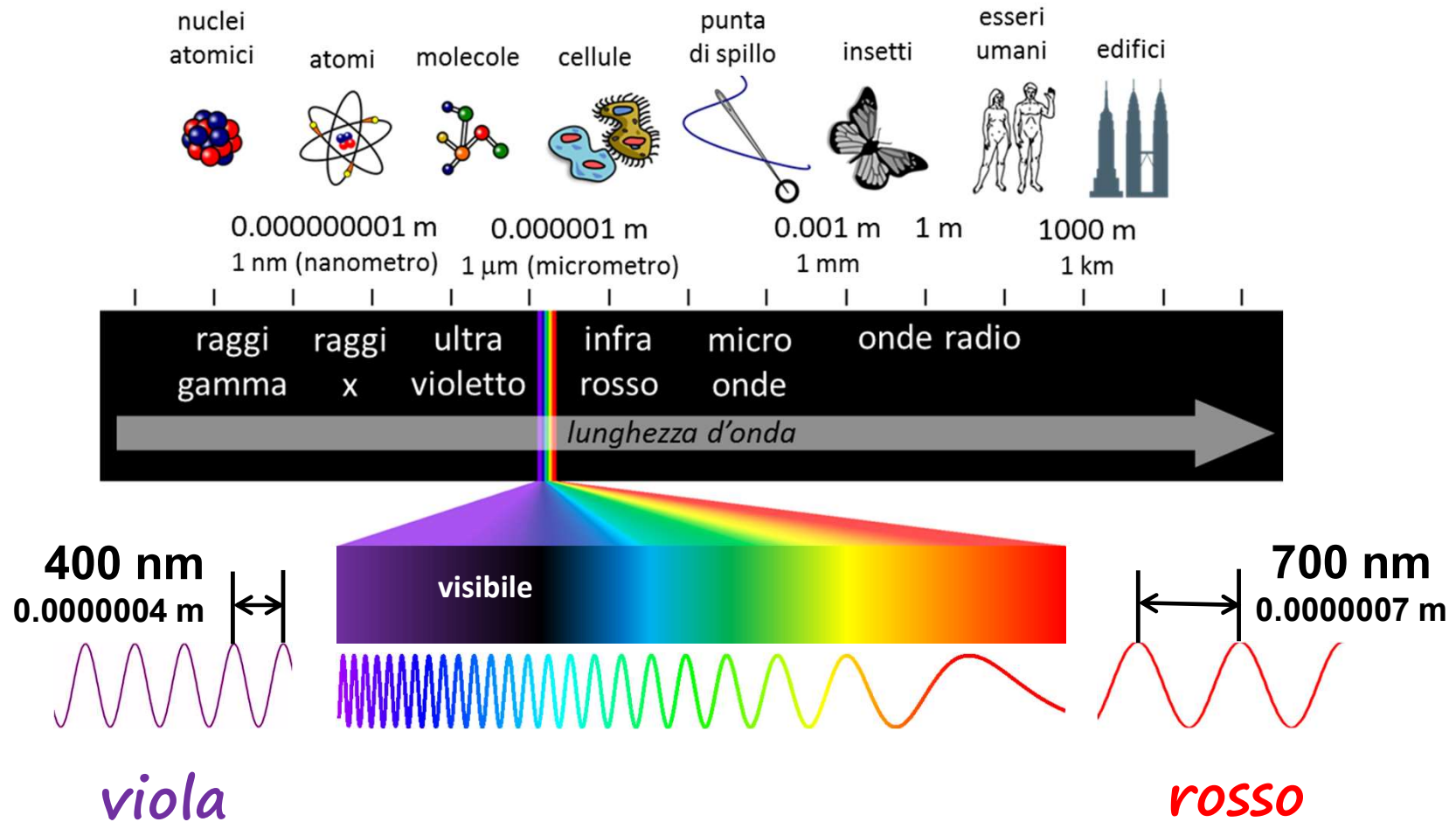
Relazione con l'Energia

$$E = h \nu$$

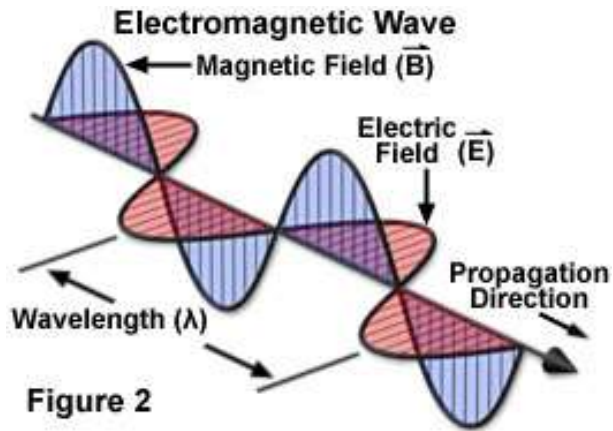
h (costante di Planck) = $6.63 \times 10^{-34} \text{ Js}$

*unità Energia più comuni:
elettonvolt (eV) o Joule (J)*

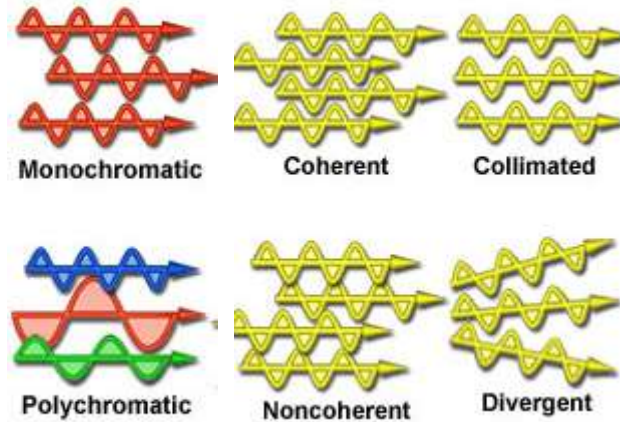
Lo spettro elettromagnetico



La Radiazione Elettromagnetica e le sue proprietà

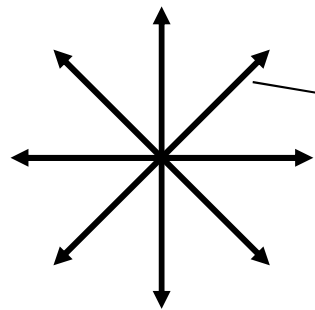


1 onda



n onde

Polarizzazione



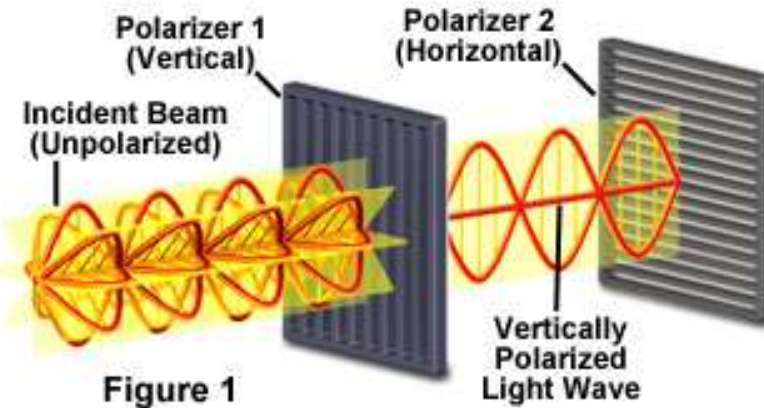
piani in cui vibra il campo elettrico di una radiazione incidente perpendicolarmente allo schermo

radiazione NON polarizzata

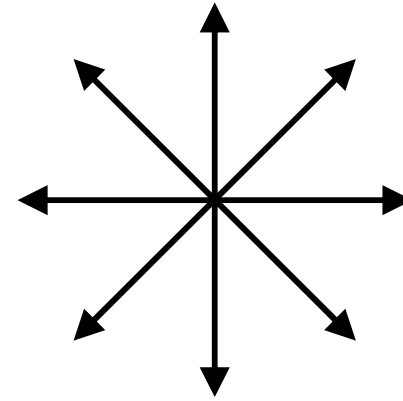
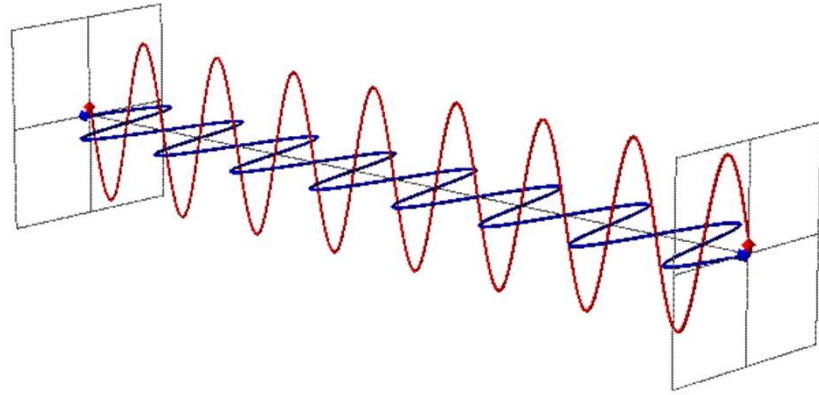


radiazione polarizzata

Polarization of Light Waves

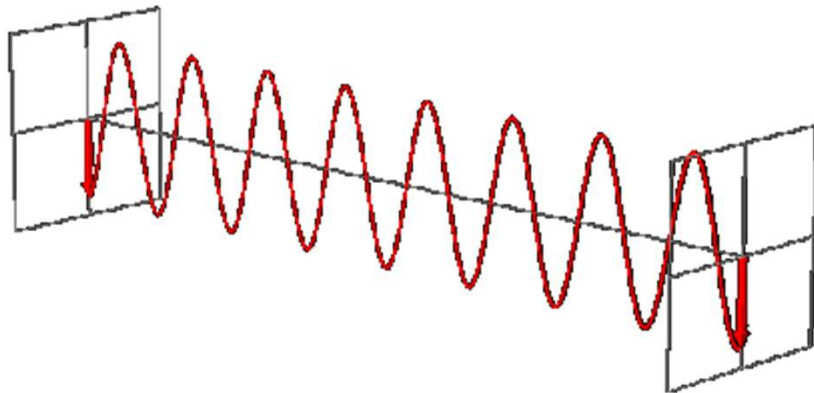


polarizzazione della luce



piani in cui vibra il campo elettrico di una radiazione incidente

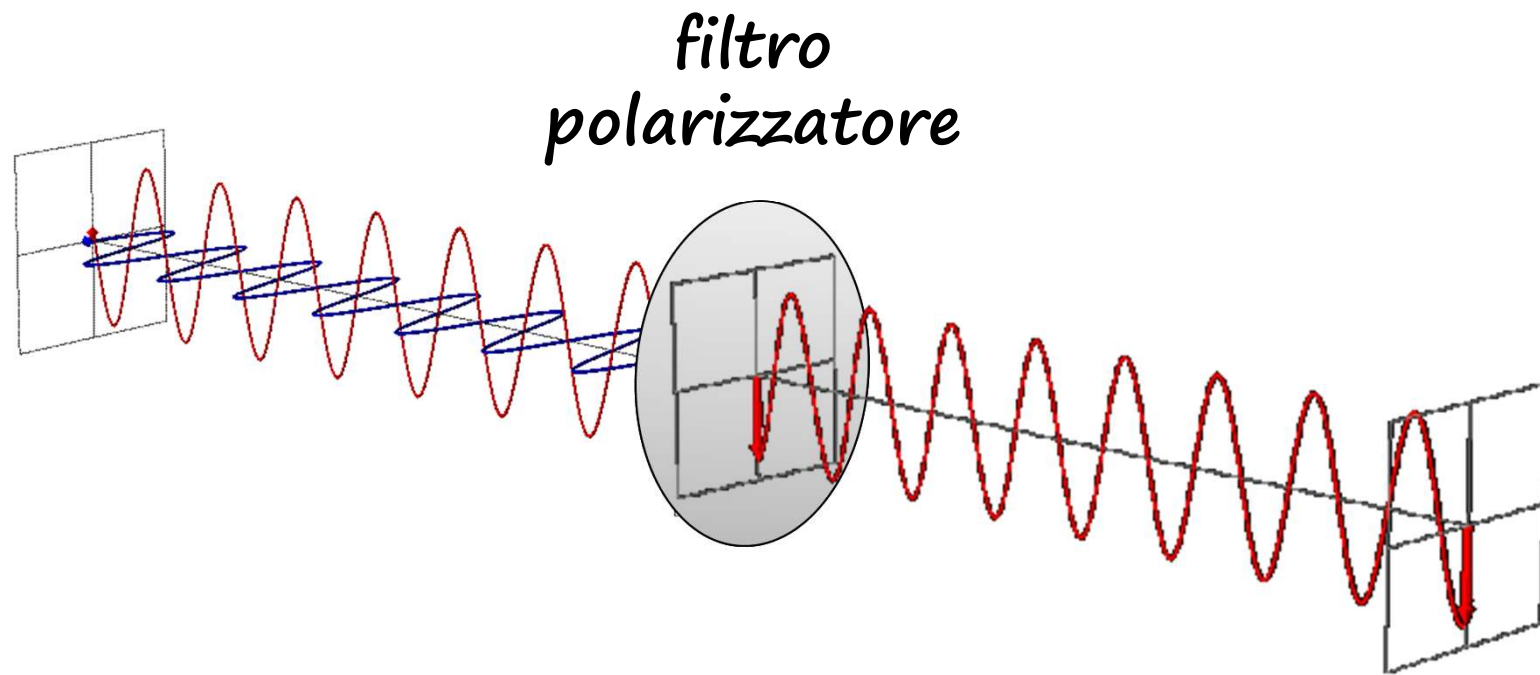
radiazione
NON polarizzata



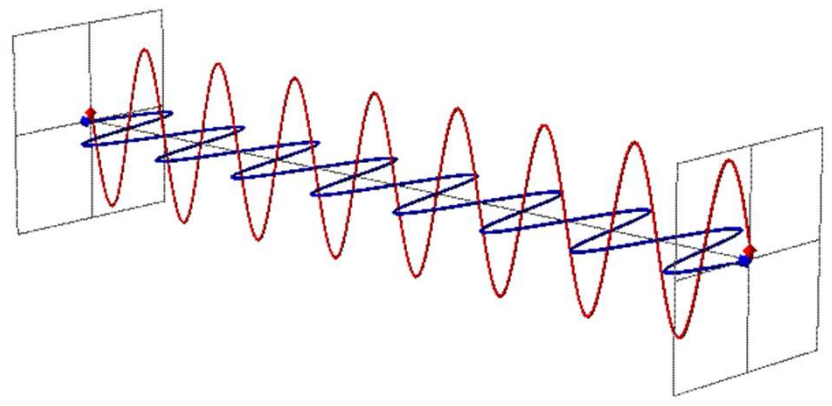
vibra in un solo piano

radiazione
polarizzata

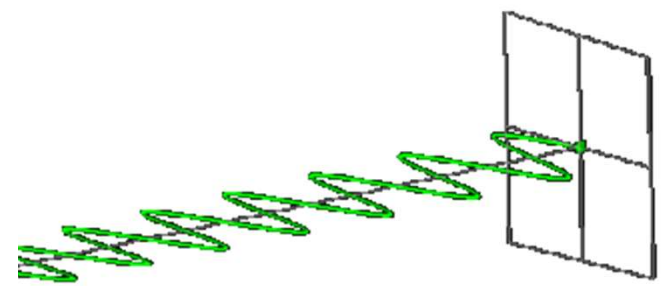
polarizzazione della luce



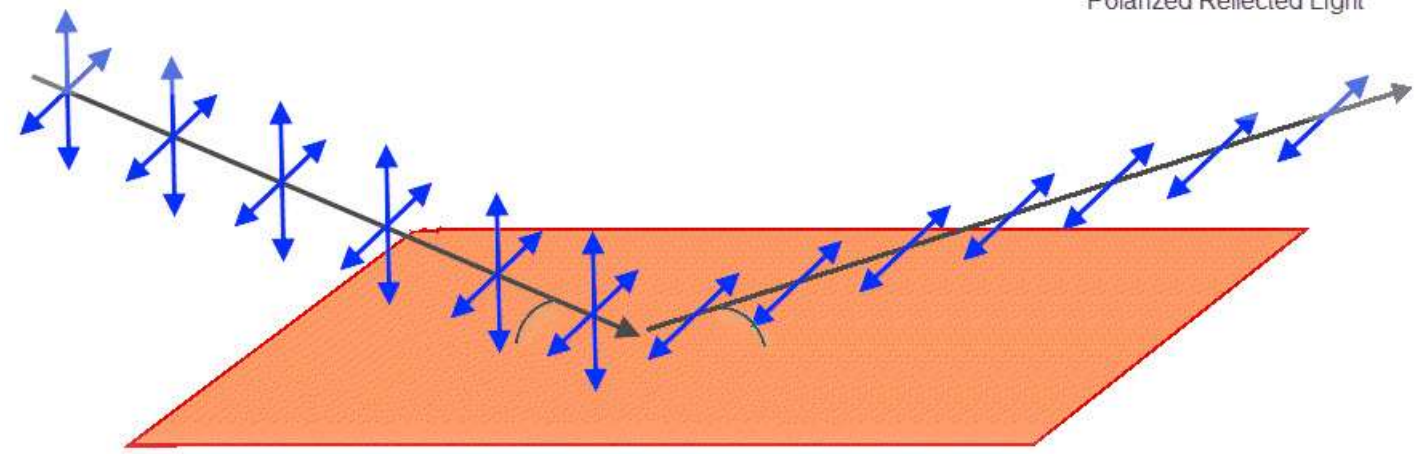
*prima della
riflessione*



*dopo della
riflessione*



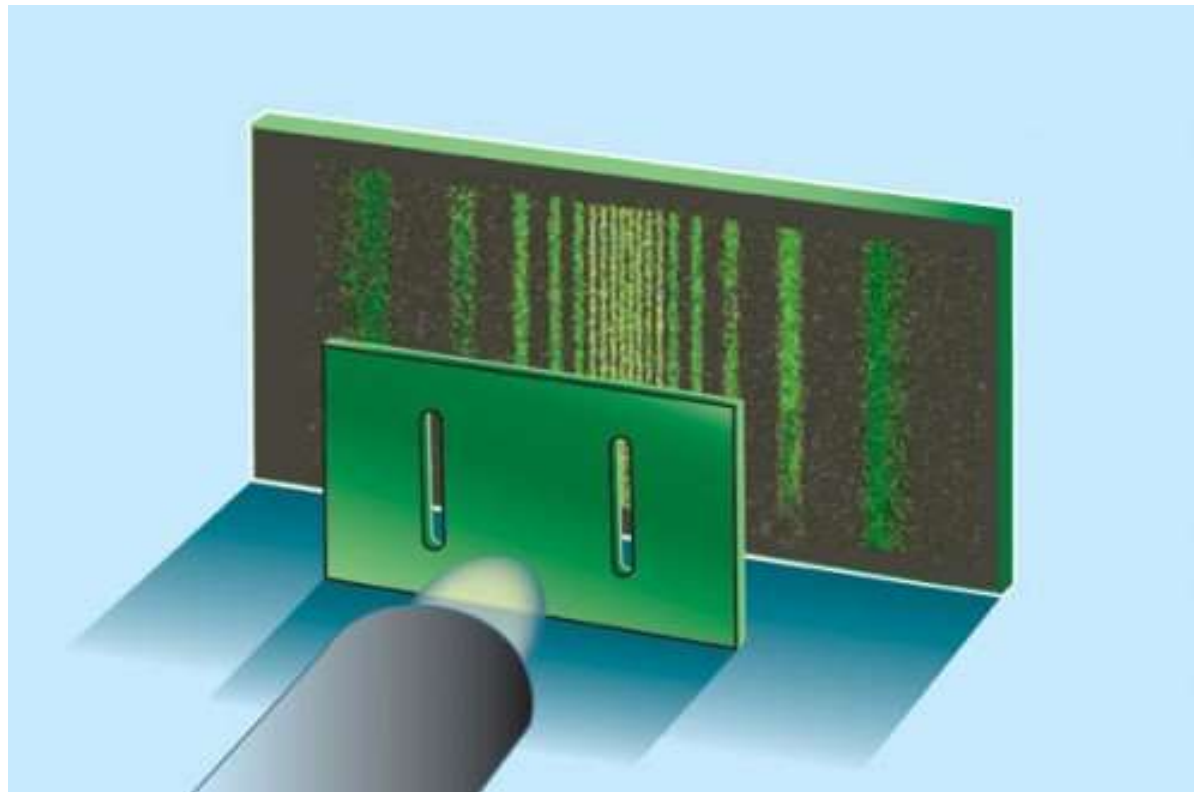
Unpolarized Incident Light



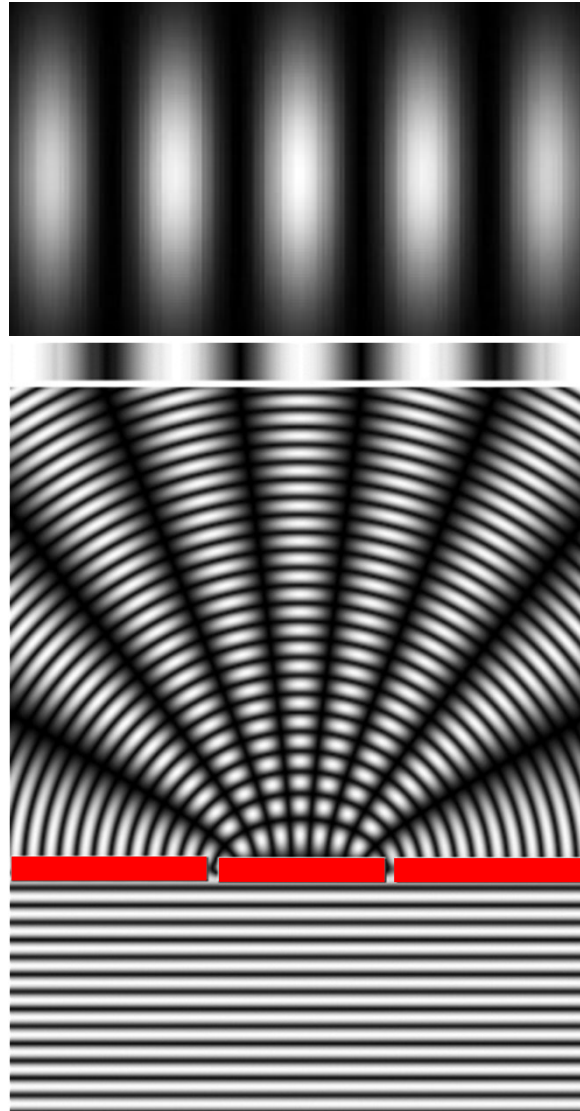
Polarized Reflected Light

Esperimento di Young *(interferenza tra onde)*

Esperimento delle due fenditure

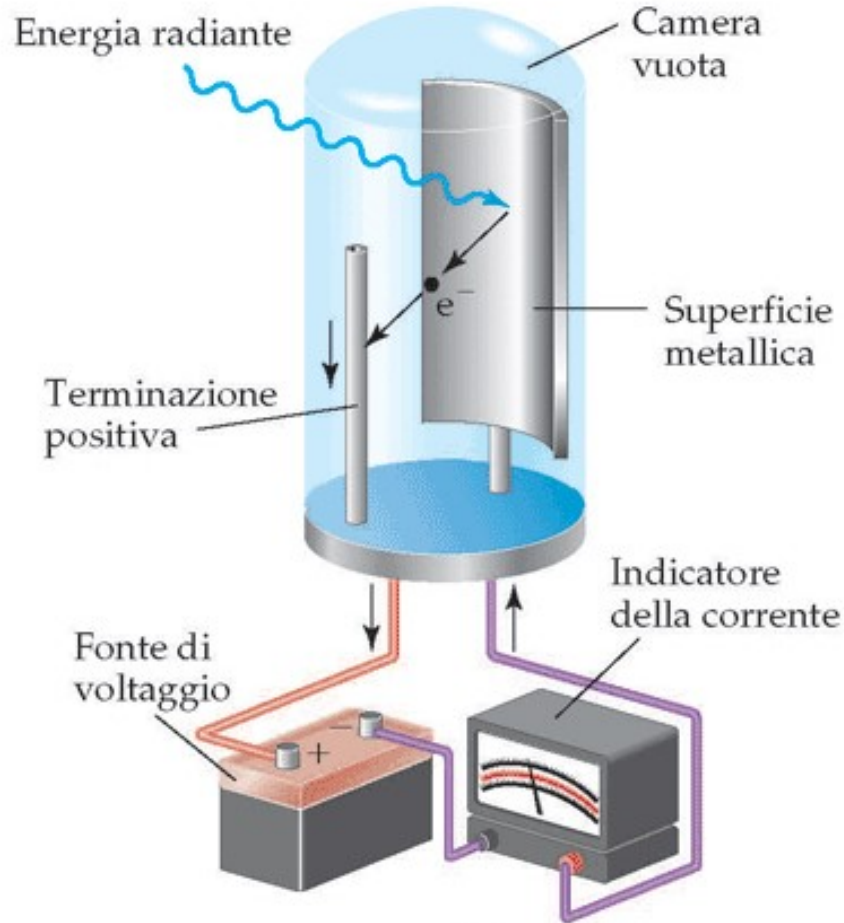


Esperimento di Young *(interferenza tra onde)*

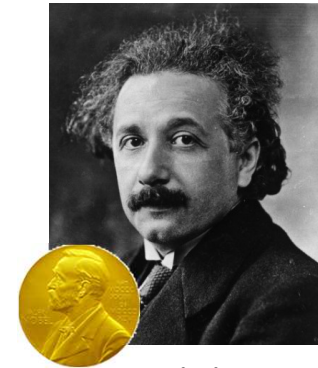


Einstein e l'effetto fotoelettrico

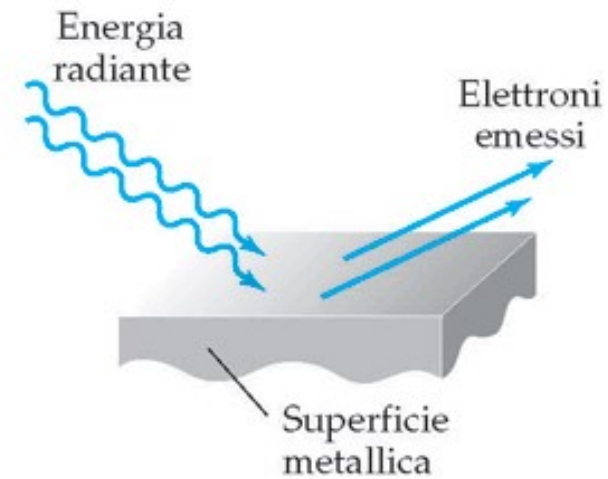
1905



fenomeno
scoperto
da *Hertz*
nel 1887



Fisica 1921

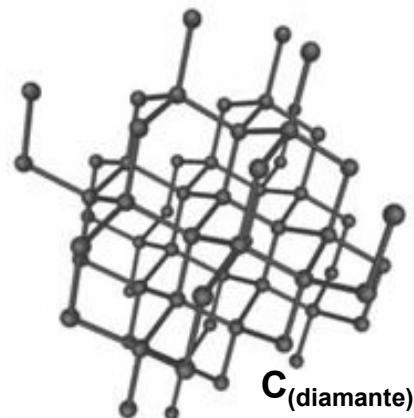
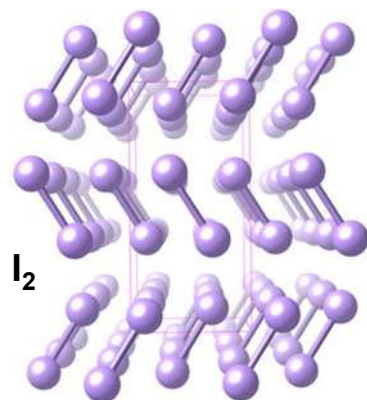
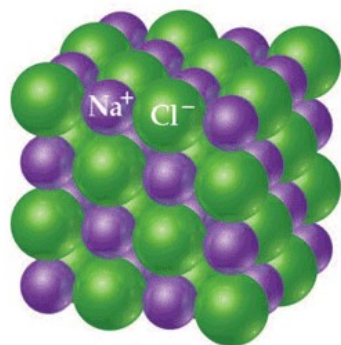


MATERIA

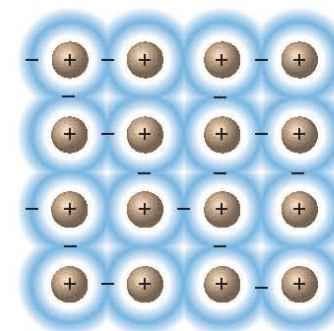
solidi

Tipo di solido	Particelle in un solido	Forze tra le particelle	Proprietà fisiche	Esempi
Ionico	Cationi e anioni	Attrazioni elettrostatiche	Duri e lucenti, alto punto di fusione, bassa conducibilità di calore ed elettricità	NaCl, CaO, MgBr ₂
Molecolare	Atomi o molecole	Forze di London, dipolo-dipolo, e/o legame idrogeno	Leggermente teneri, punto di fusione basso o medio, bassa conducibilità di calore ed elettricità	CH ₄ , C ₆ H ₁₂ O ₆ (glucosio), H ₂ O, Kr
Struttura covalente	Atomi	Legame covalente	Molto duri, punto di fusione elevato, bassa conducibilità di calore ed elettricità	C (diamante), SiO ₂ (quarzo), SiC, BN
Metallico	Atomi	Legame metallico	Teneri o duri, da basso ad alto punto di fusione, buona conducibilità del calore ed elettrica	Na, Fe, Au, Ag, Al

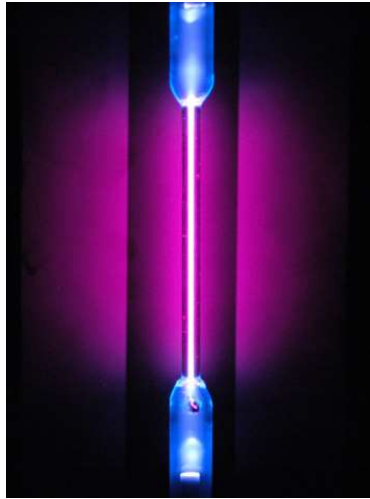
NaCl



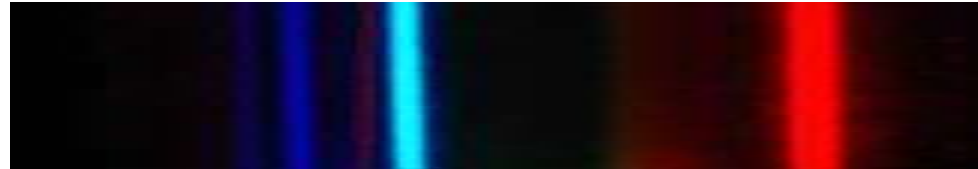
Ag



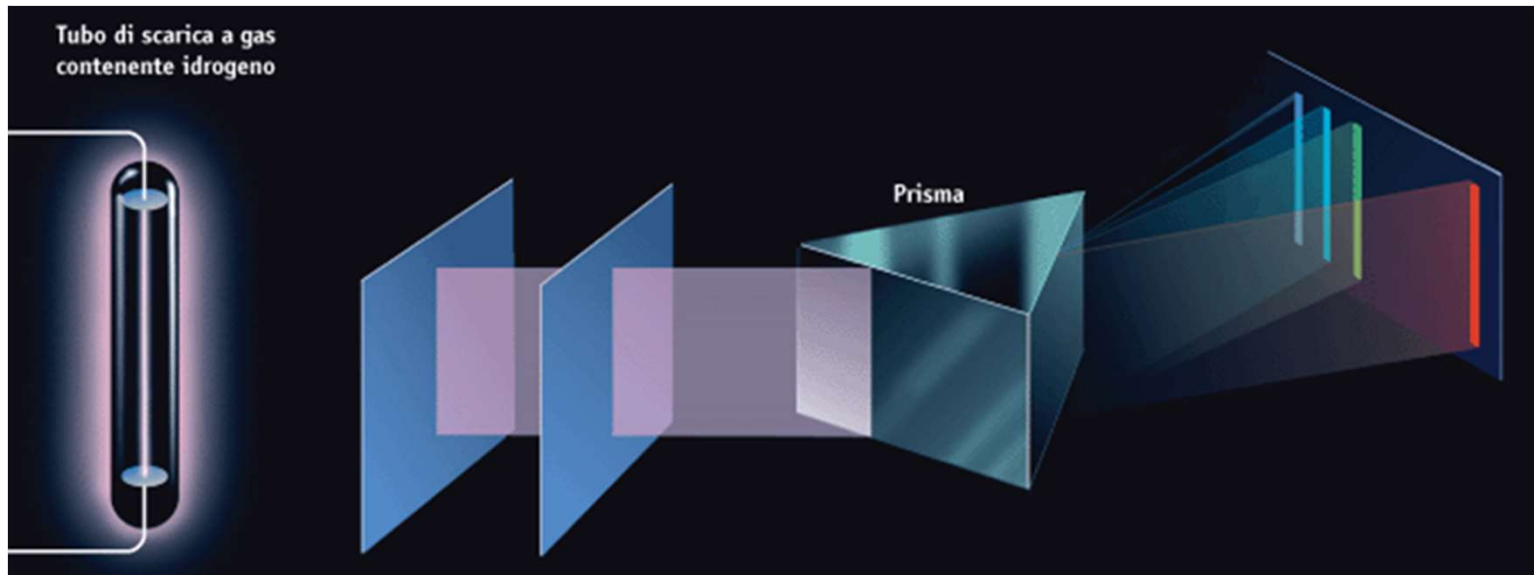
spettroscopia atomica



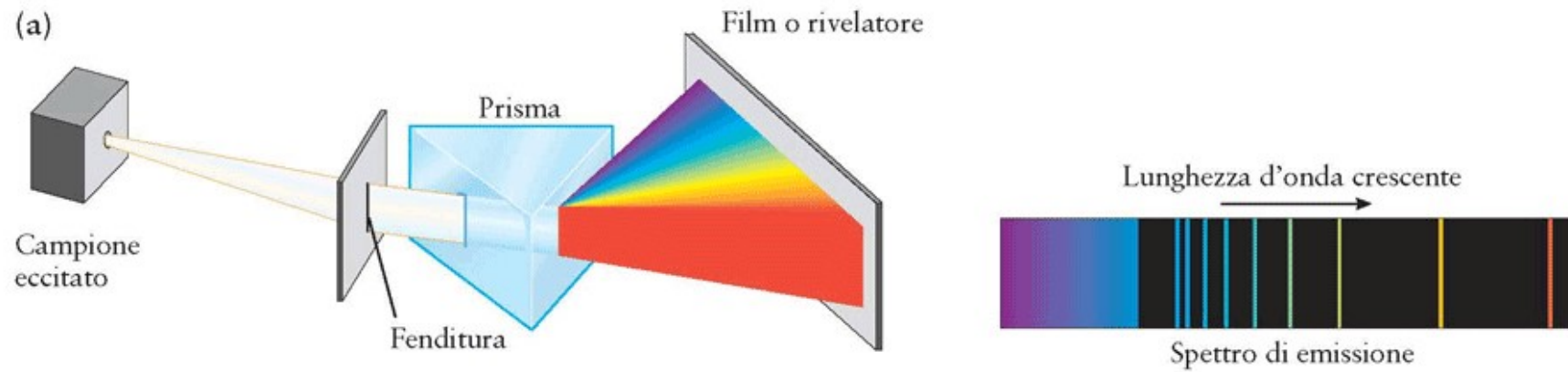
emissione idrogeno



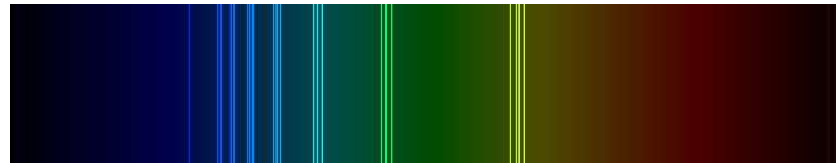
spettro di emissione idrogeno



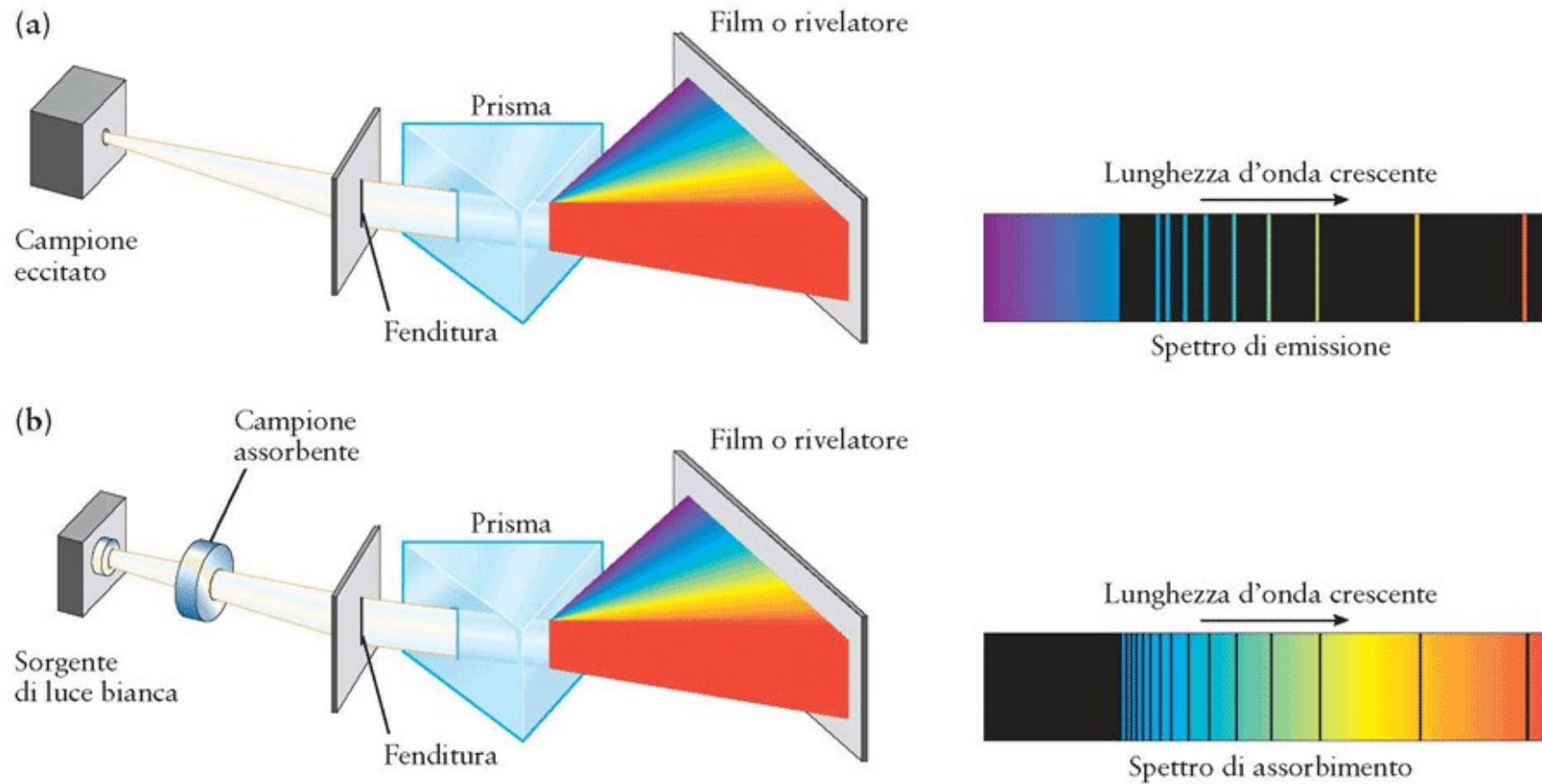
Spettroscopia atomica di emissione



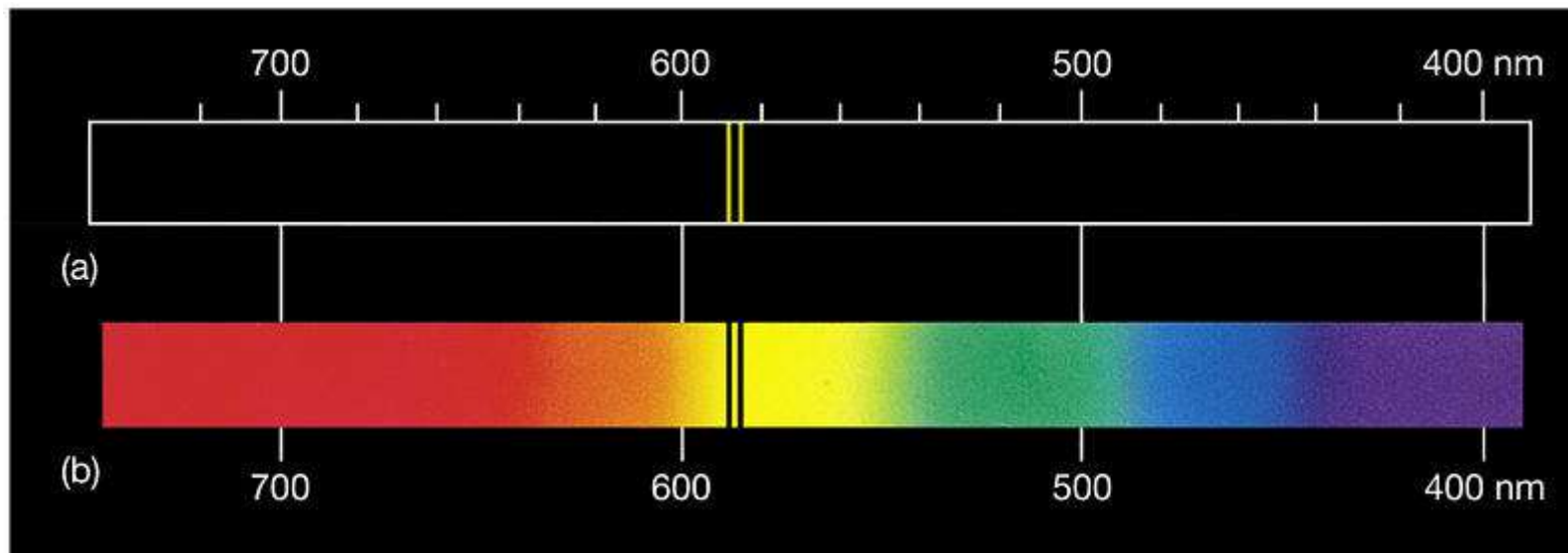
Spettroscopia atomica di emissione



Spettroscopia atomica di emissione *e di assorbimento*

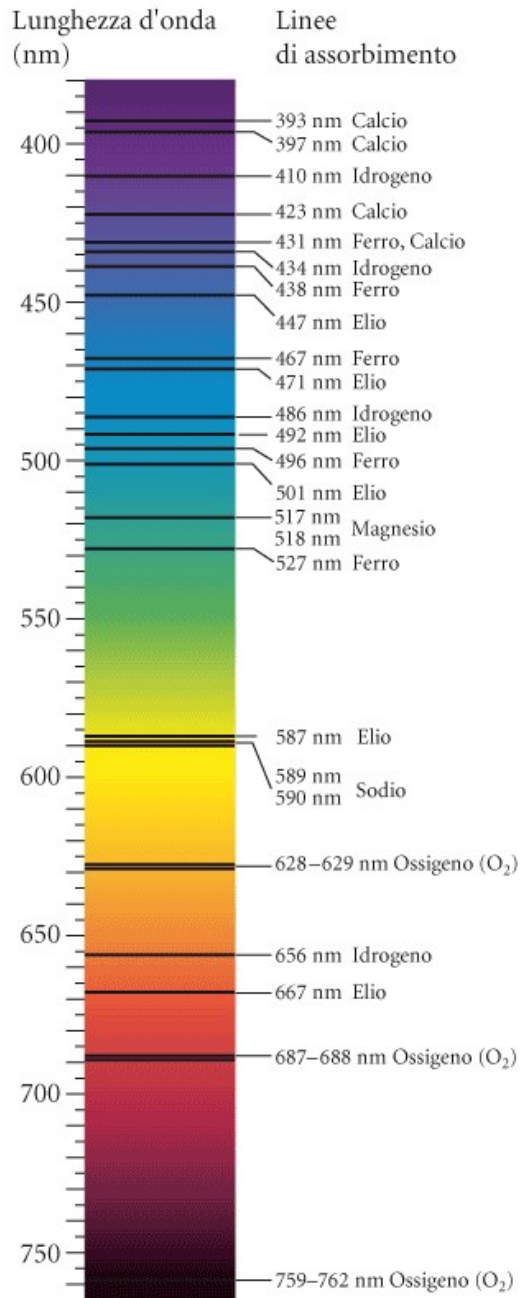


Spettroscopia atomica di emissione *e di assorbimento*

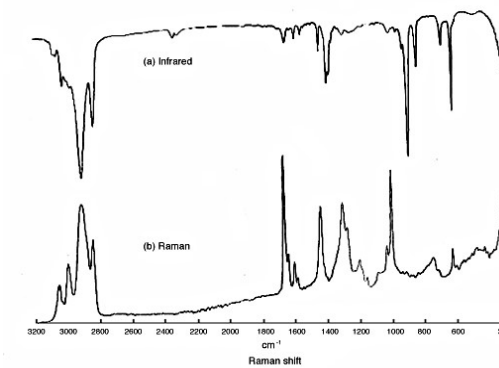
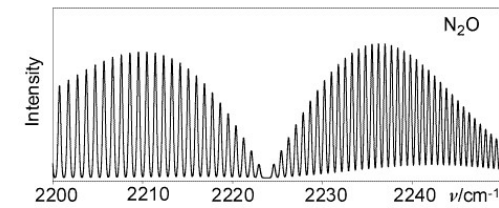
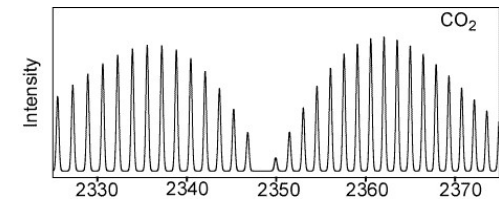
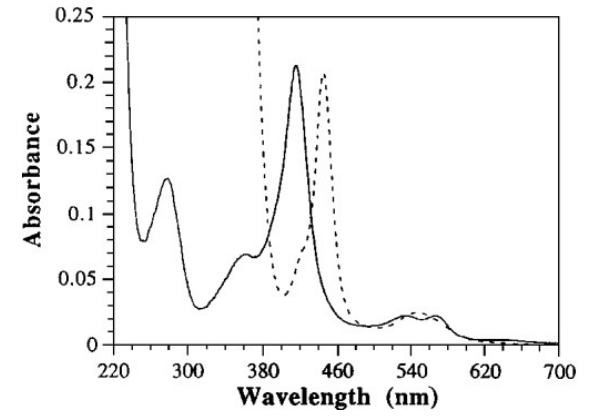
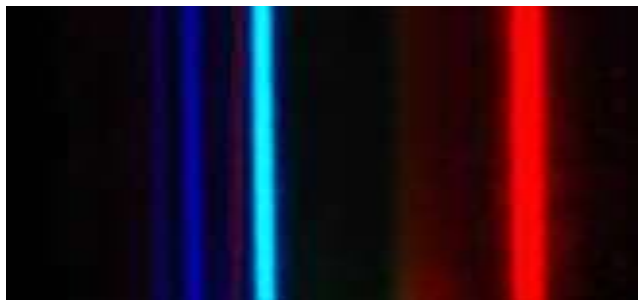
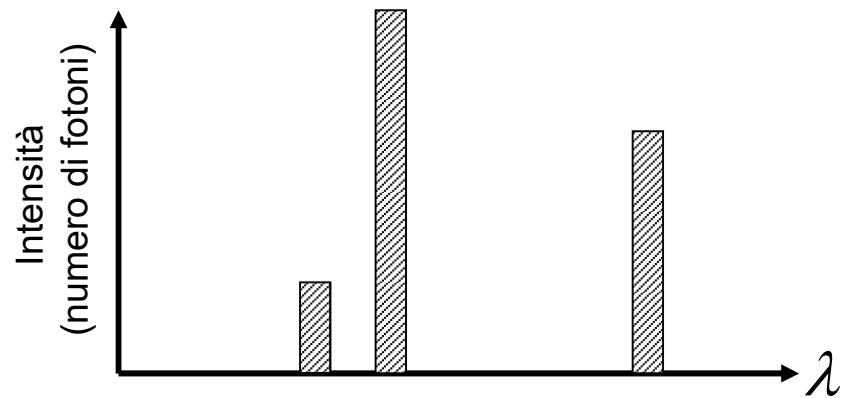
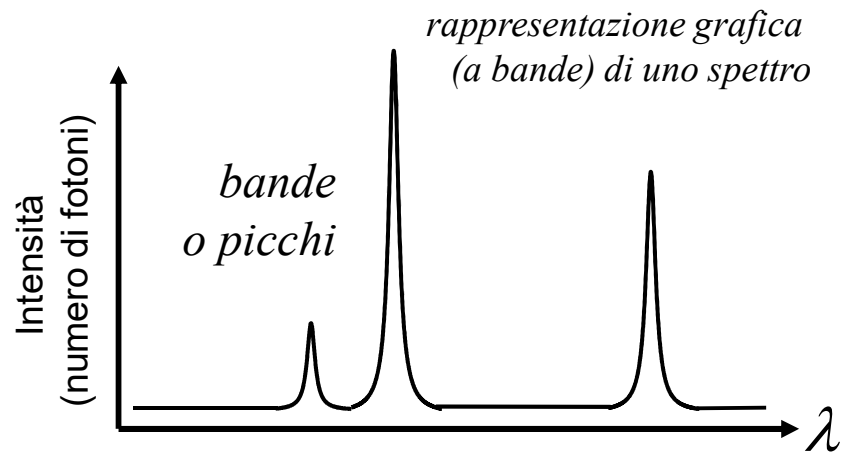


Spettri di emissione e di assorbimento del sodio (Na)

spettro del SOLE (linee di Fraunhofer)



La Struttura Quantistica della Materia

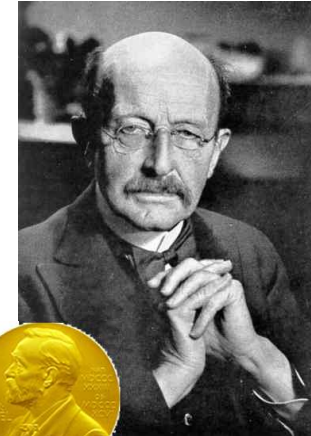


l'ipotesi di Planck

1901



Fisica
1918



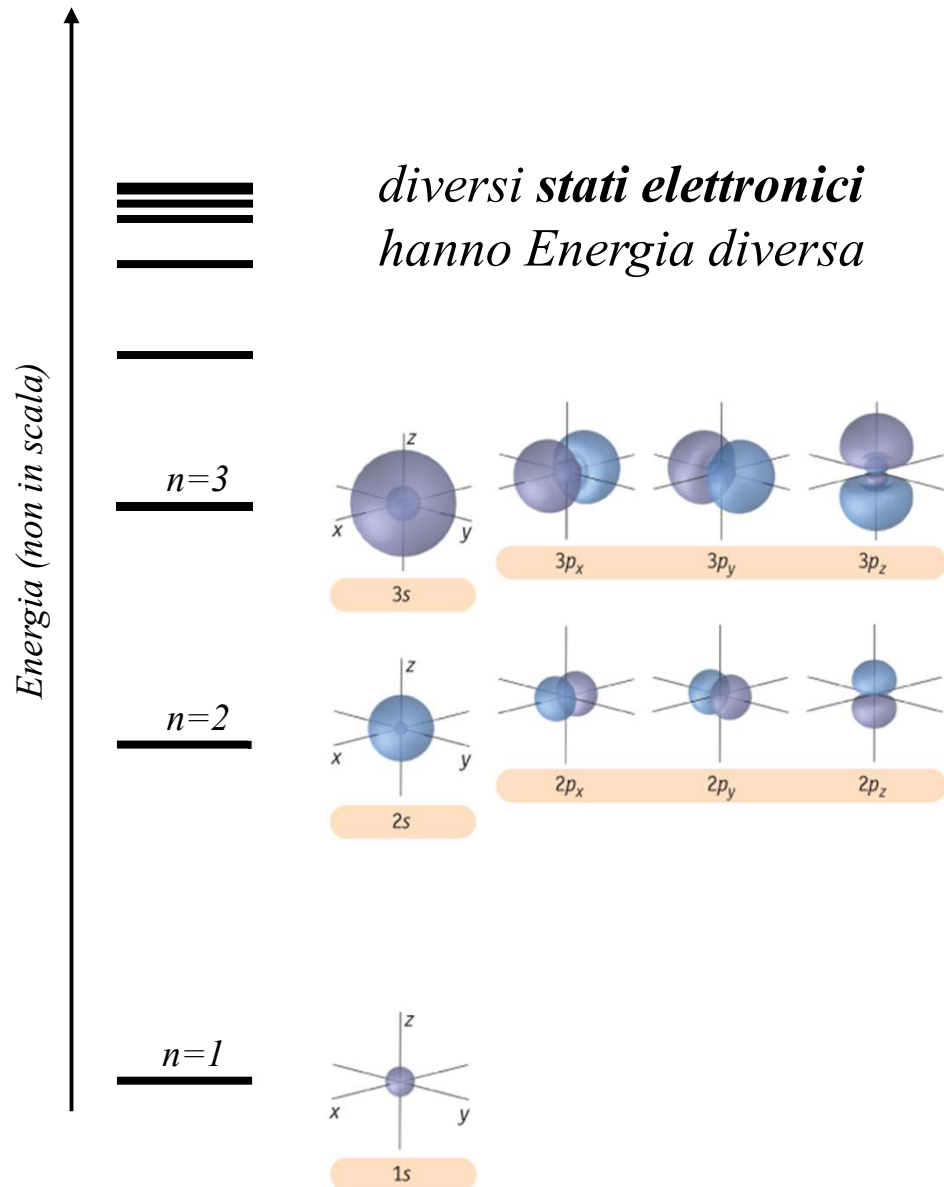
un sistema può avere solo valori **DISCRETI** di energia (“**quanti**” di energia)

$$h\nu$$

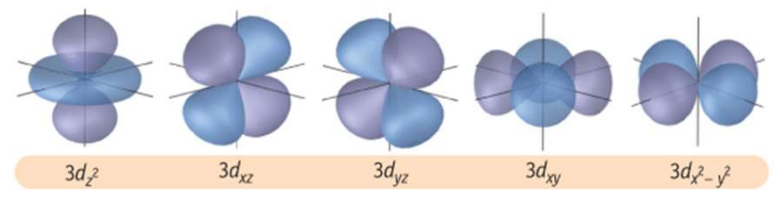
→ l'energia è “**QUANTIZZATA**”

La Struttura Quantistica della Materia

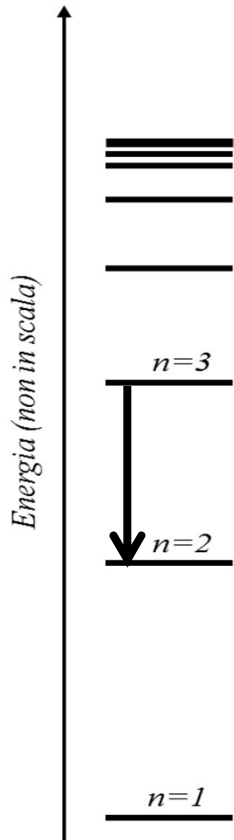
ATOMI



$$E_n = -\frac{e^4 m_e}{8\epsilon_0^2 n^2 h^2}$$



atomo di Idrogeno
 i "livelli energetici" sono correlati alla "probabilità" di trovare l'elettrone più e meno vicino al nucleo



$$E = -\frac{e^4 m}{8\varepsilon_0^2 n^2 h^2} \quad r = n^2 a_0 \quad n = 1, 2, 3, \dots$$

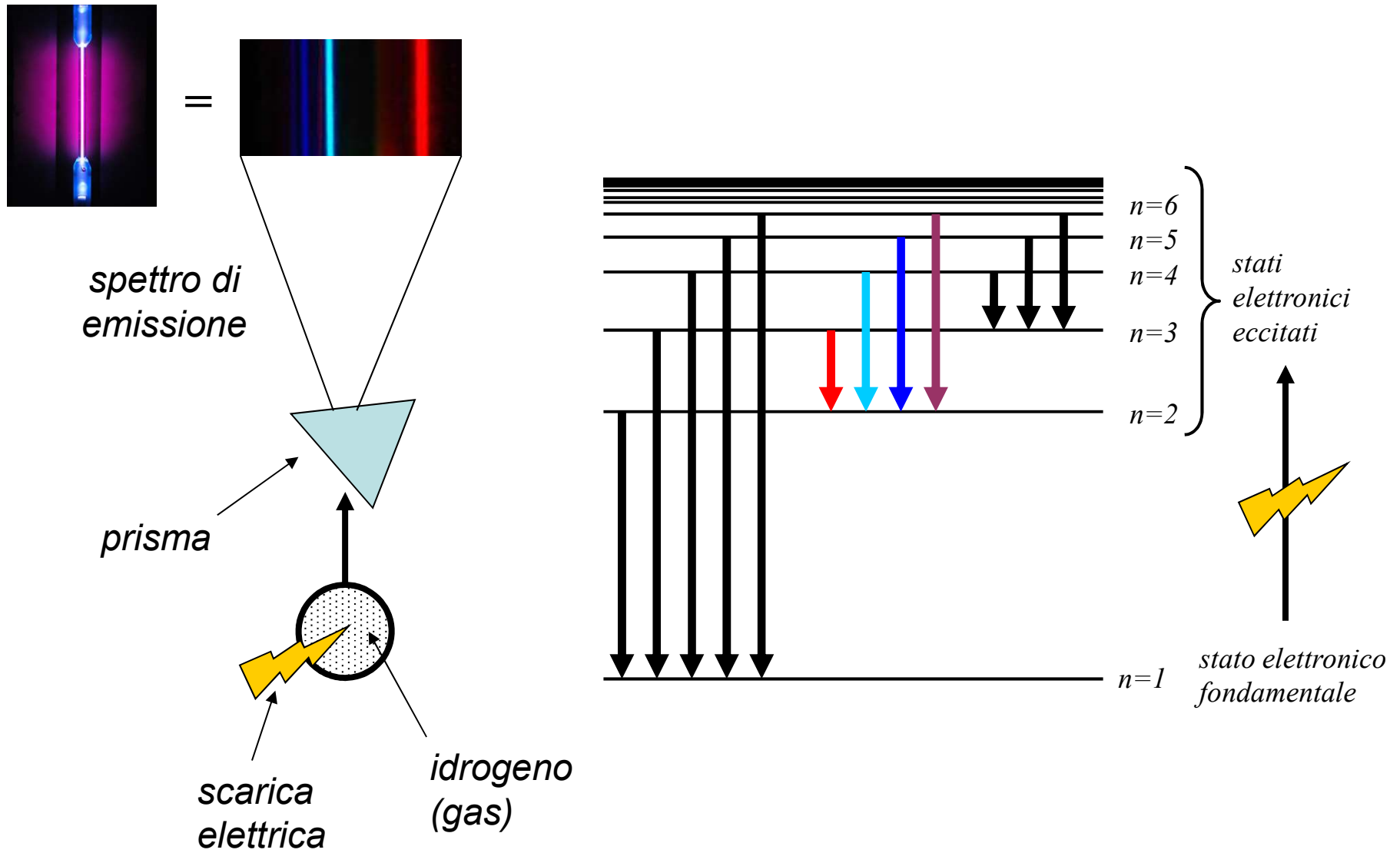
$$\Delta E_{3 \rightarrow 2} = E_{n=3} - E_{n=2} = \frac{e^4 m}{8\varepsilon_0^2 h^2} \left(\frac{1}{2^2} - \frac{1}{3^2} \right)$$

$$\Delta E = h\nu \quad (\text{Planck ed Einstein})$$

$$\nu_{3 \rightarrow 2} = \frac{e^4 m}{8\varepsilon_0^2 h^3} \left(\frac{1}{2^2} - \frac{1}{3^2} \right) = 0.45731 \times 10^{15} \text{ s}^{-1}$$

$$\lambda_{3 \rightarrow 2} = \frac{c}{\nu_{3 \rightarrow 2}} = \frac{299\,792\,458 \text{ ms}^{-1}}{0.45731 \times 10^{15} \text{ s}^{-1}} = 6.56 \times 10^{-7} \text{ m}$$

La Struttura Quantistica della Materia



Orbitali molecolari

parallelismo

atomi

approssimazione della
funzione d'onda
dell'**atomo** come
prodotto di

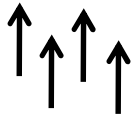
orbitali atomici

(funzioni d'onda mono-
elettroniche)

E



aufbau



molecole

approssimazione della
funzione d'onda
della **molecola** come
prodotto di

orbitali molecolari

(funzioni d'onda mono-
elettroniche)

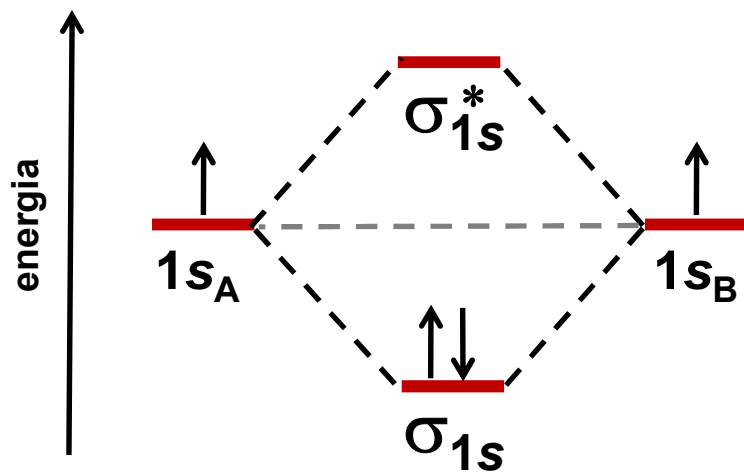
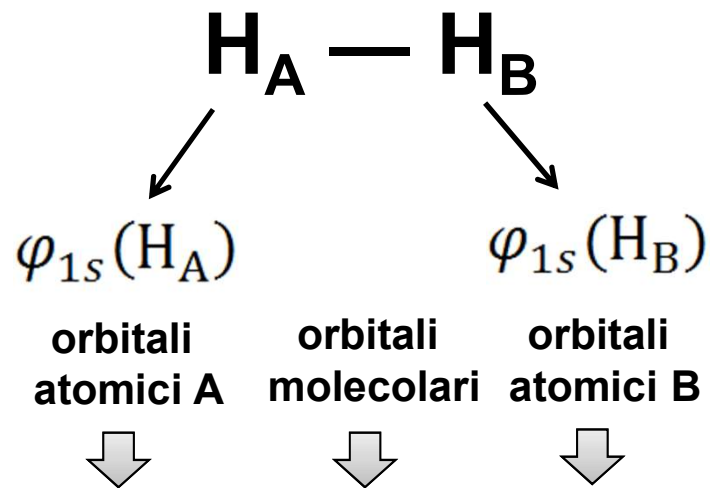
E



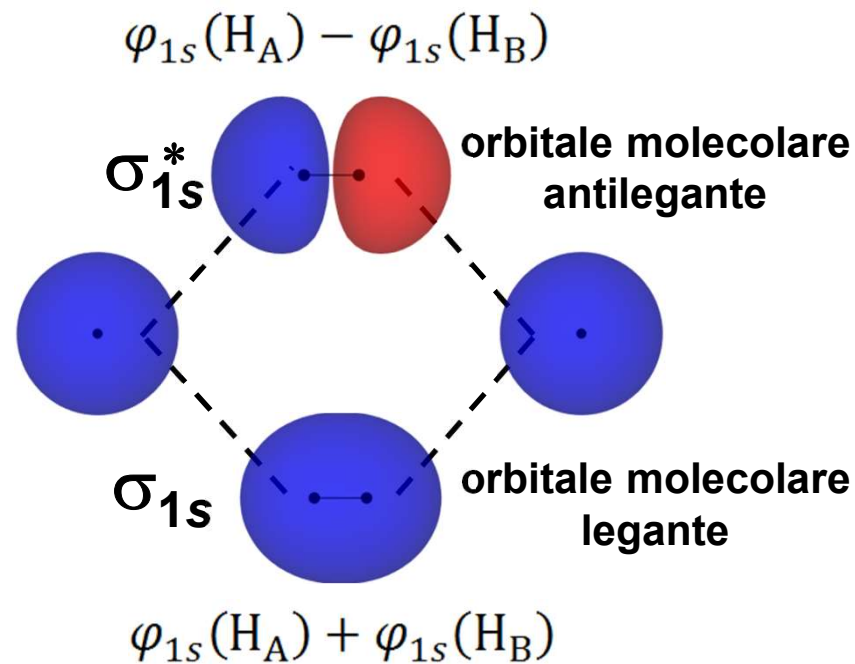
aufbau

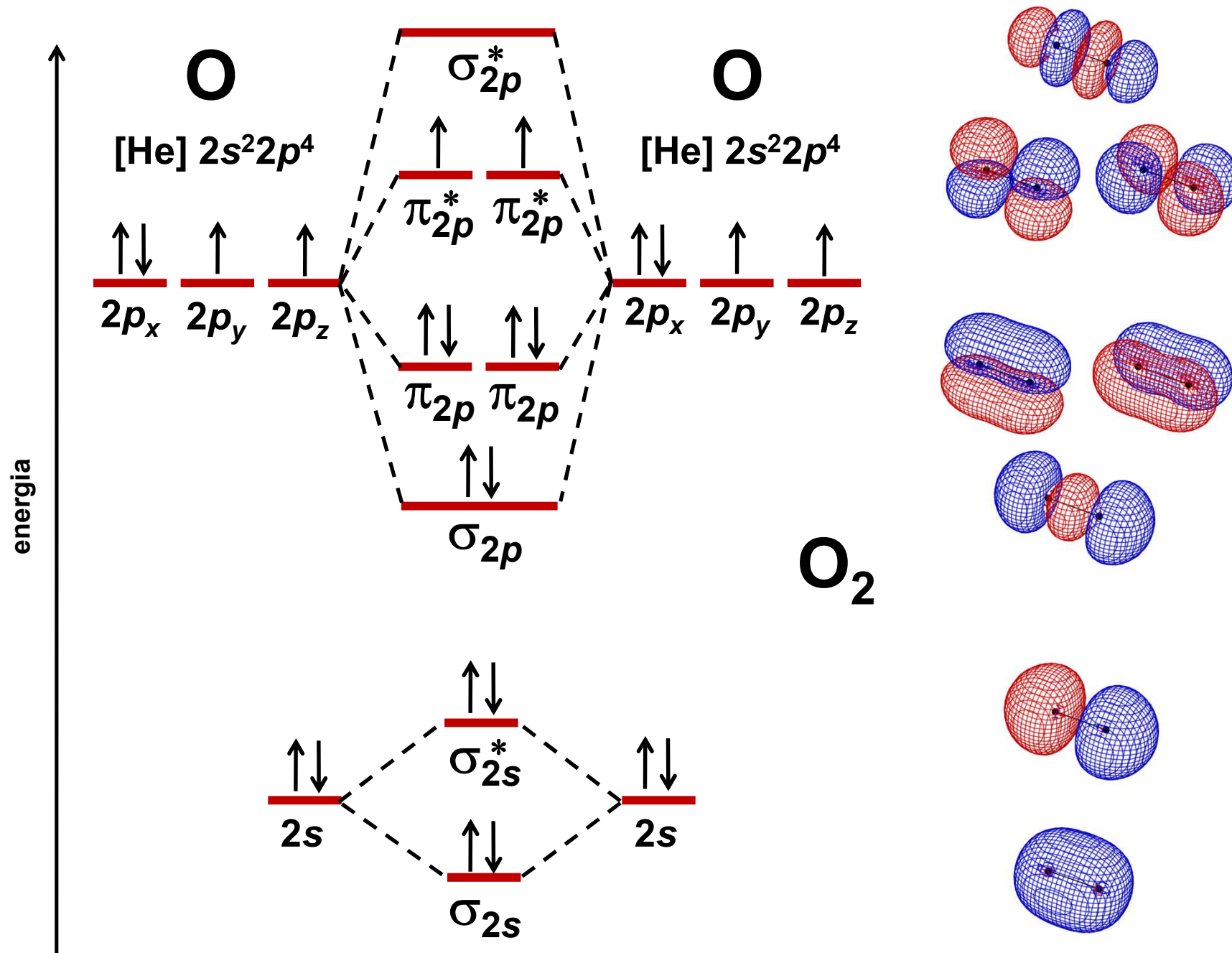


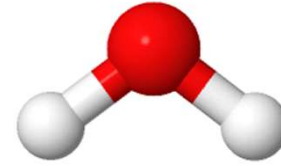
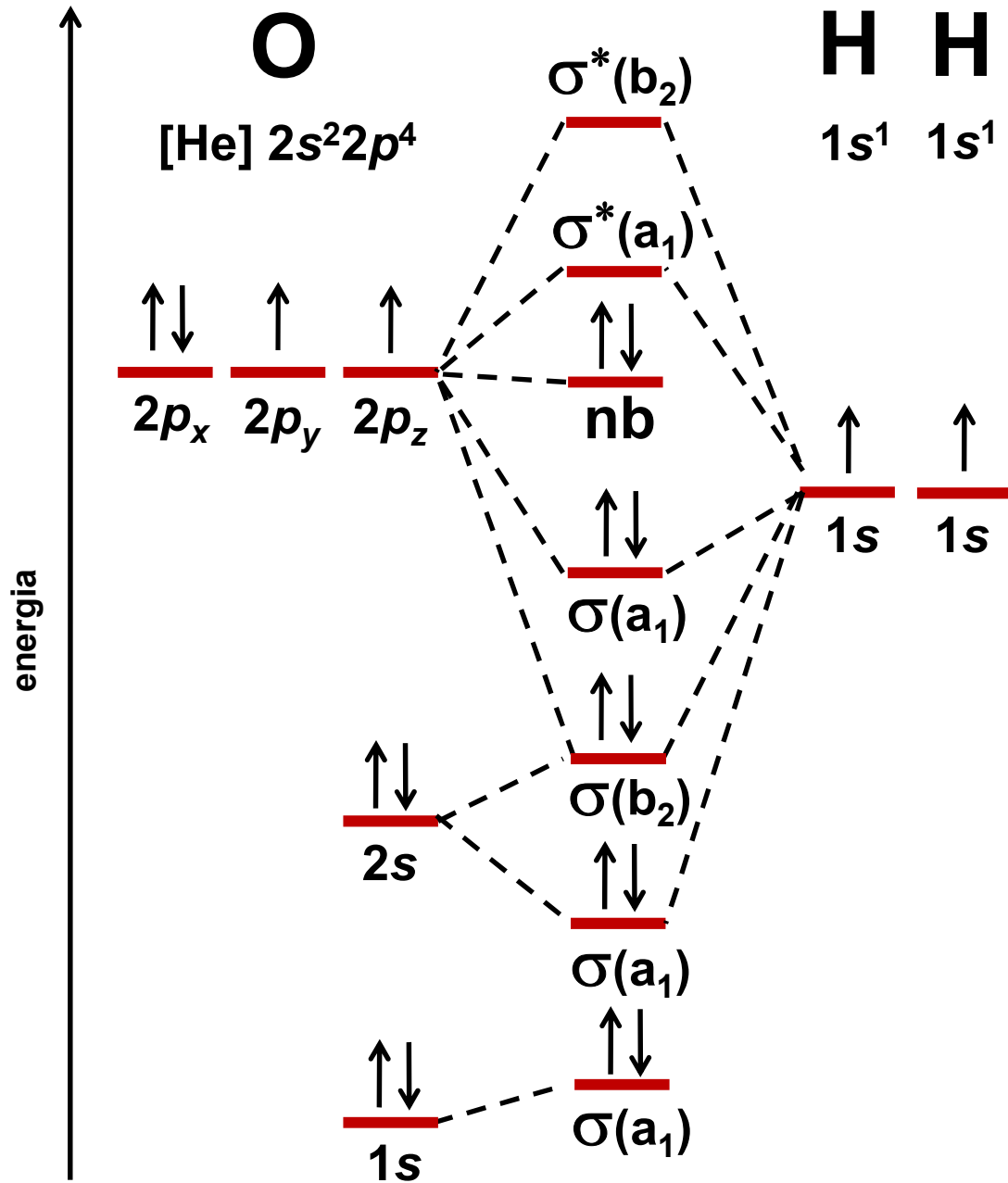
molecola idrogeno H₂



Similmente agli elettroni negli atomi isolati, anche nelle molecole i “livelli energetici” sono correlati a diverse “probabilità” di trovare gli elettroni attorno ai nuclei



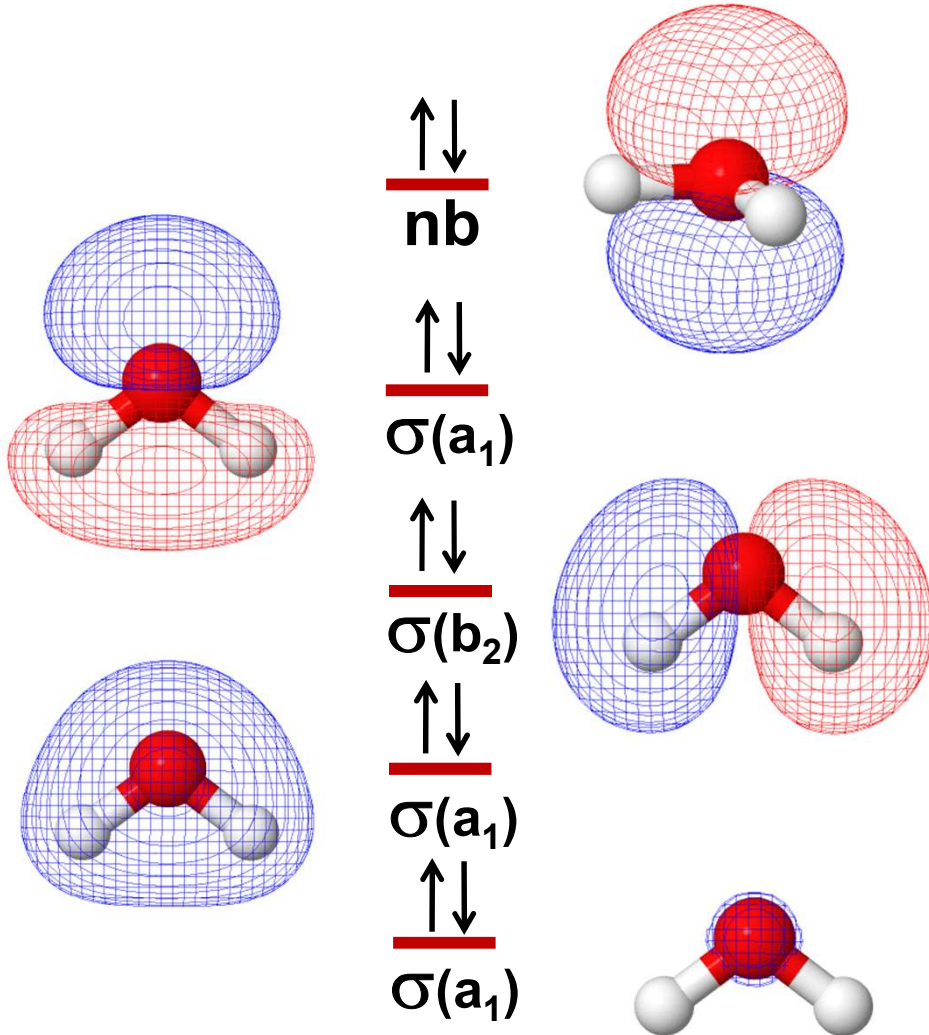




*descrizione
MO-LCAO
per l'acqua*

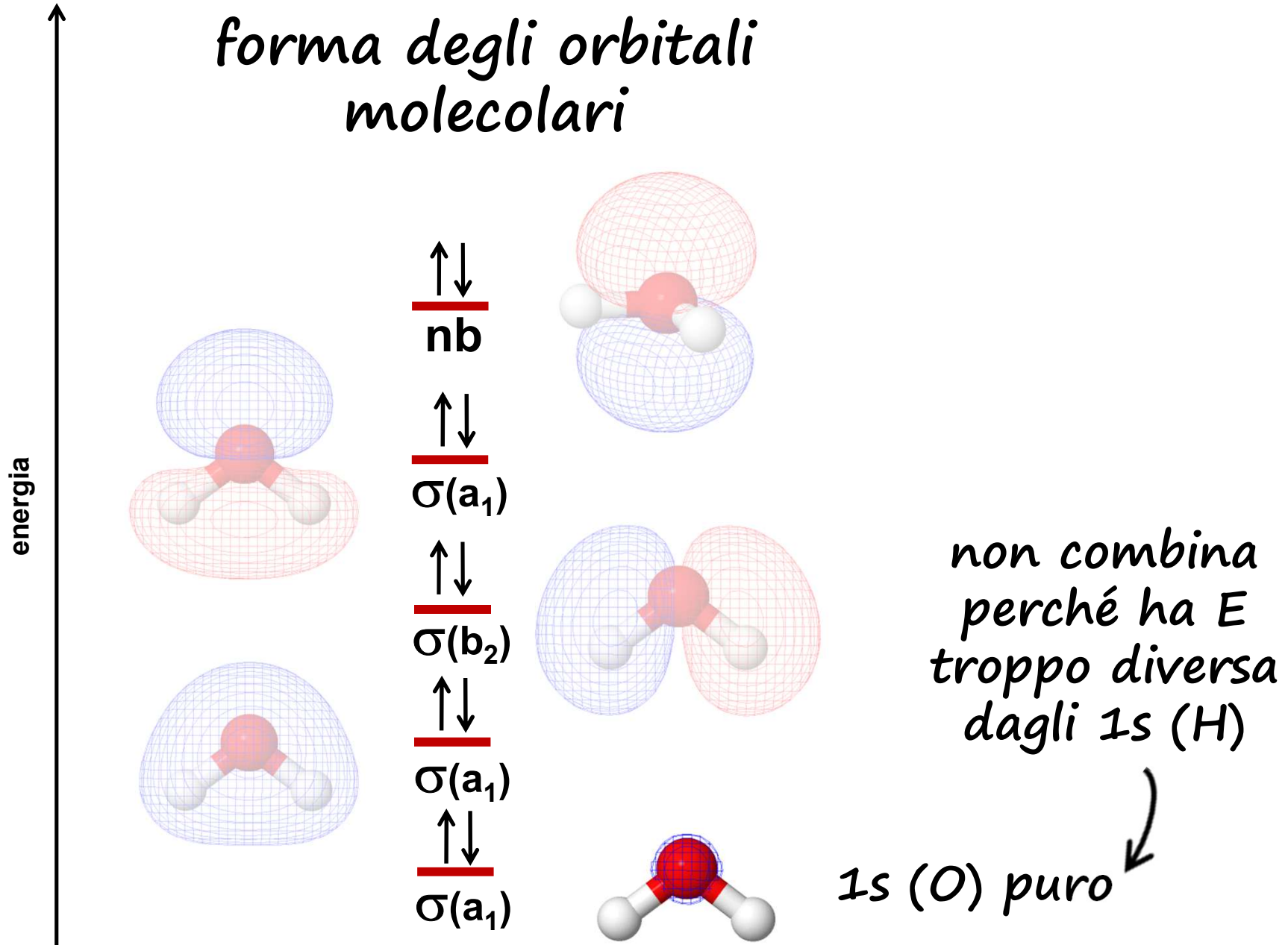
forma degli orbitali molecolari

energia

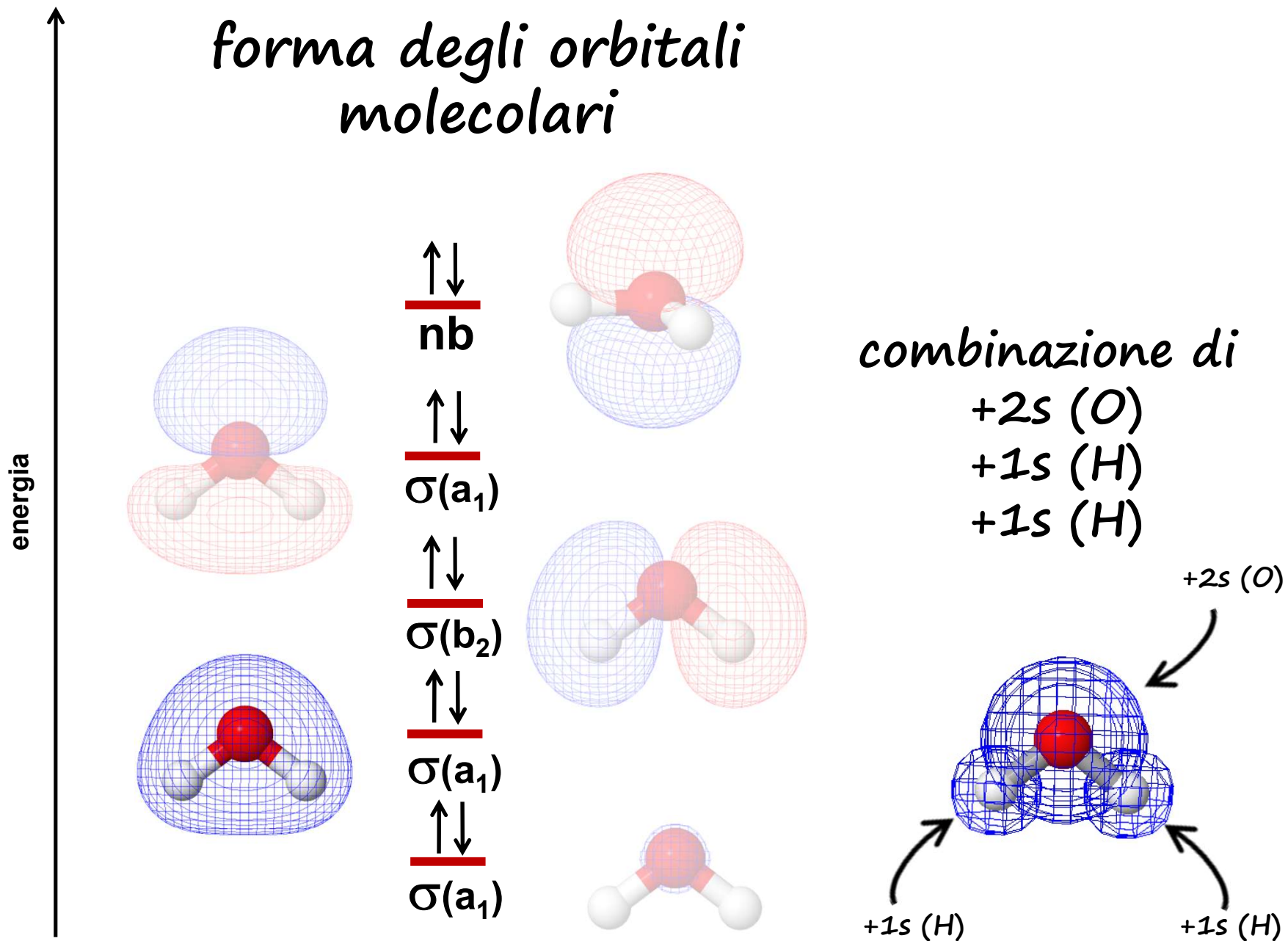


**orbitali
delocalizzati
su tutta la
molecola,
non solo tra
due nuclei**

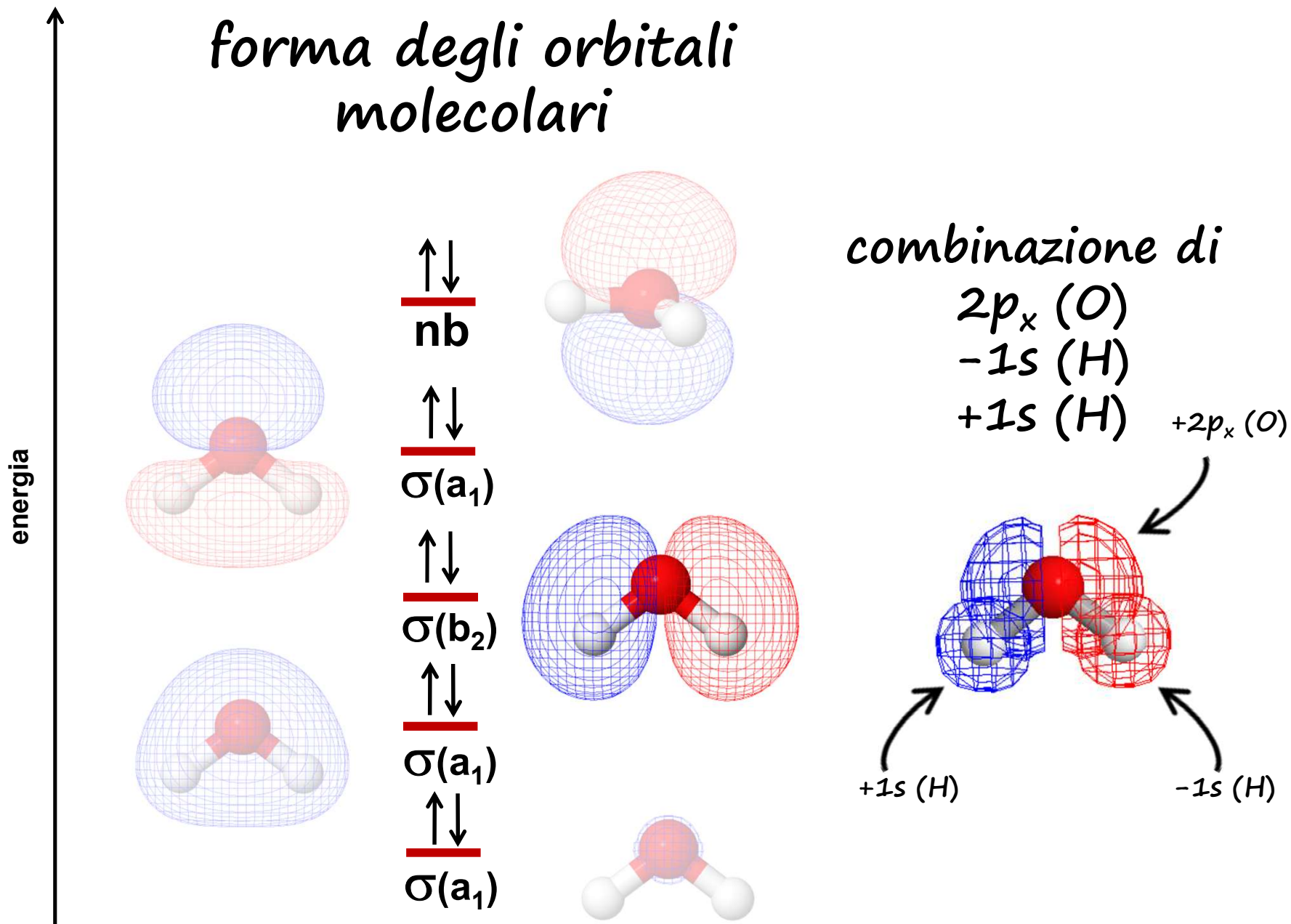
forma degli orbitali molecolari



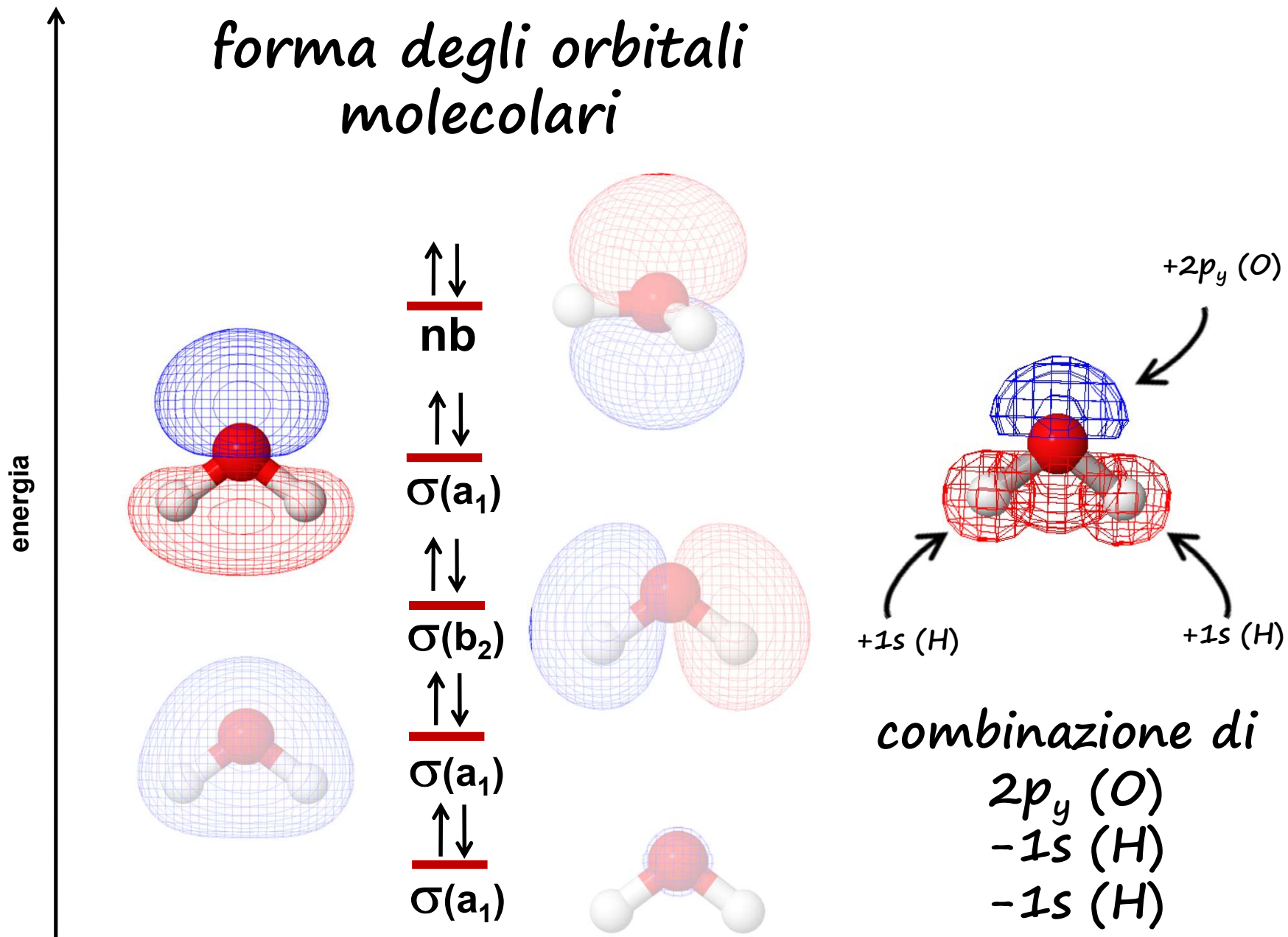
forma degli orbitali molecolari



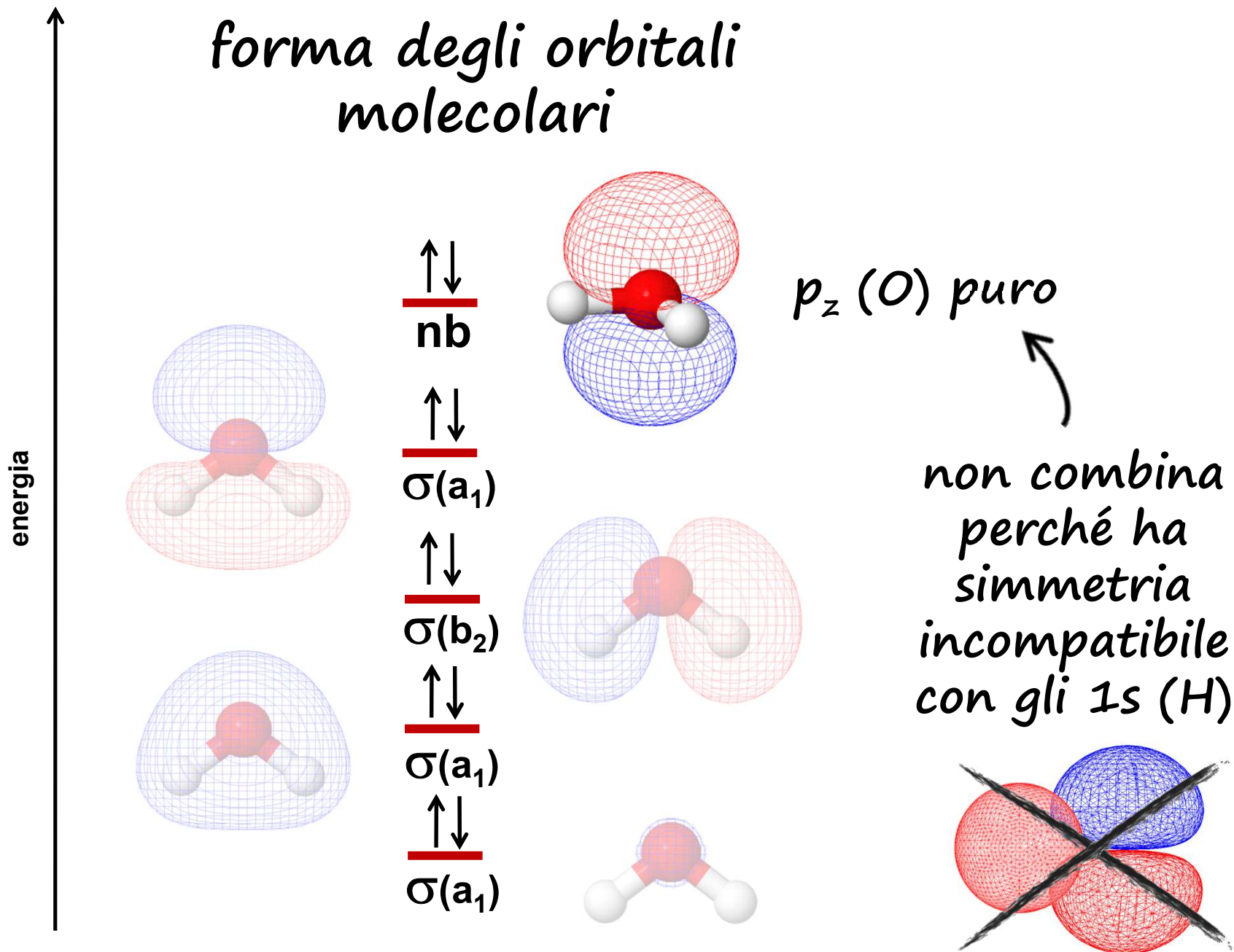
forma degli orbitali molecolari



forma degli orbitali molecolari



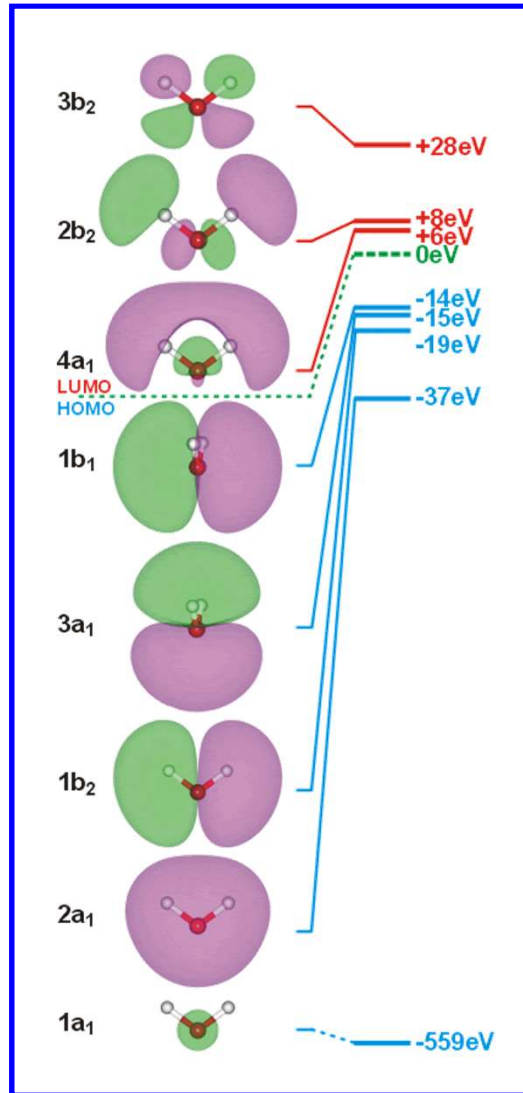
forma degli orbitali molecolari



La Struttura Quantistica della Materia

$$E = E_{\text{electronic}} + E_{\text{vibrational}} + E_{\text{rotational}} + E_{\text{translational}}$$

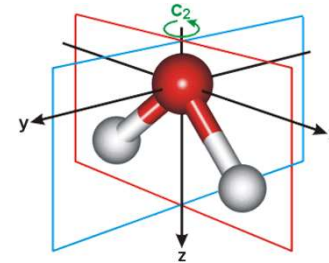
ELETTRONICA



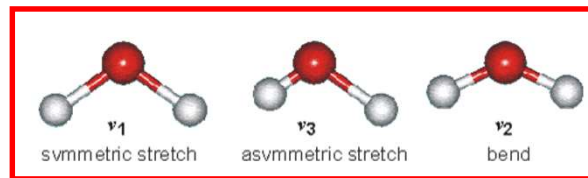
associata alla
"posizione"
degli **elettroni**

ENERGIA molecolare

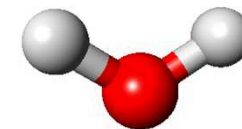
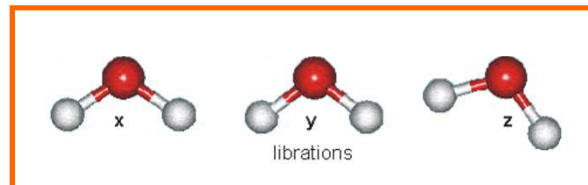
associata alla
"posizione"
dei **nuclei**



VIBRAZIONALE

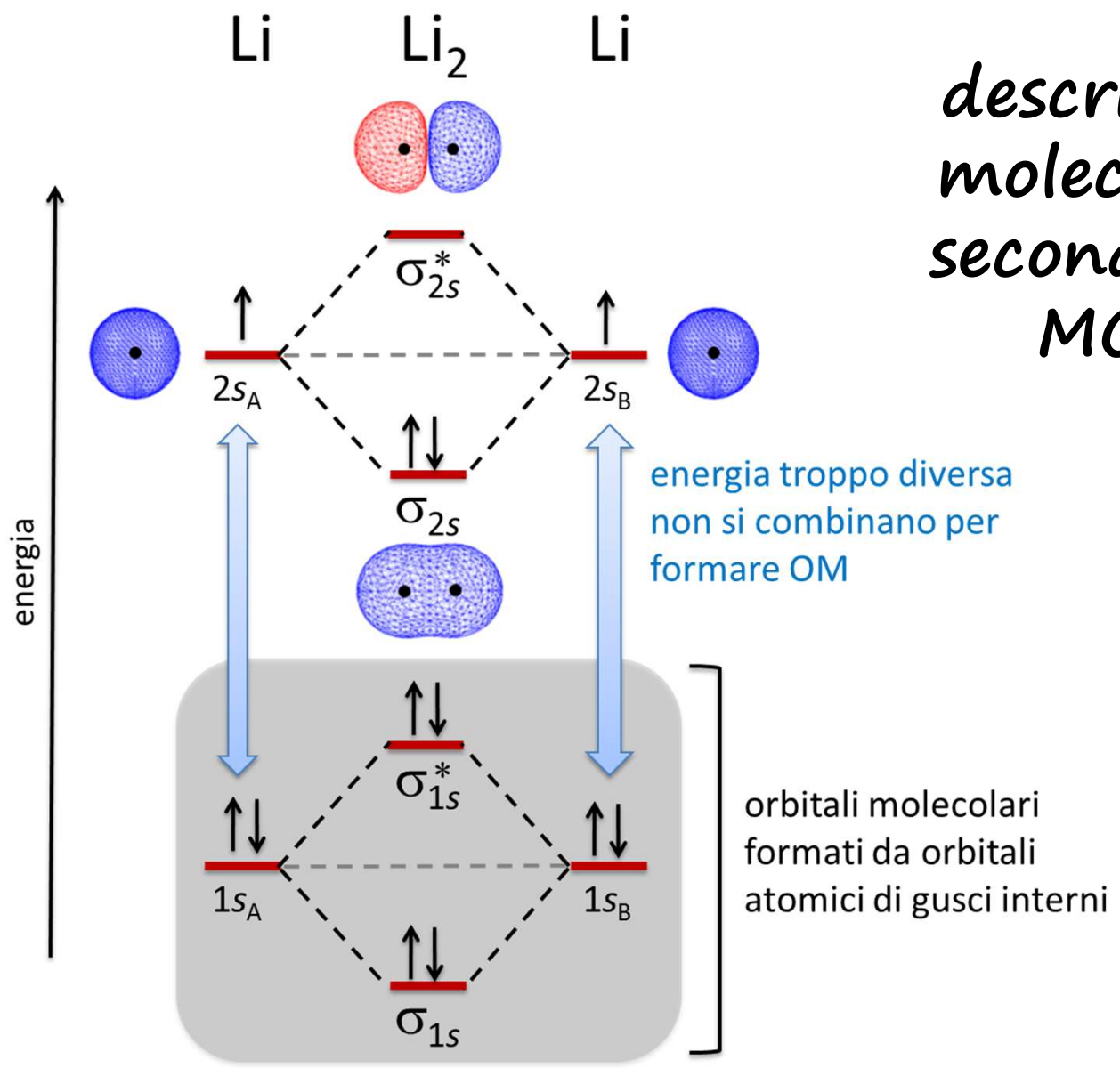


ROTAZIONALE

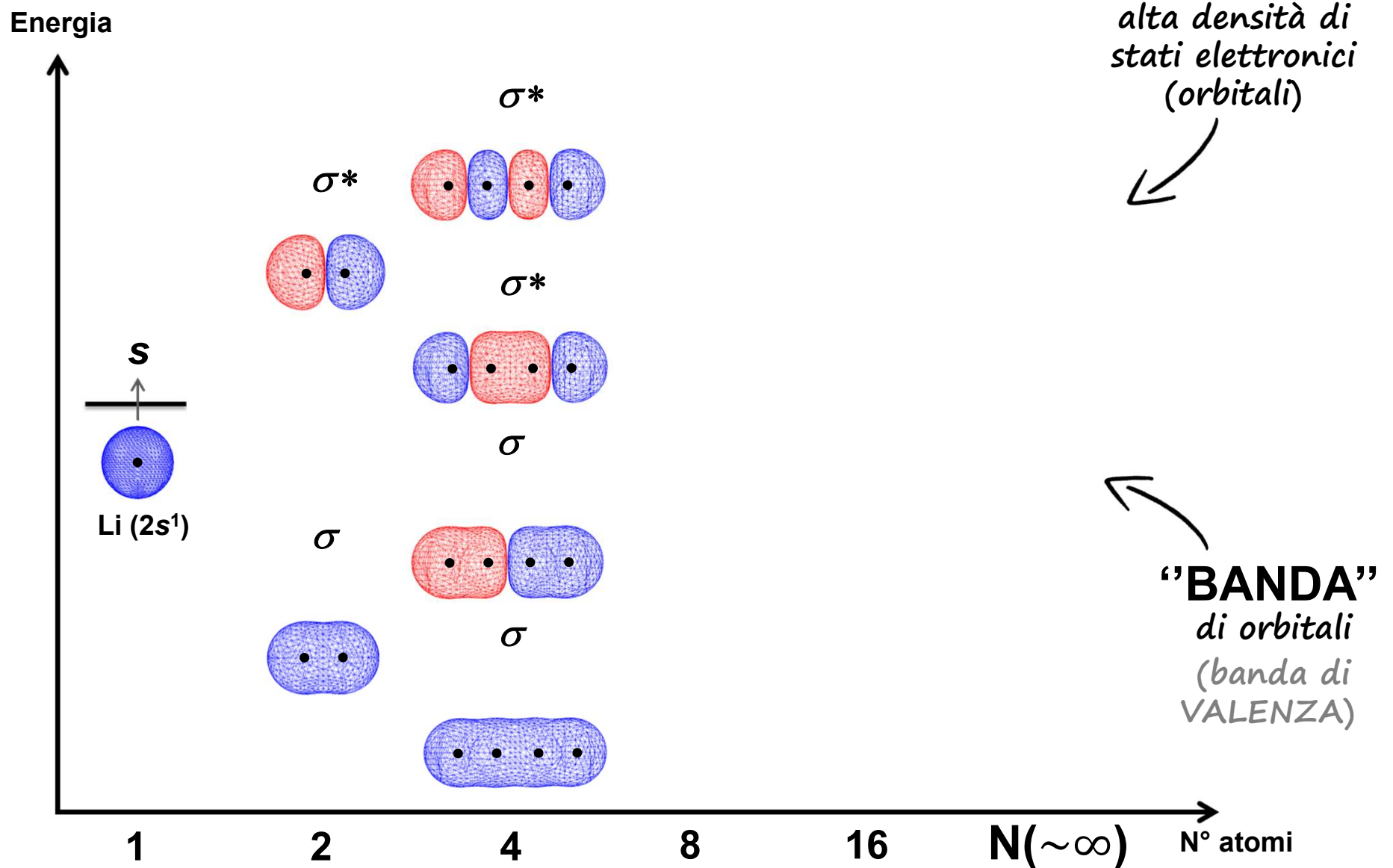


teoria quantistica dei solidi (teoria delle bande)

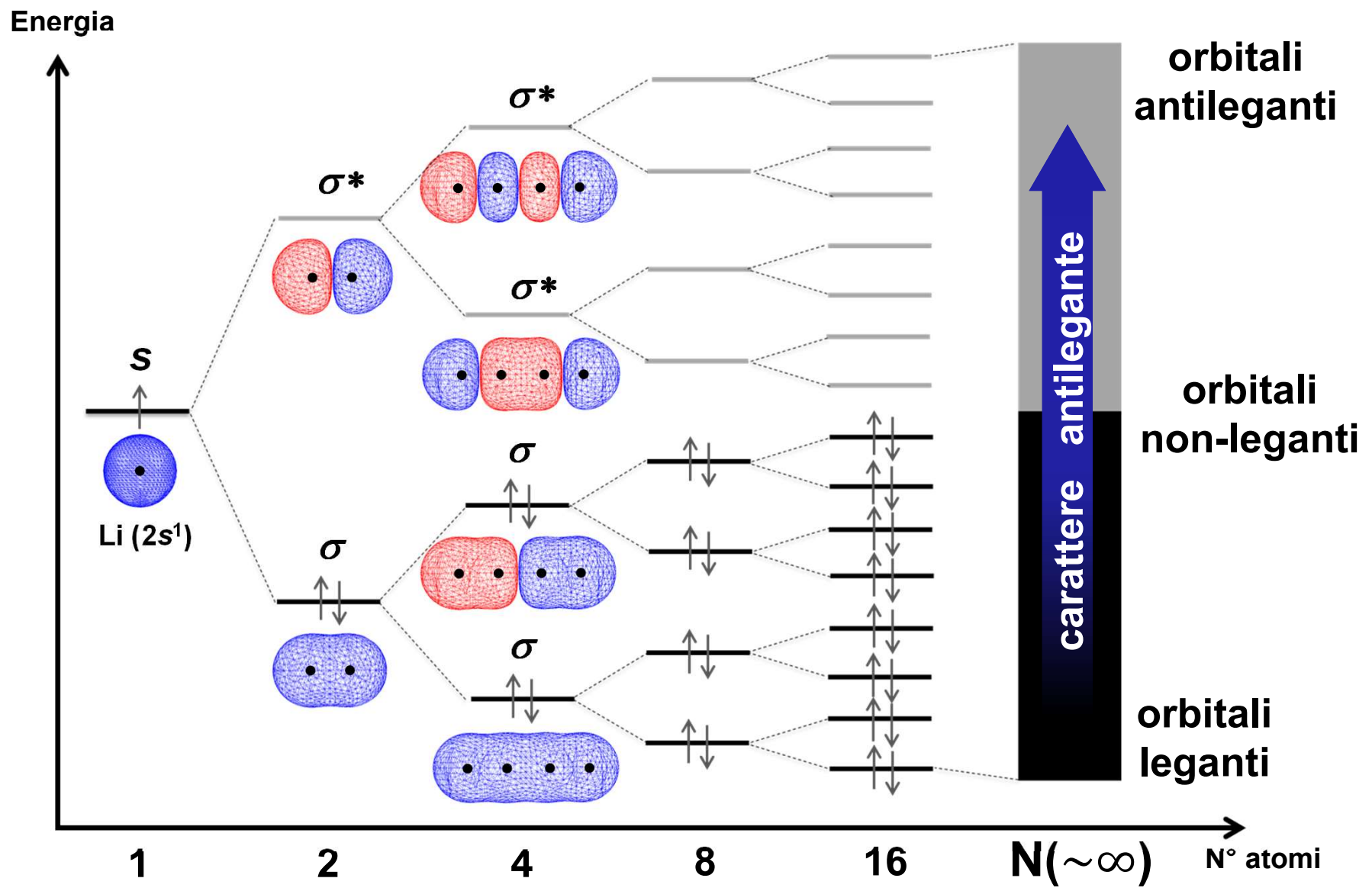
descrizione della molecola di Litio secondo la teoria MO-LCAO



teoria quantistica dei solidi (teoria delle bande)

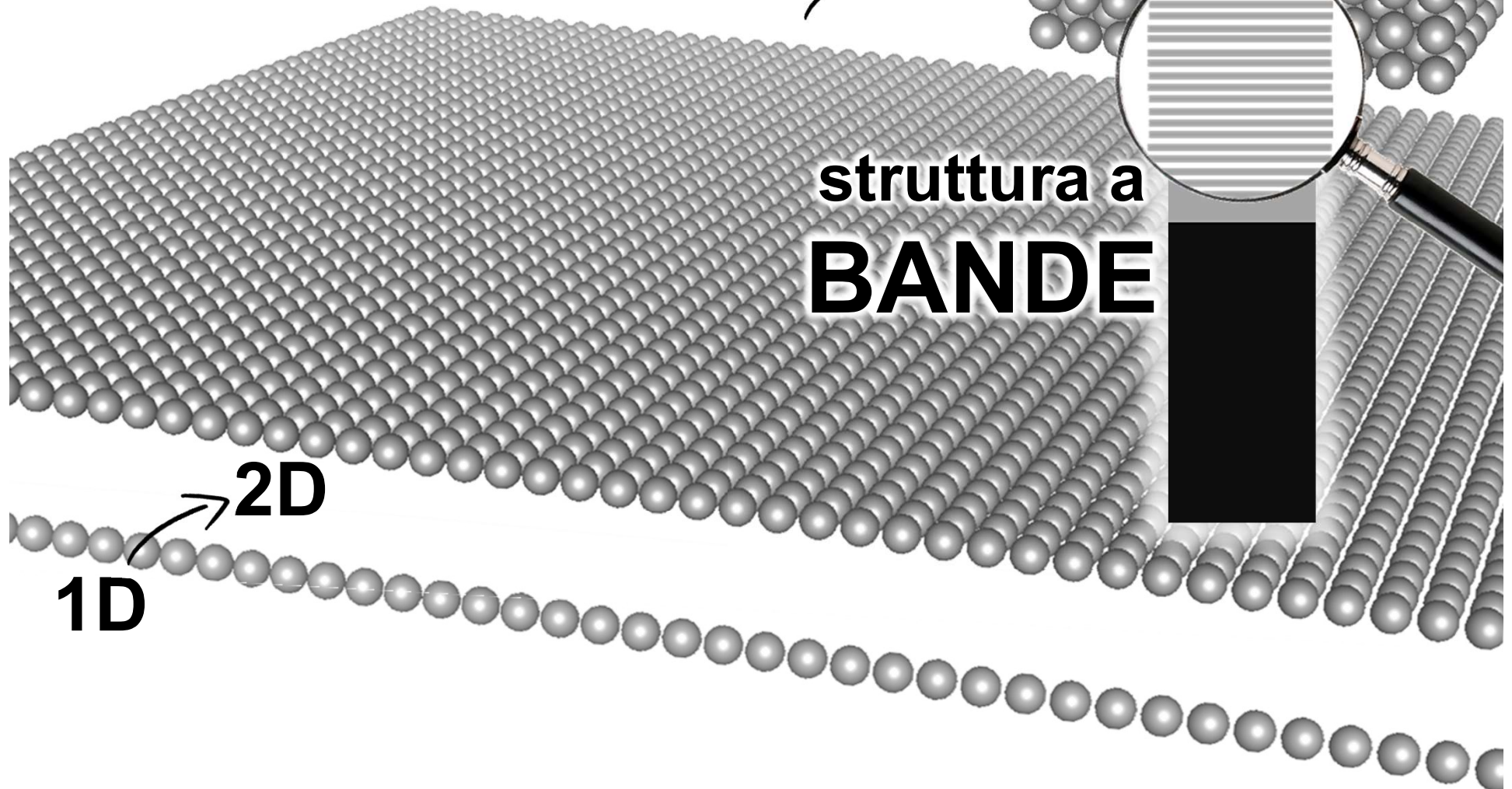


teoria quantistica dei solidi (teoria delle bande)

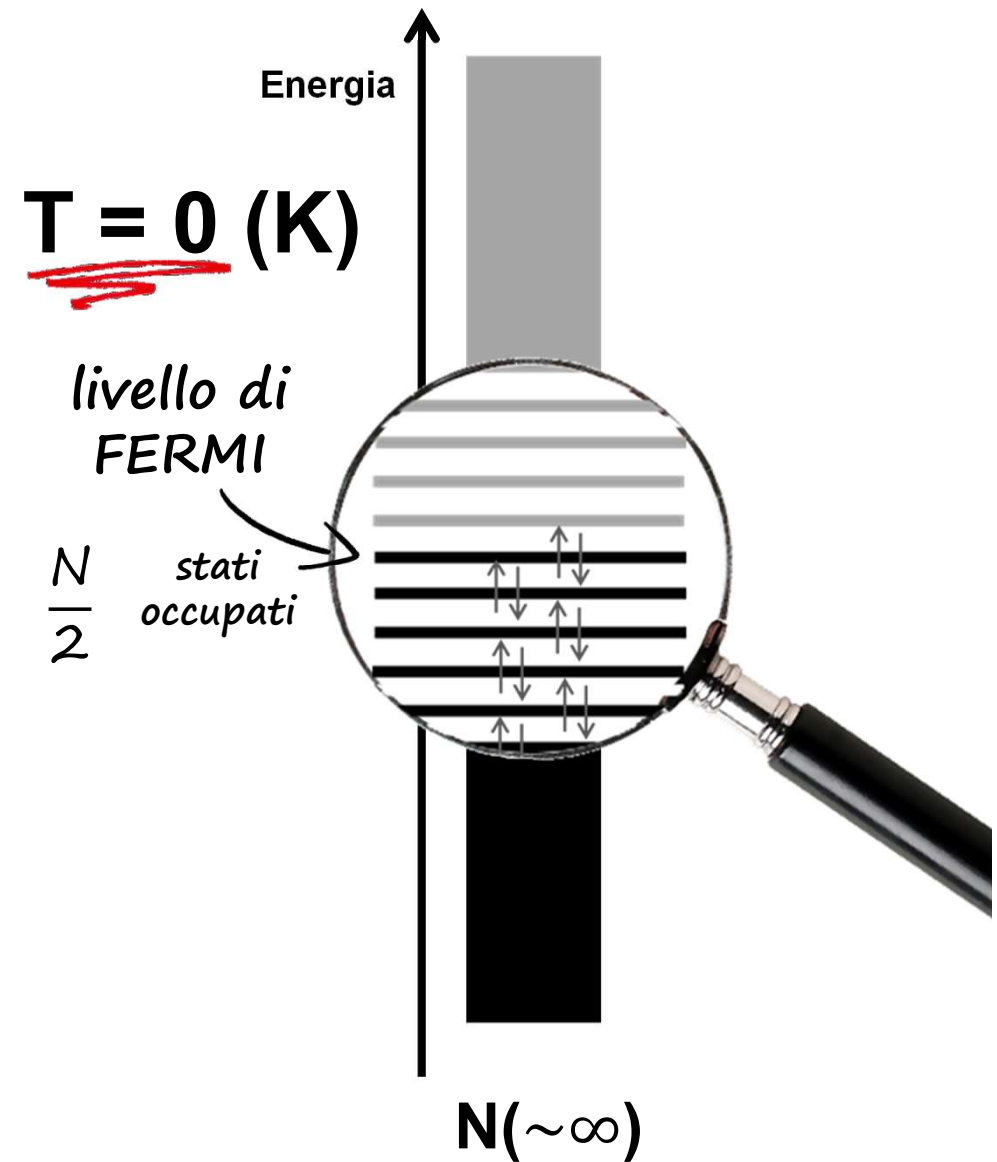


teoria quantistica dei solidi (teoria delle bande)

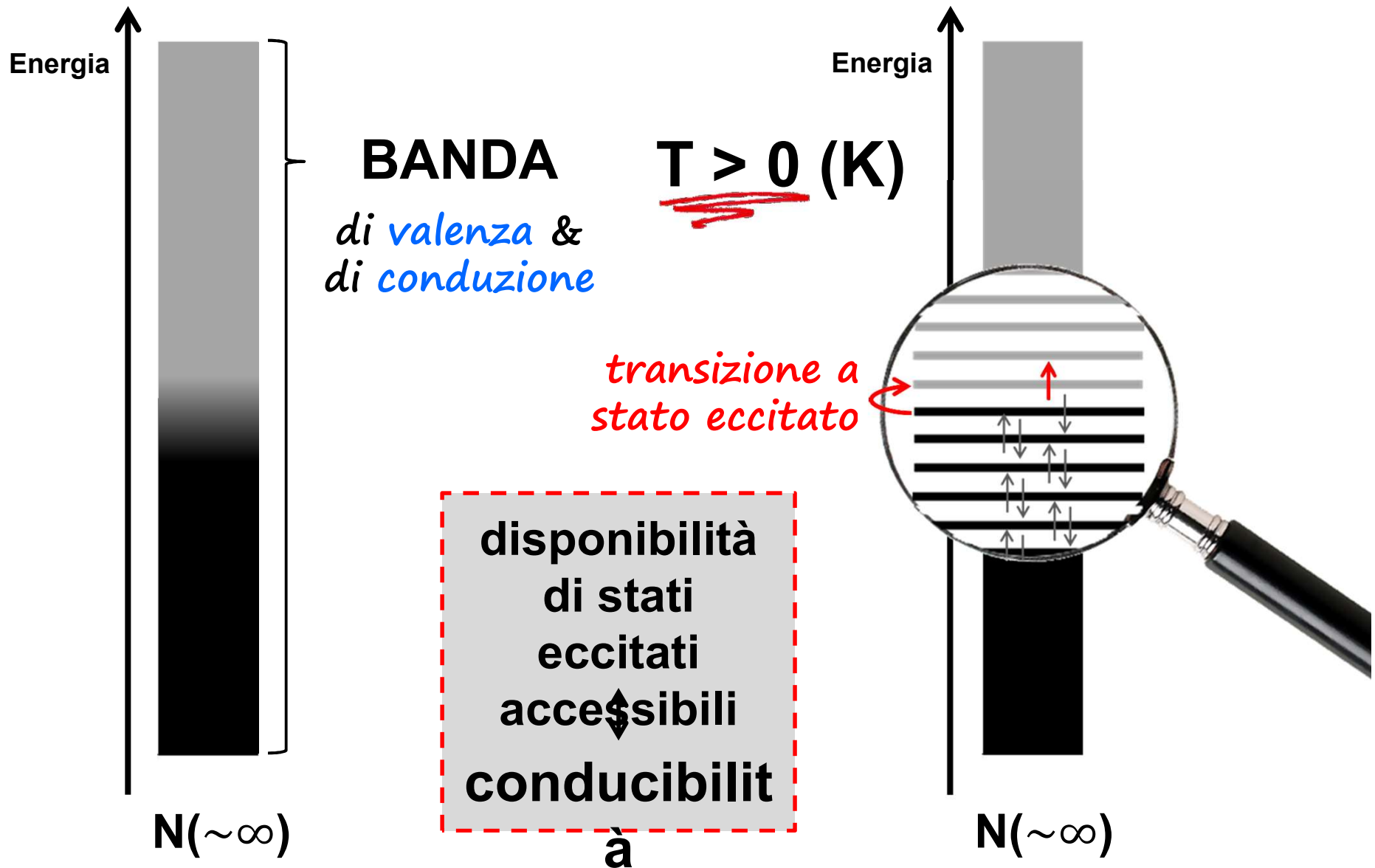
*stesso ragionamento vale
anche per disposizioni di
atomi in 2D e 3D*



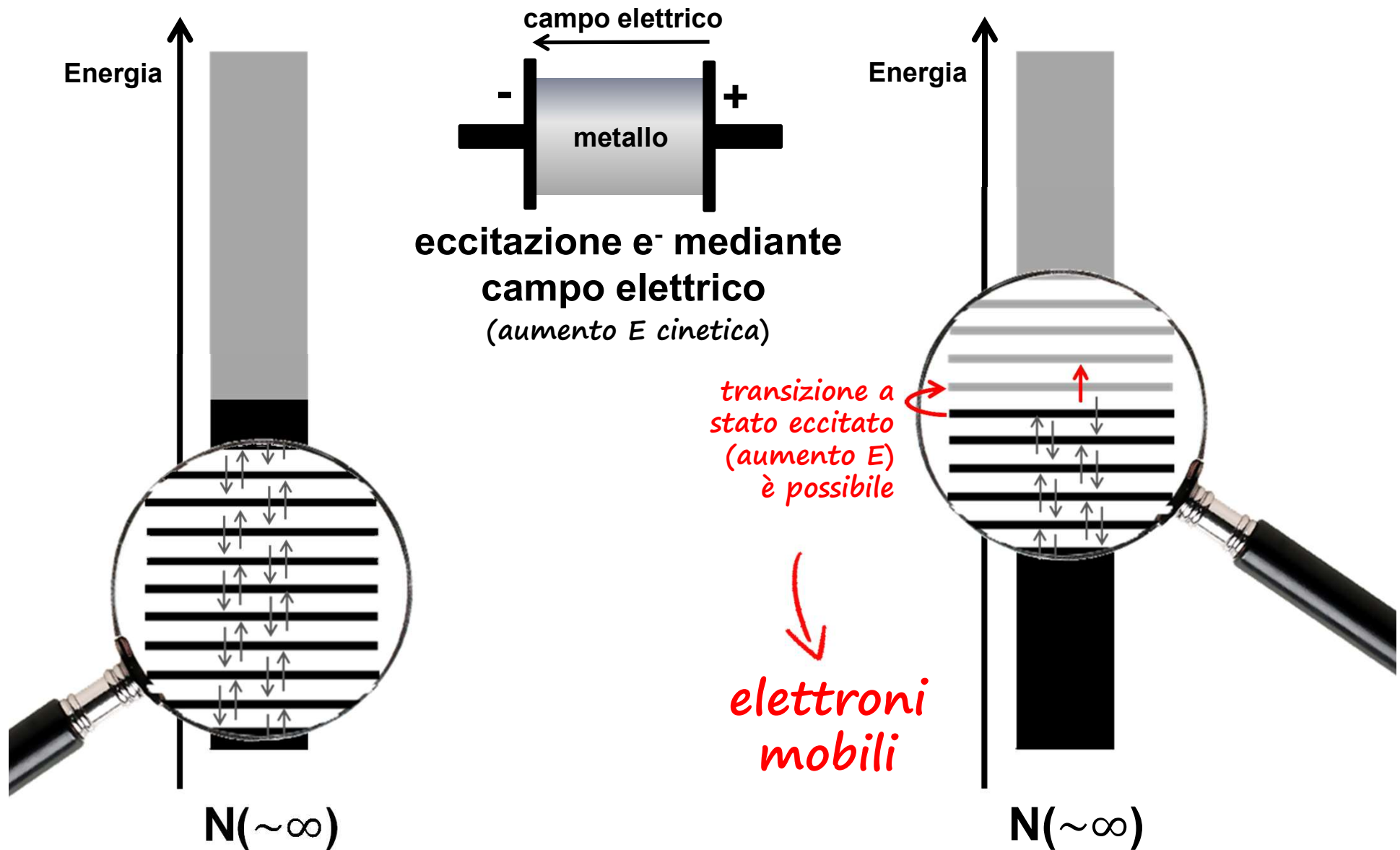
livello di Fermi



spiegazione conduzione elettrica



spiegazione conduzione elettrica



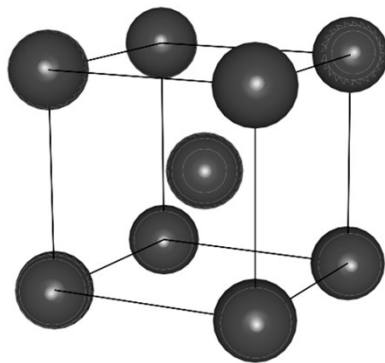
conduttori, isolanti e semiconduttori

conduttori

es. metalli

(celle bcc)

numero coordinazione 8
"buona" sovrapposizione
tra orbitali



Na, Li, ...

semiconduttori

es. semi-metalli (Si, Ge, ...)

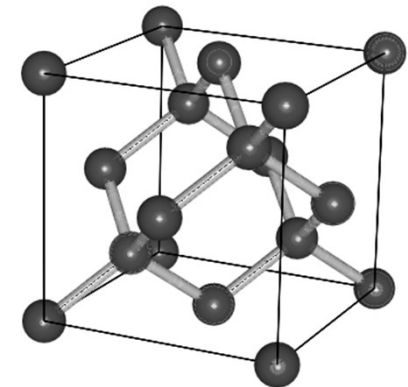
situazione intermedia

isolanti

es. non-metalli

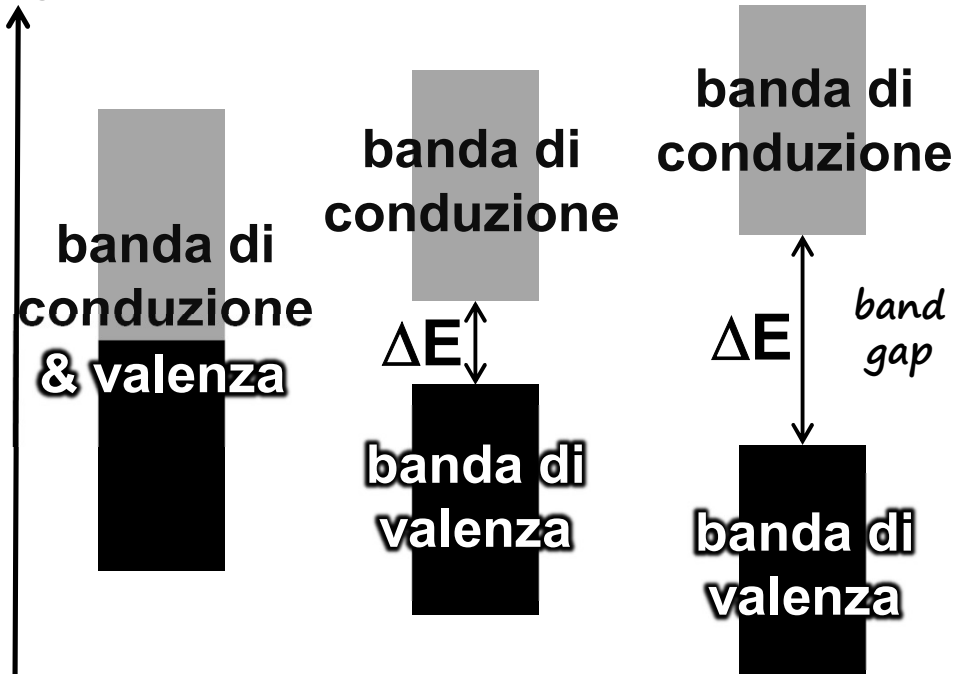
(celle + complesse)

numero coordinazione 4
"cattiva" sovrapposizione
tra orbitali

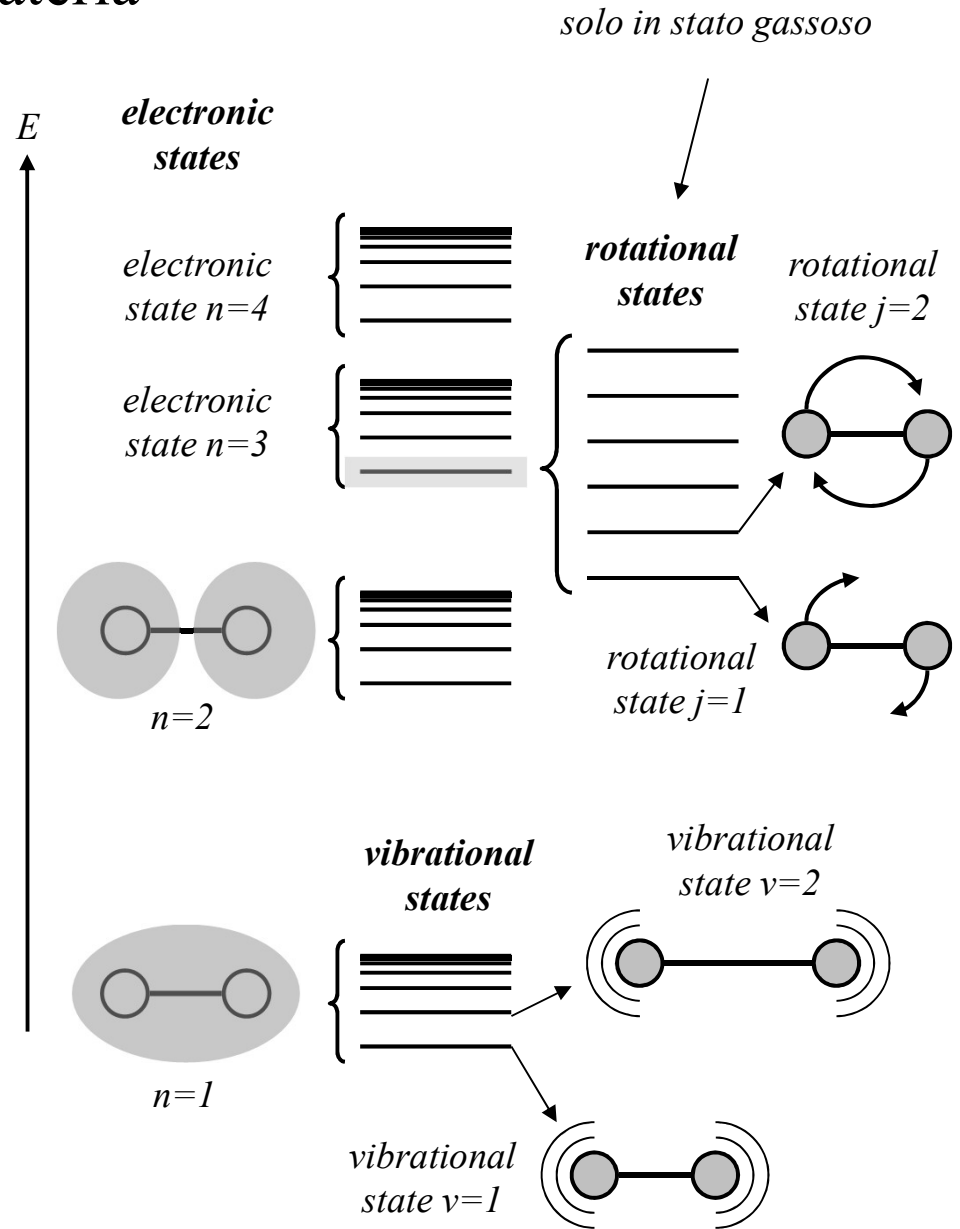
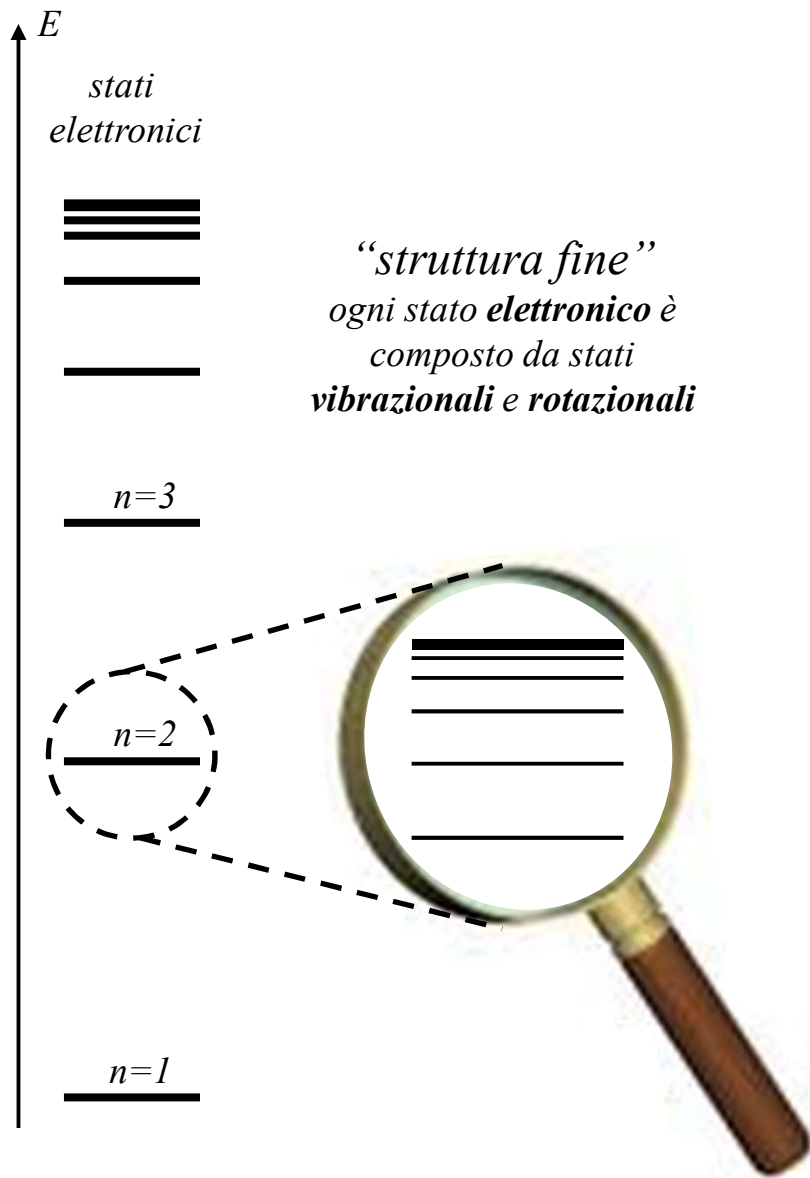


C (diamante)

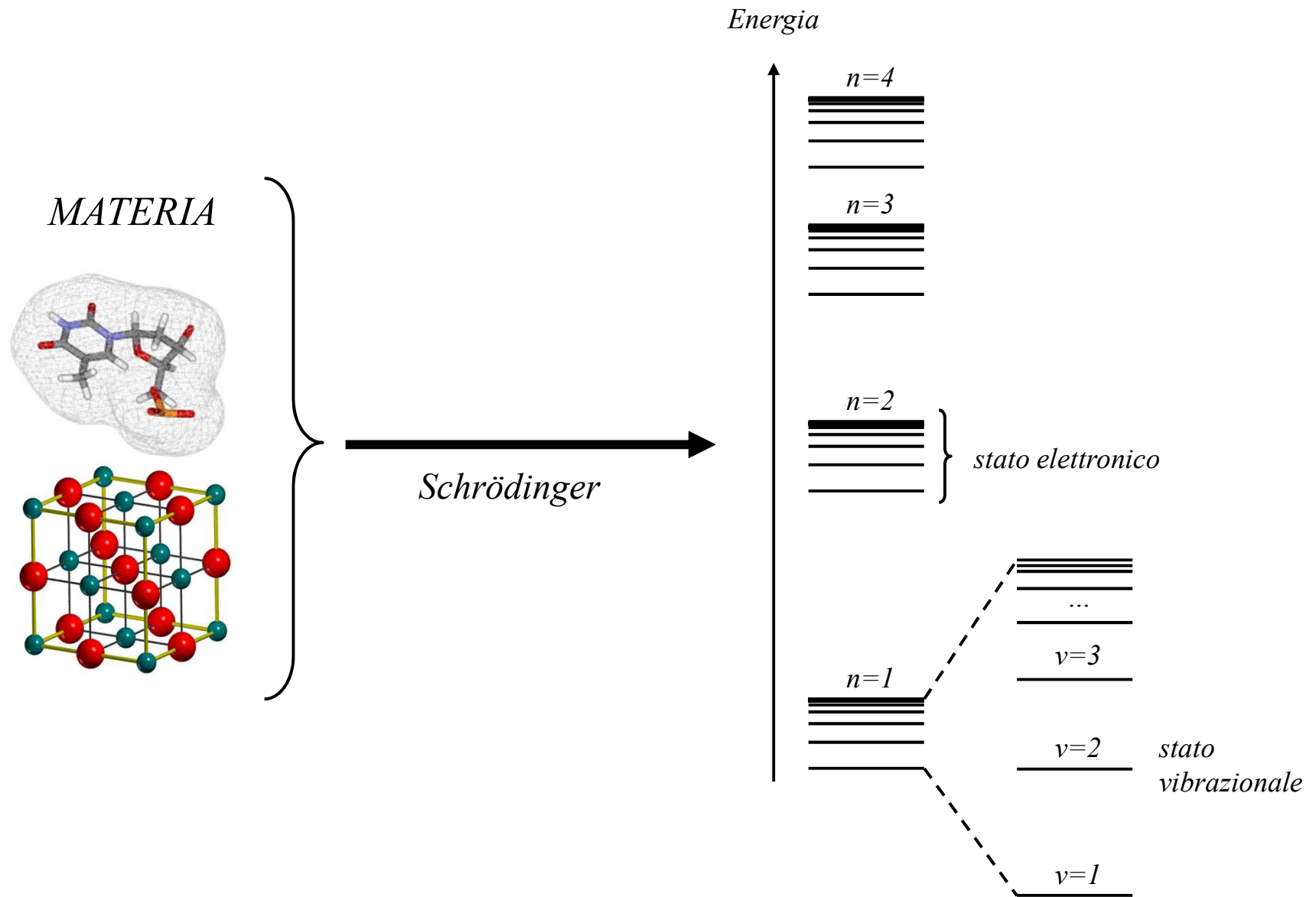
energia



La Struttura Quantistica della Materia



La Struttura Quantistica della Materia

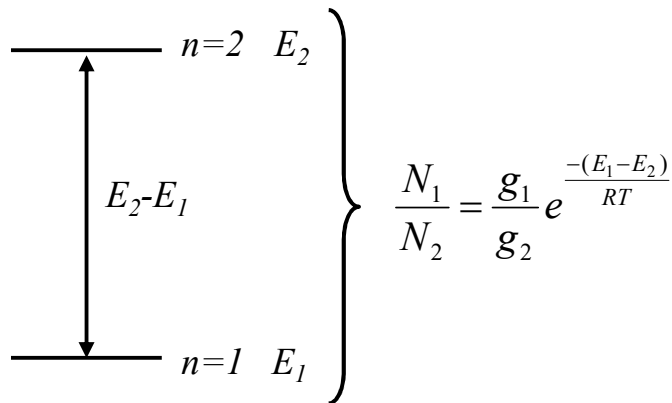
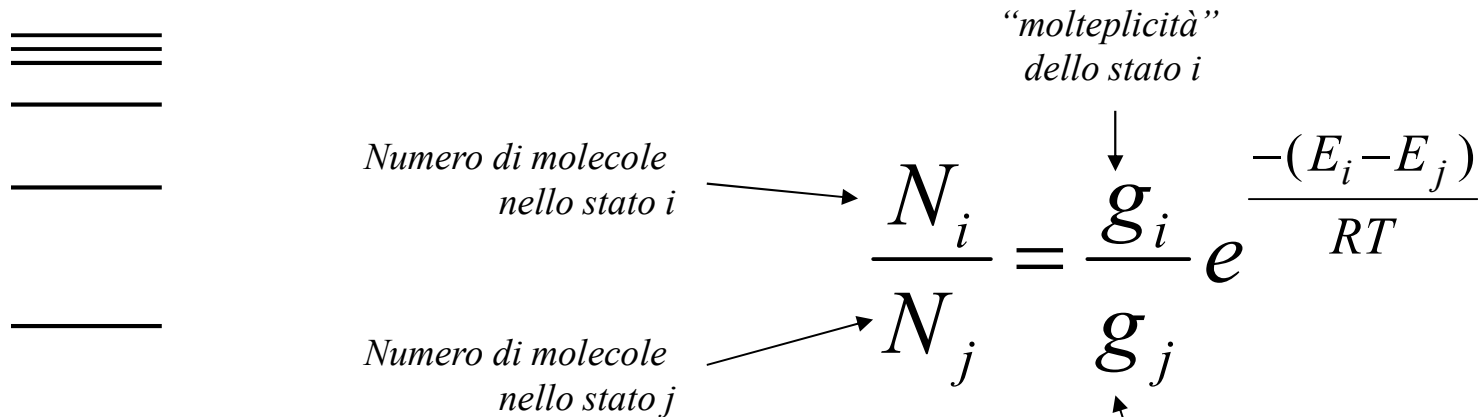


La Struttura Quantistica della Materia

*Che energia hanno
queste molecole?*

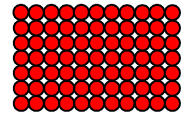
Numero di molecole in una mole di campione: 6.022×10^{23}

Quantità tipicamente utilizzate (1mL soluzione 100-0.1μM): $6.022 \times 10^{16} - 6.022 \times 10^{13}$ molecole



*Distribuzione di Boltzmann
valida all'equilibrio termico, ad una data
temperatura T ed in assenza di radiazione*

La Struttura Quantistica della Materia

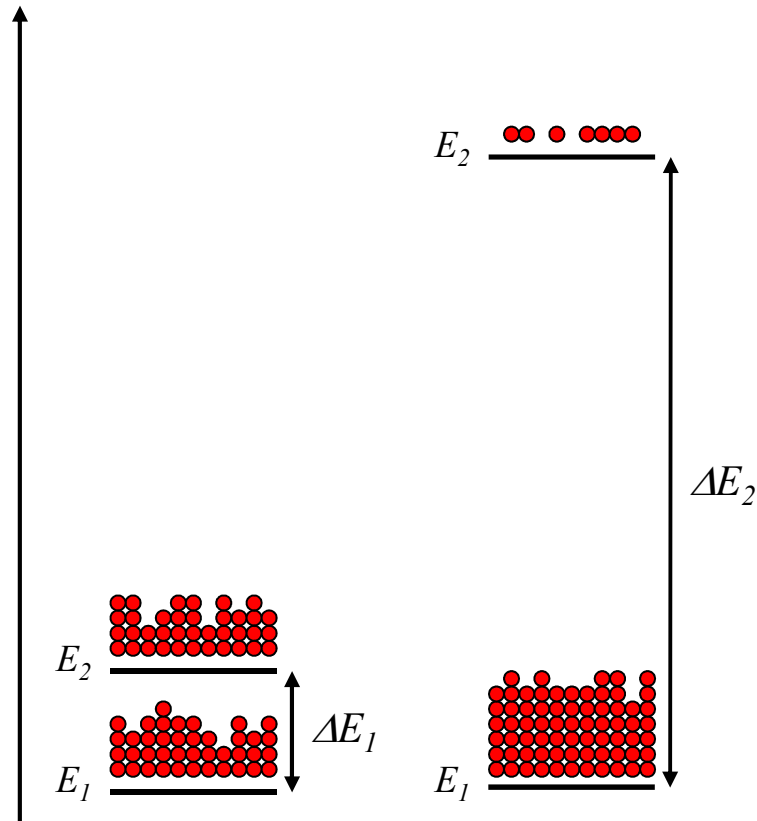


*insieme di molecole
di un campione*

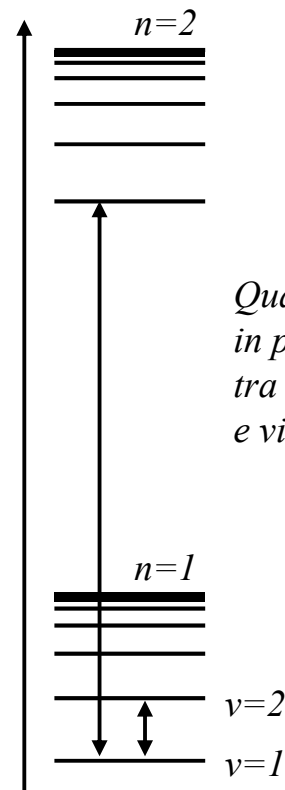
$$\frac{N_i}{N_j} = \frac{g_i}{g_j} e^{\frac{-(E_i - E_j)}{RT}}$$

*la differenza in popolazione è
proporzionale alla differenza in
energia tra i due stati, con lo
stato ad energia più bassa
avente la più alta popolazione*

Energia



Energia



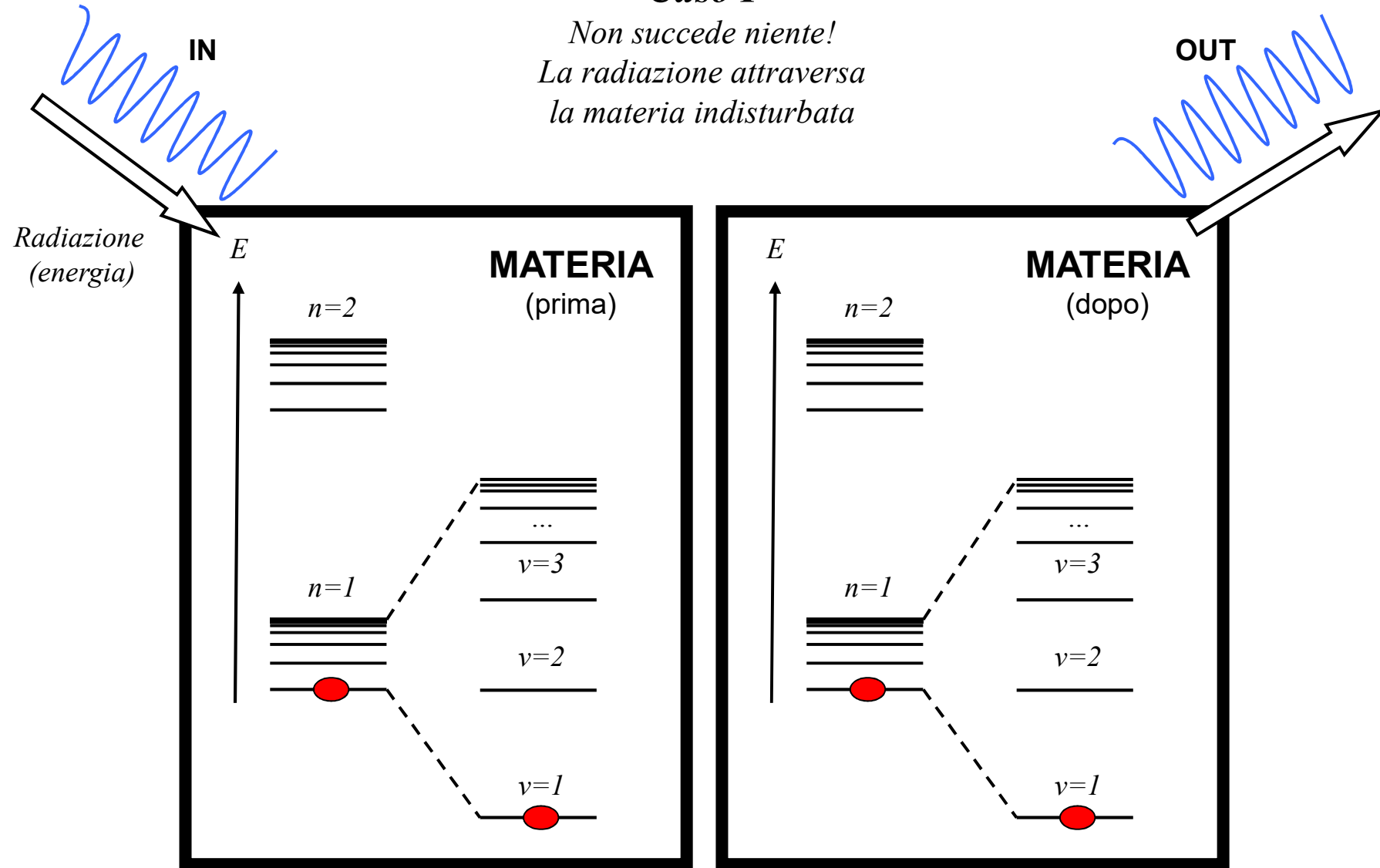
*Quale sarà la differenza
in popolazione
tra stati elettronici
e vibrazionali?*

interazione
LUCE-MATERIA

Interazione tra Radiazione e Materia

Caso I

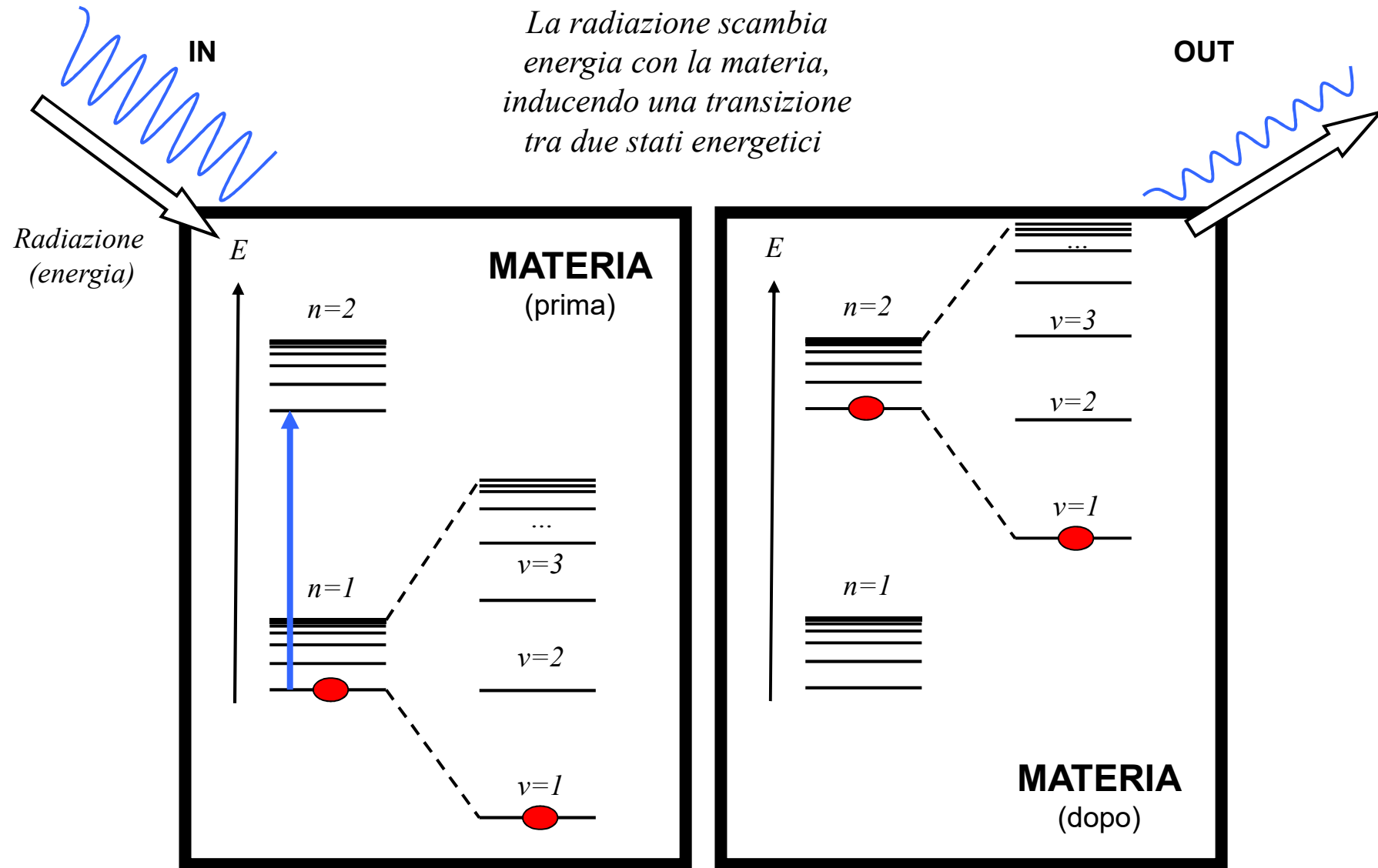
*Non succede niente!
La radiazione attraversa
la materia indisturbata*



Interazione tra Radiazione e Materia

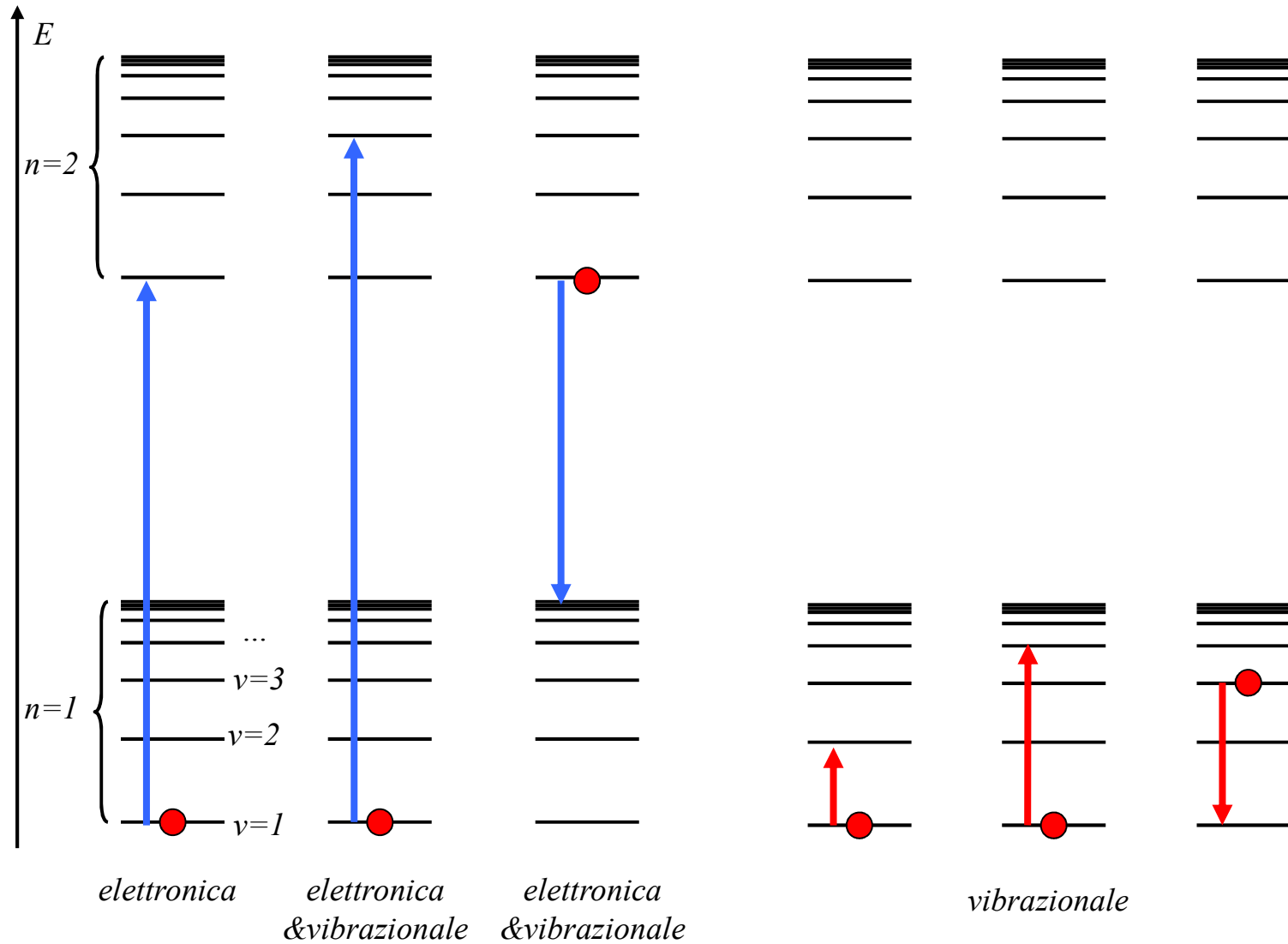
Caso II

La radiazione scambia energia con la materia, inducendo una transizione tra due stati energetici

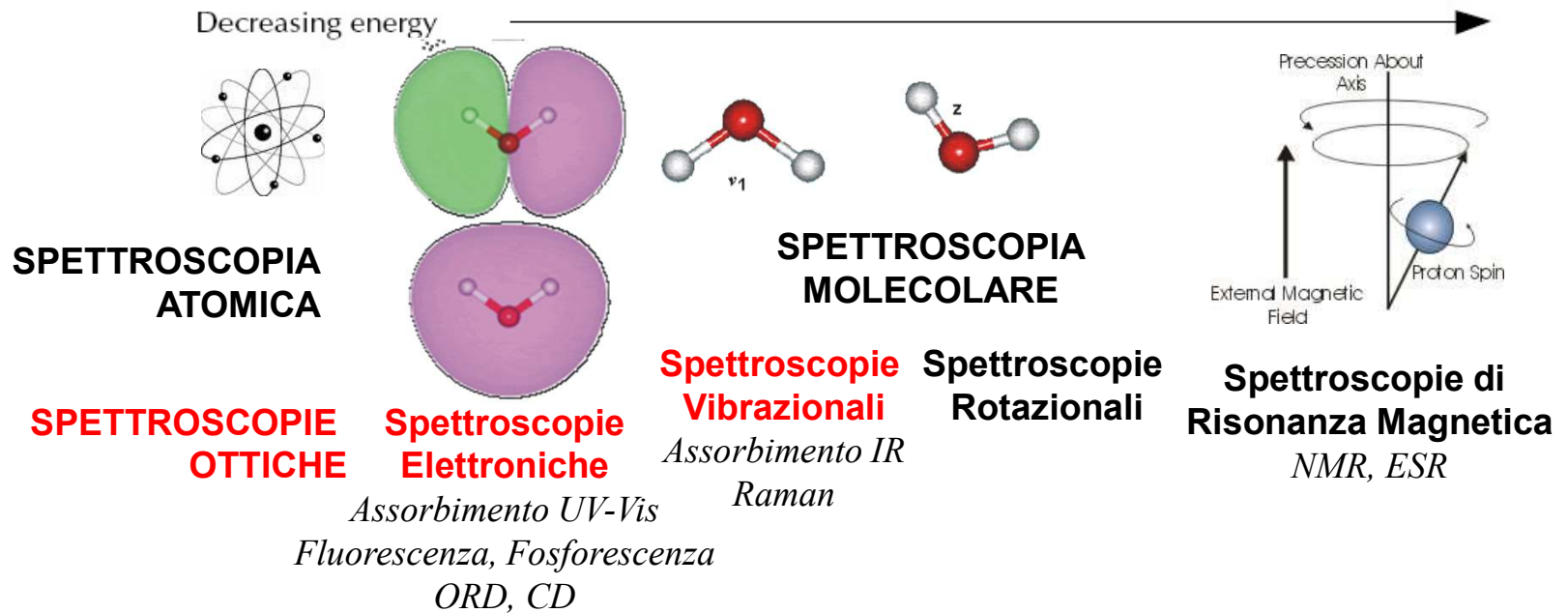
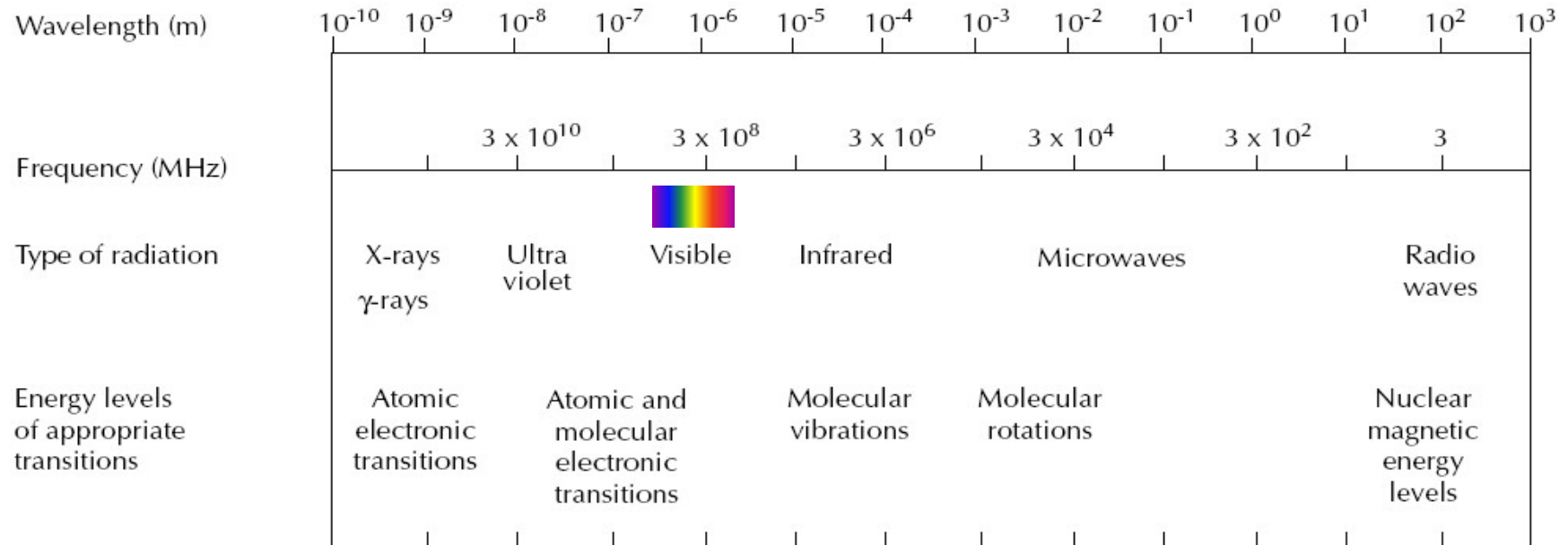


Interazione tra Radiazione e Materia

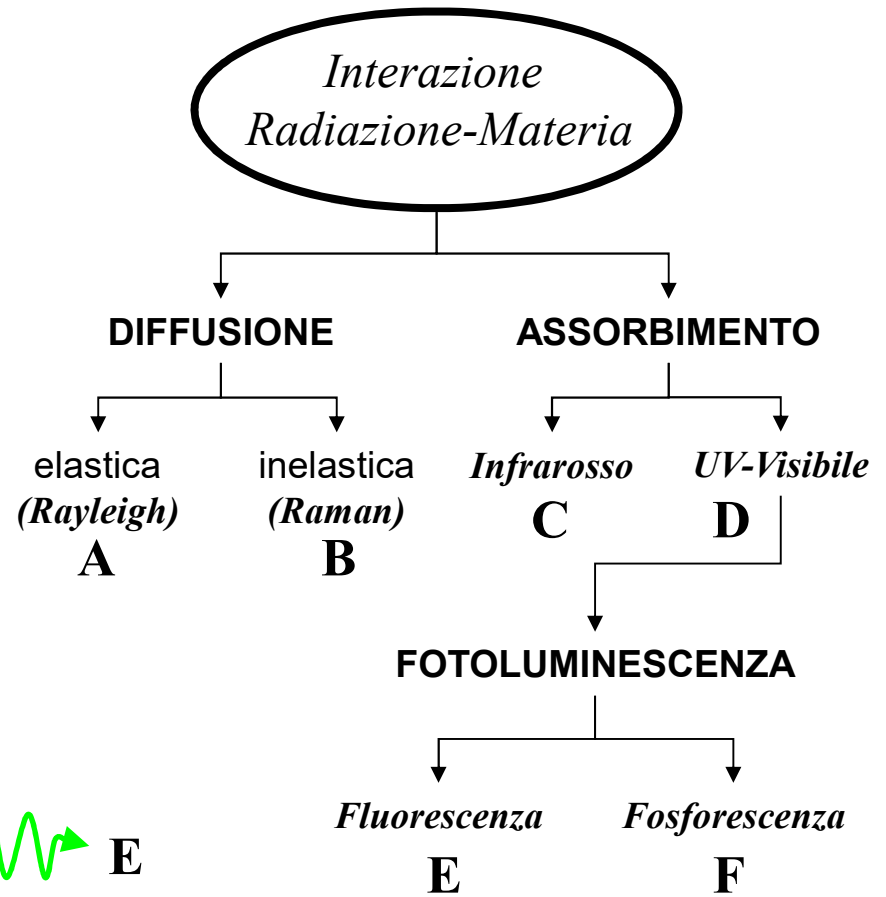
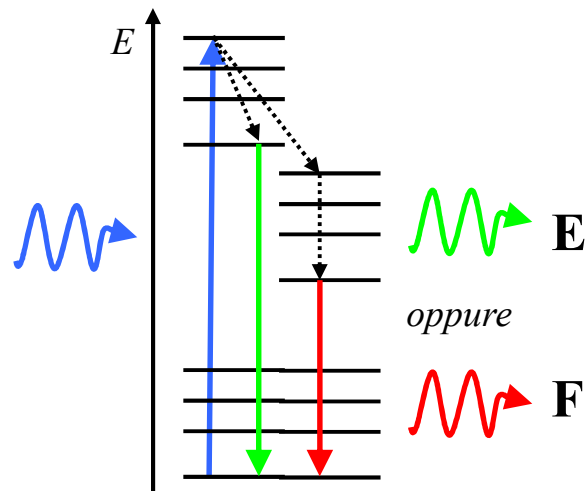
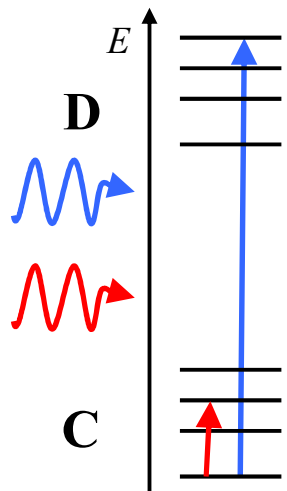
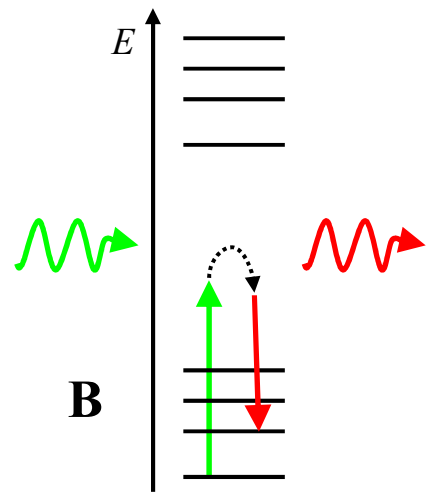
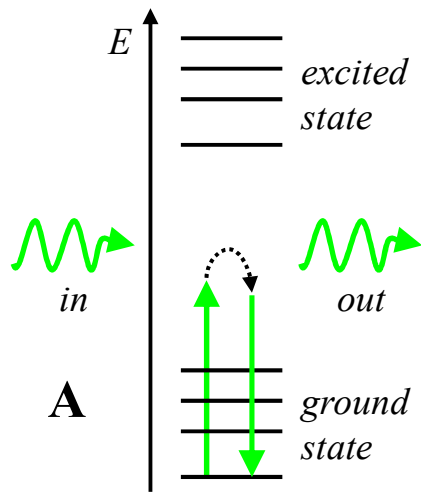
Diversi tipi di transizione: diverse energie in gioco!



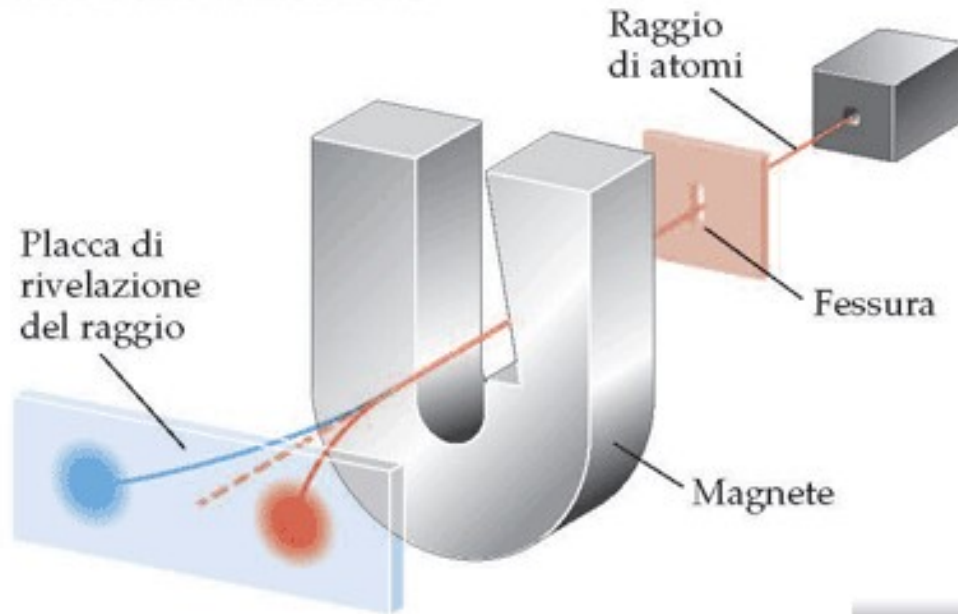
Interazione tra Radiazione e Materia



Interazione tra Radiazione e Materia

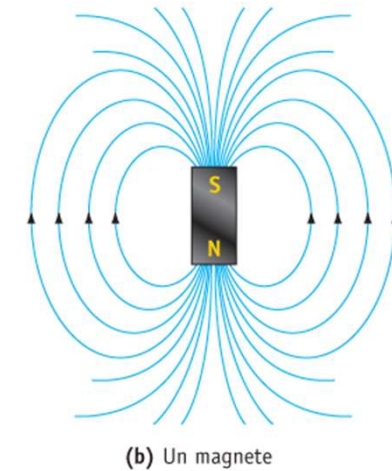
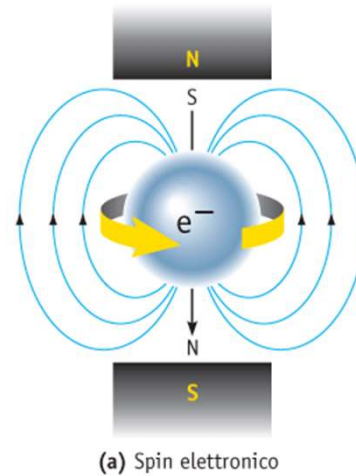


lo spin elettronico

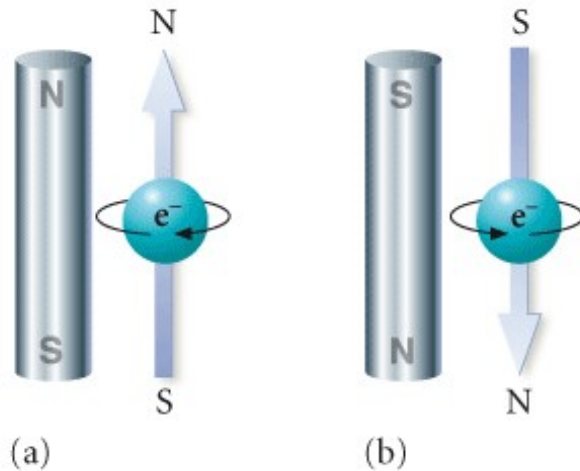


**esperimento
Stern-Gerlach (1921)**

scoperta dello
spin elettronico
Uhlenbeck-Goudsmit (1925)



il numero quantico di spin m_s



lo spin elettronico è

quantizzato

può assumere solo 2 possibili orientazioni del dipolo magnetico (due versi di rotazione)

si introduce un

numero quantico di spin

può assumere solo due valori, corrispondenti a 2 possibili orientazioni del dipolo magnetico

$$m_s$$
$$+\frac{1}{2} (\uparrow) \quad -\frac{1}{2} (\downarrow)$$

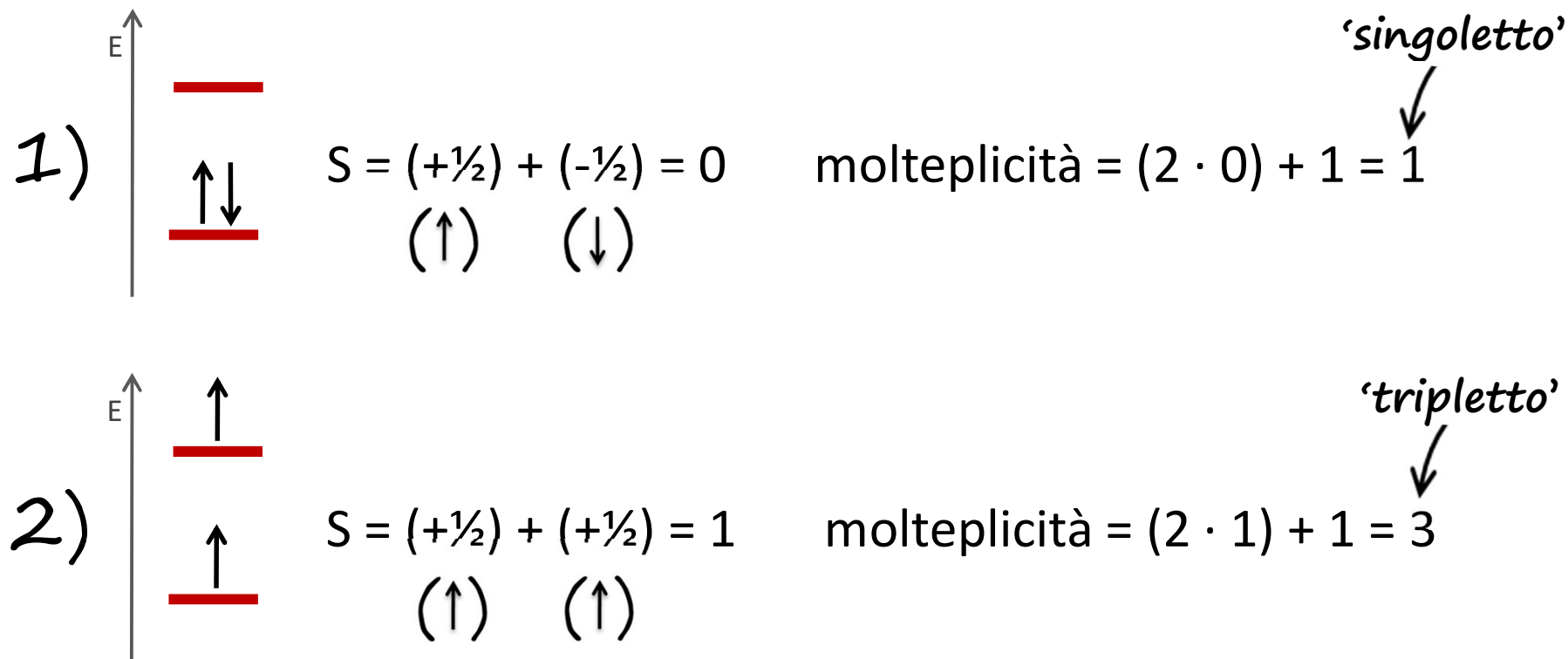
spin "up" spin "down"

stati elettronici di tripletto e singoletto

in una molecola di sono più ($n > 2$) elettroni...

*S è lo spin totale
(somma di tutti gli spin)*

$$\text{molteplicità di spin} = 2 \cdot S + 1$$

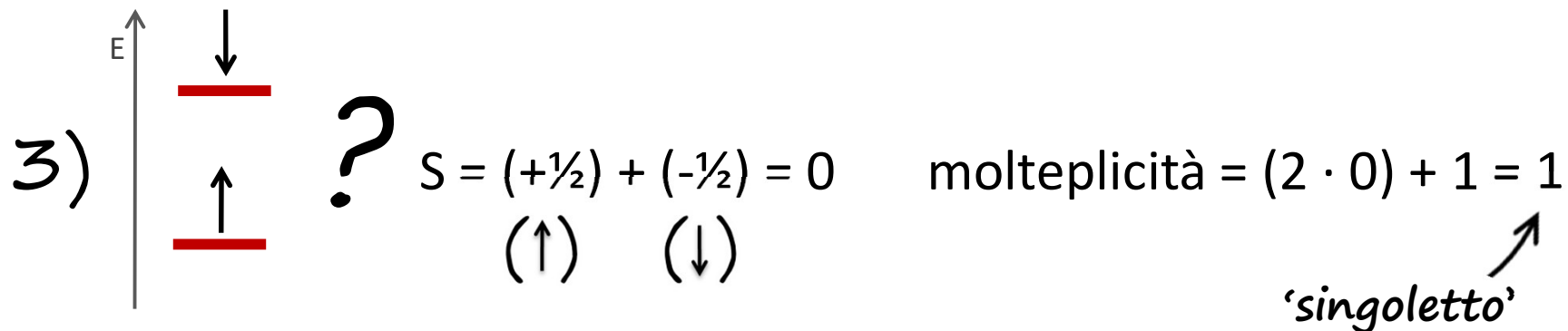


stati elettronici di tripletto e singoletto

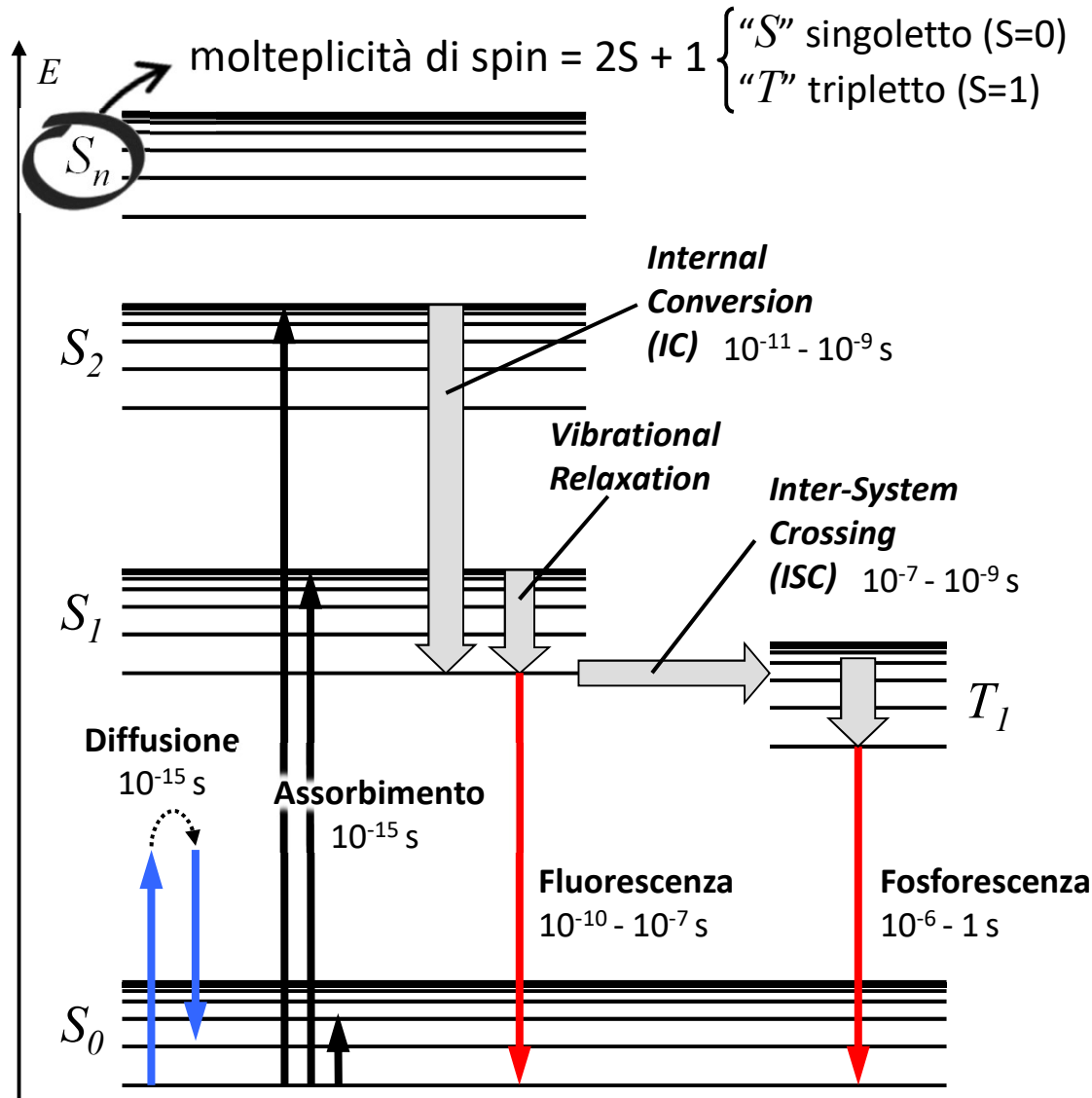
in una molecola di sono più ($n > 2$) elettroni...

S è lo spin totale
(somma di tutti gli spin)

$$\text{molteplicità di spin} = 2 \cdot S + 1$$






Interazione tra Radiazione e Materia (diagramma di Jablonski)



REGOLE DI SELEZIONE

Stabiliscono quali transizioni possono avvenire (i.e. hanno più probabilità di avvenire)

per transizioni elettroniche
 $\Delta S = 0$

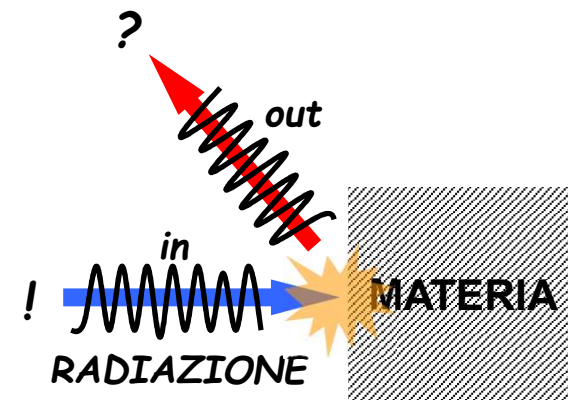
-  transizioni con assorbimento di radiazione
-  transizioni **radiative** (con emissione di radiazione)
-  transizioni **non radiative** (senza emissione di radiazione)

Strumentazione Spettroscopia Ottica

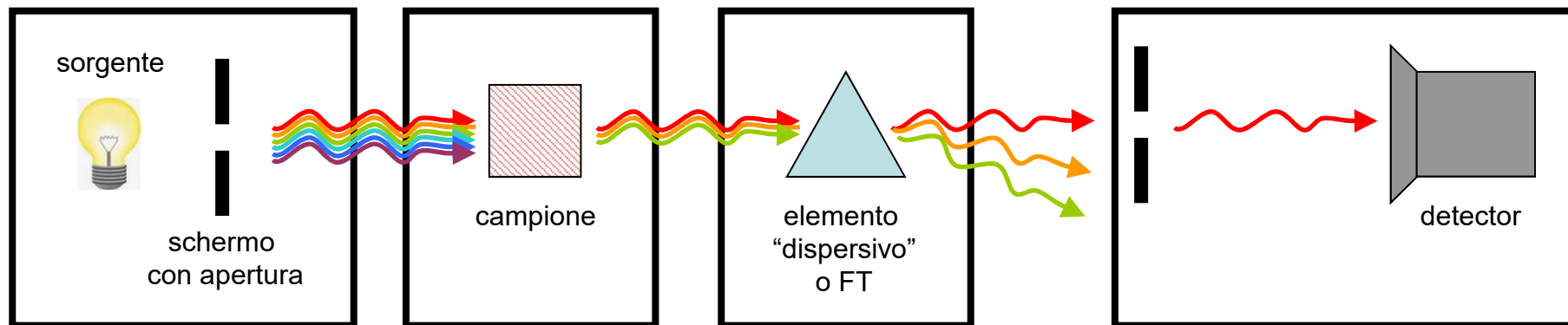
Strumentazione in Spettroscopia Ottica

SCOPO:

1. selezionare/determinare la radiazione *incidente* sulla materia (*poli- / mono-cromatica*)
2. analizzare la radiazione dopo l'interazione con la materia



Esempio spettroscopia di Assorbimento UV-vis



sorgente di radiazione

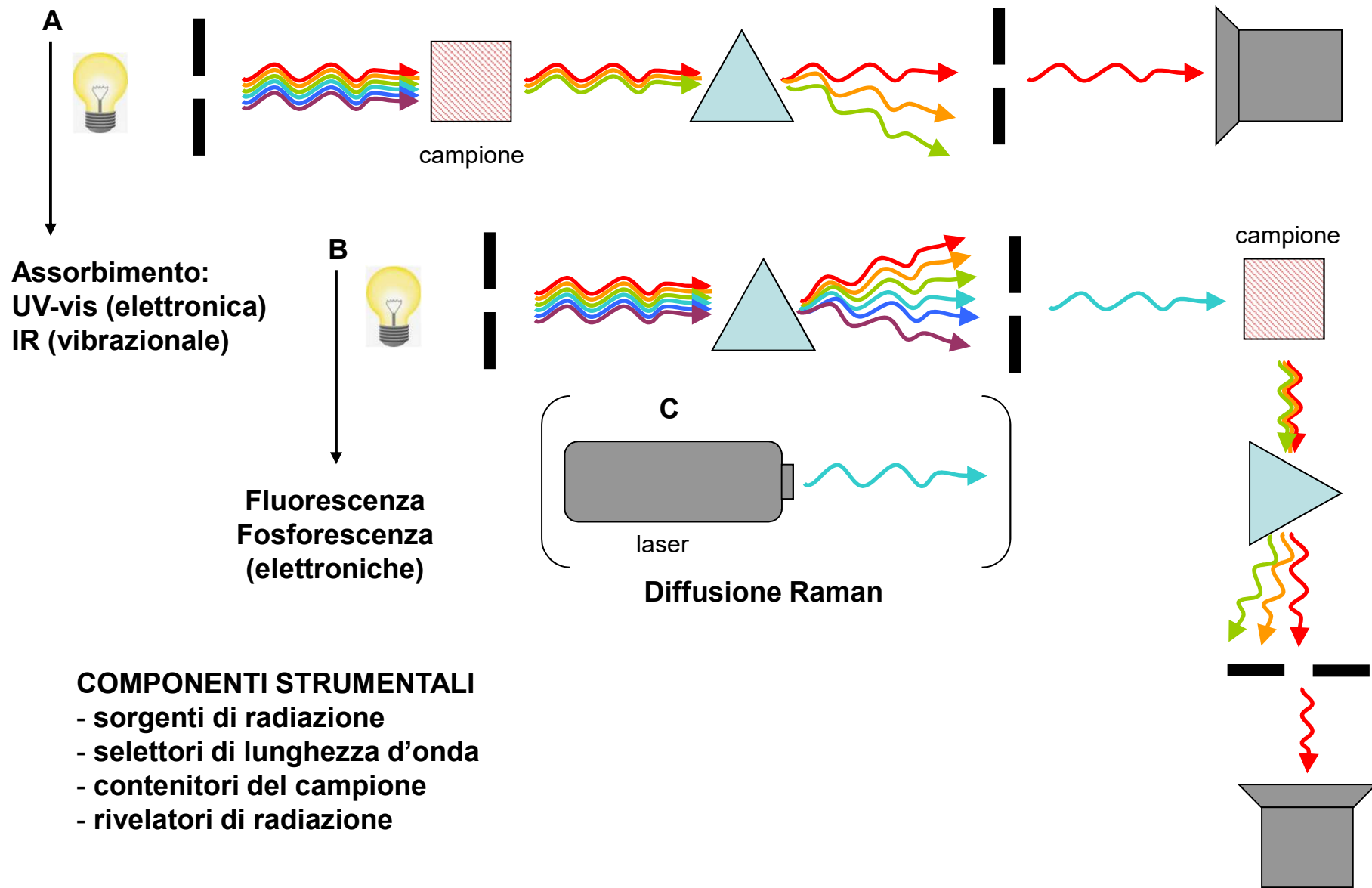
campione

analizzatore componenti radiazione

sistema di rilevazione

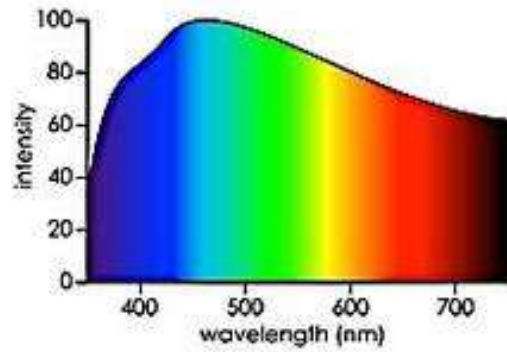
Componenti presenti in tutte le spettroscopie ottiche (cambiano le caratteristiche e la sequenza e geometria)

Strumentazione in Spettroscopia Ottica

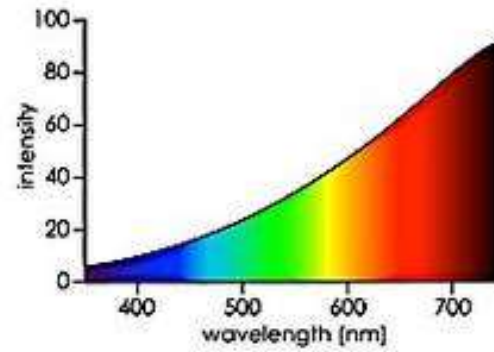




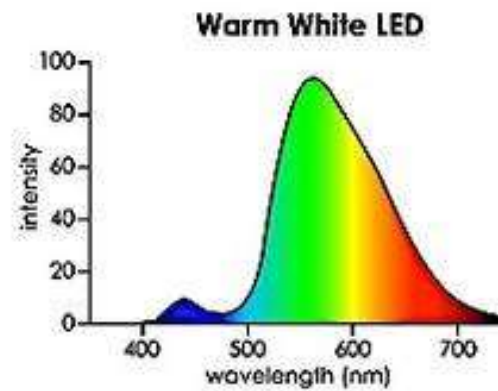
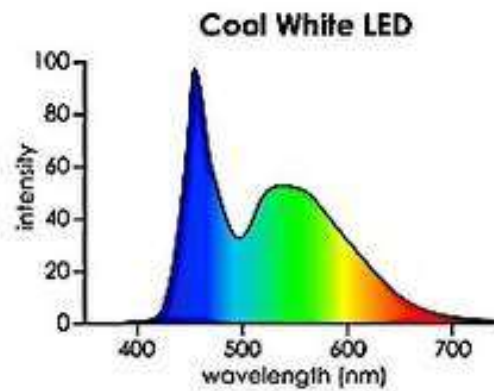
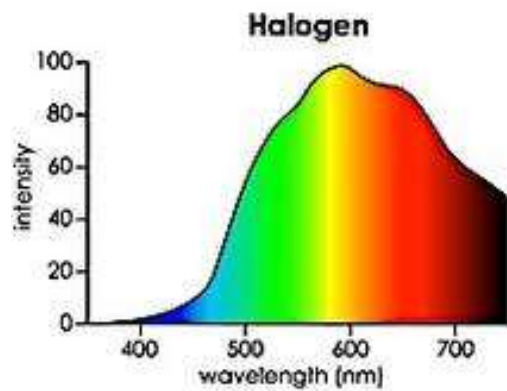
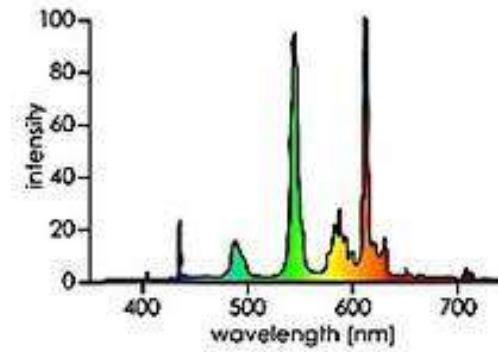
Daylight



Incandescent

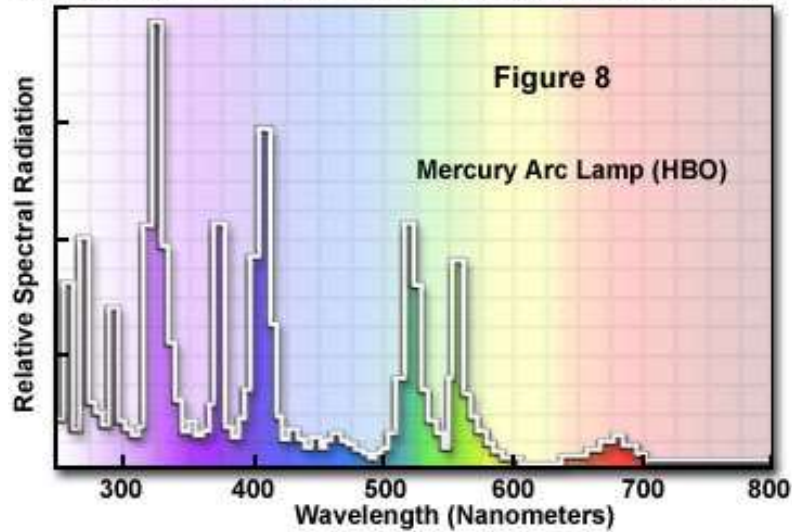


Fluorescent

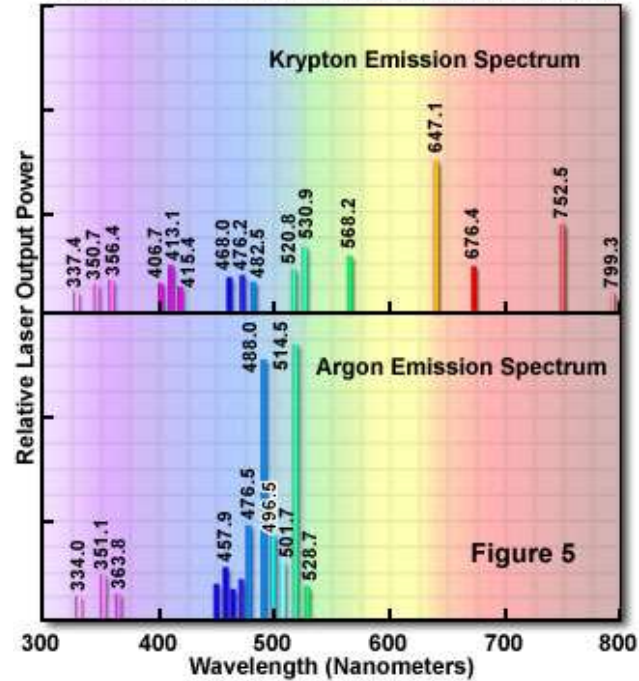


Strumentazione in Spettroscopia Ottica

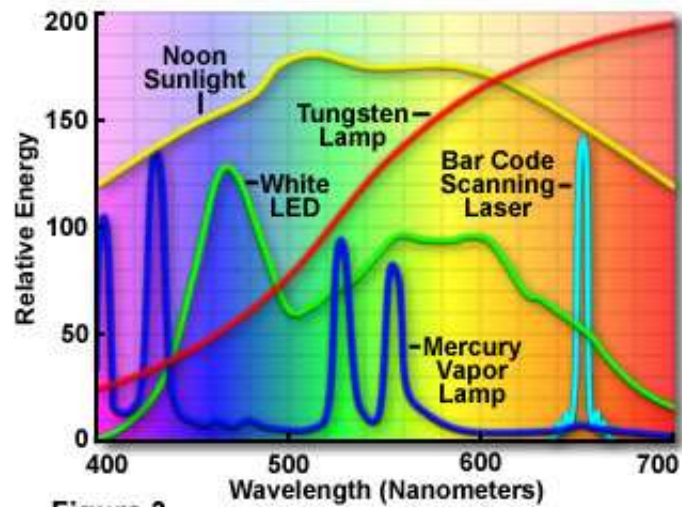
Mercury Arc Lamp UV and Visible Emission Spectrum



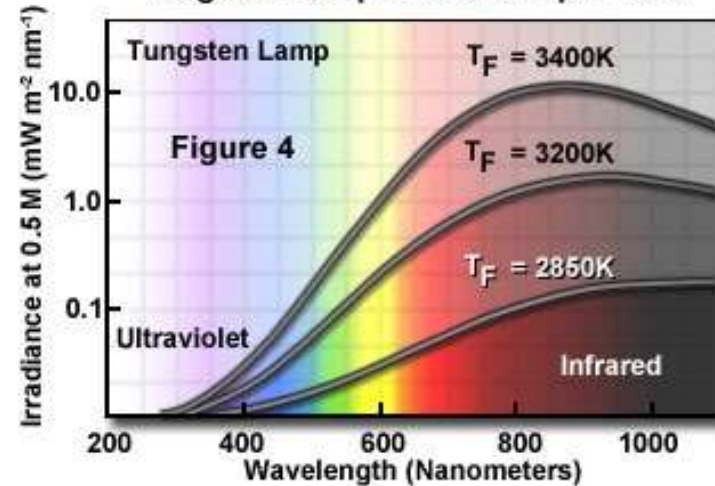
Laser Illumination Source Emission Spectra



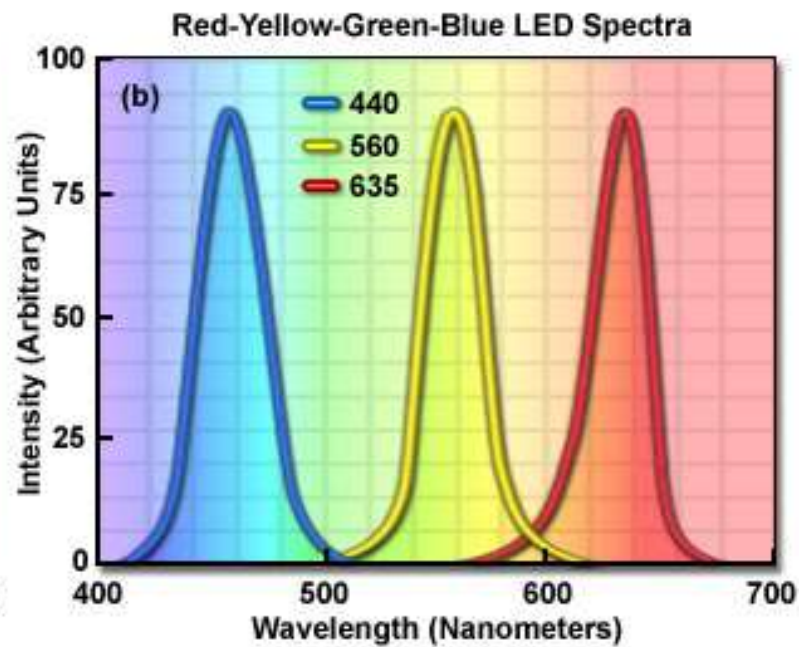
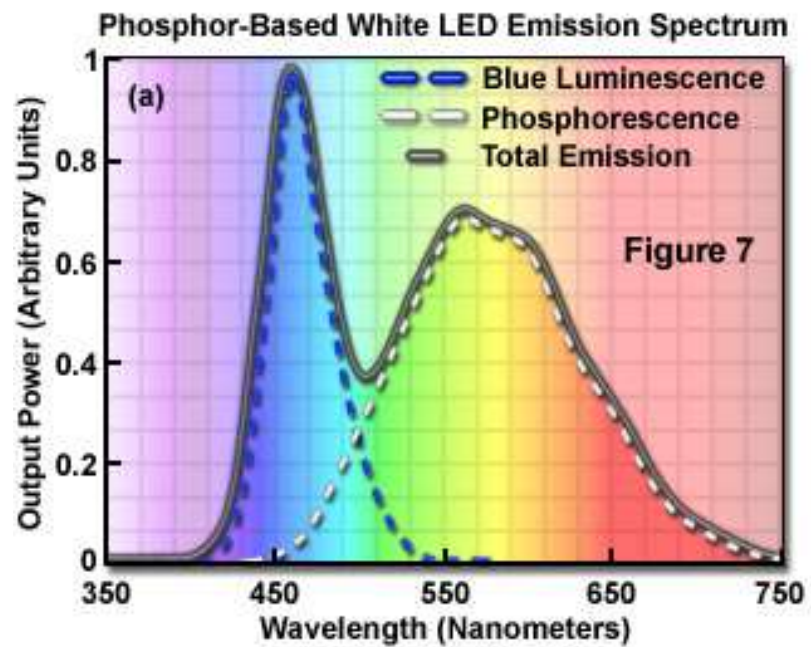
Spectra From Common Sources of Visible Light



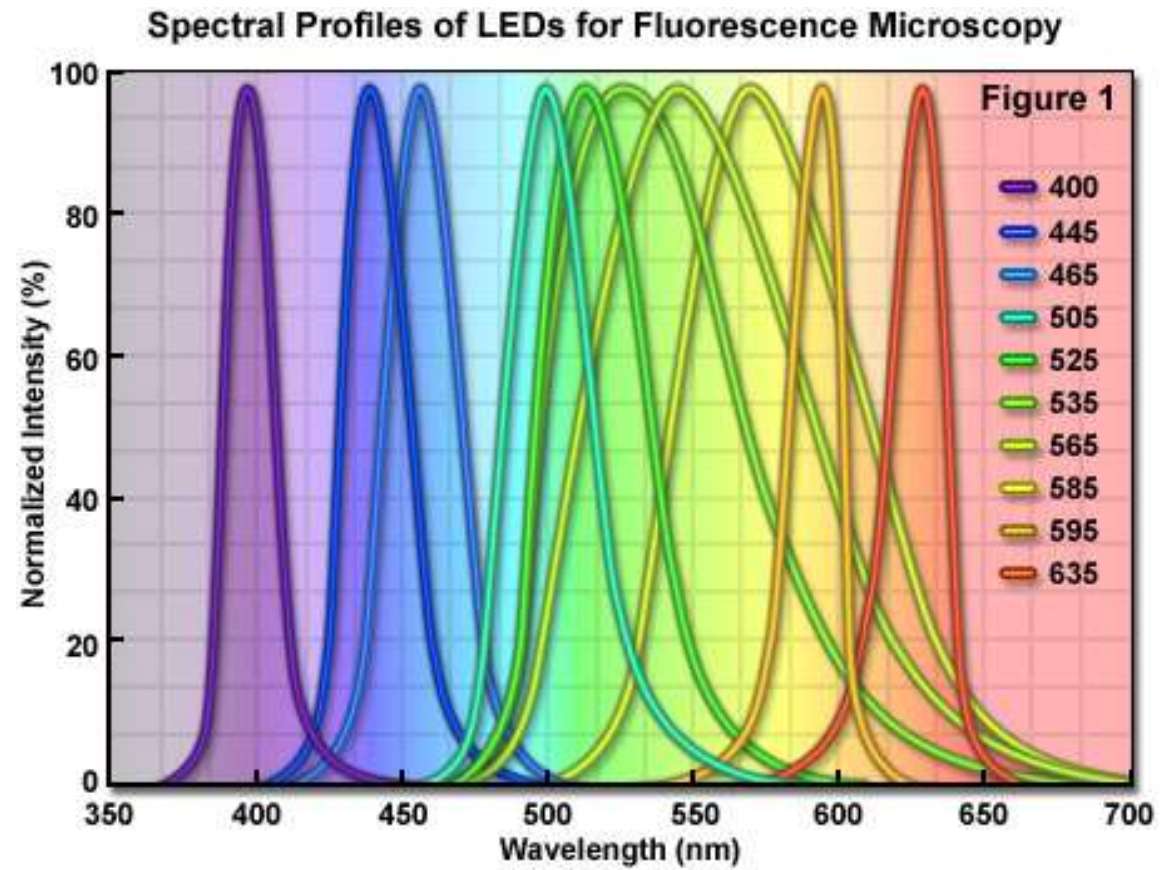
Tungsten Lamp Emission Spectrum

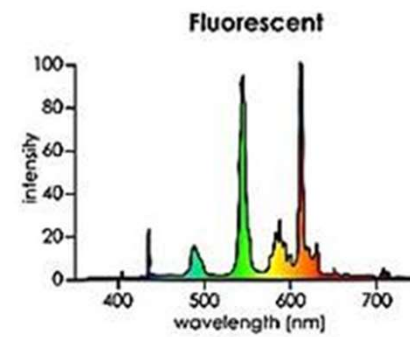
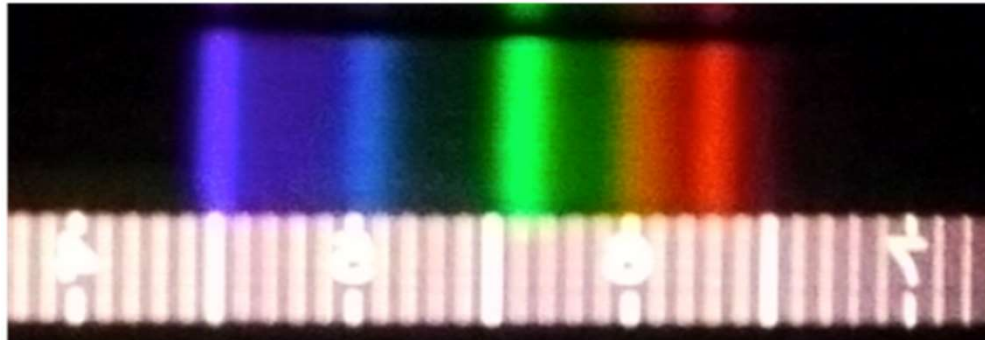
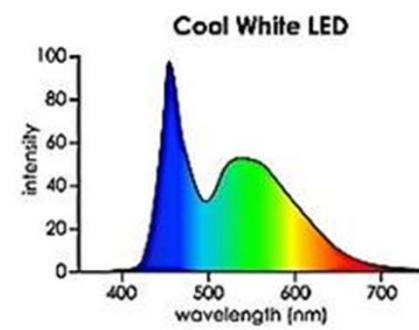
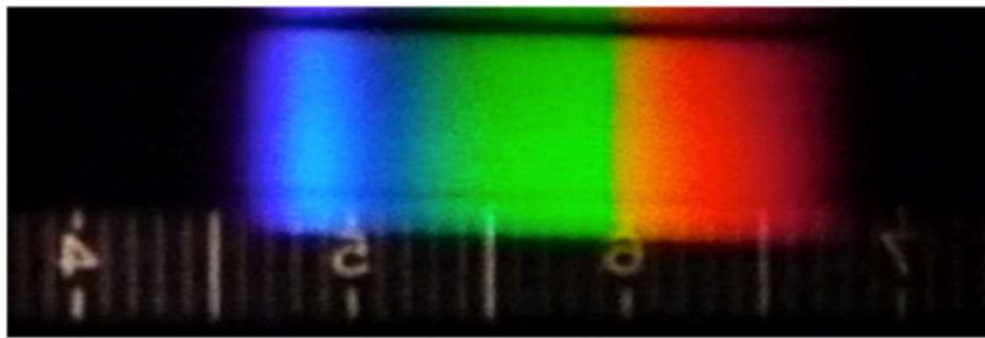
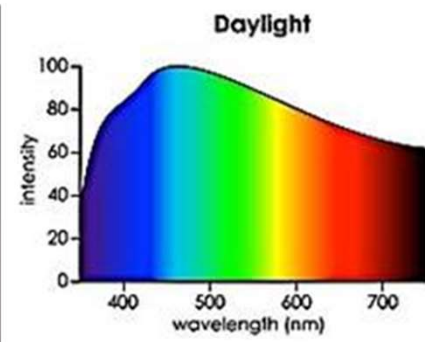
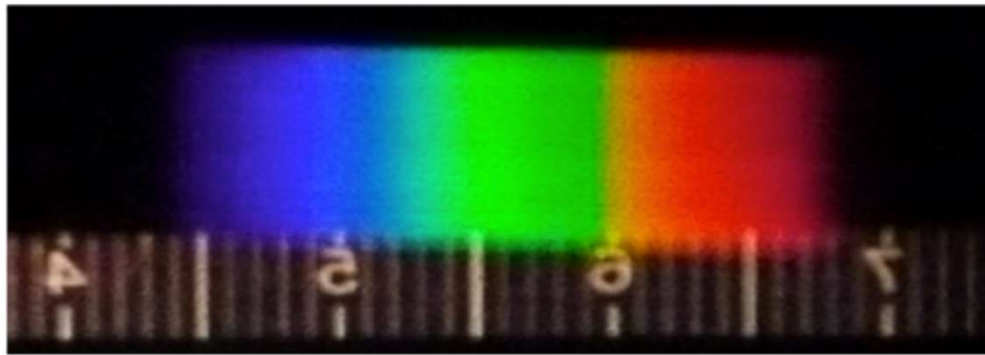


White Light LEDs

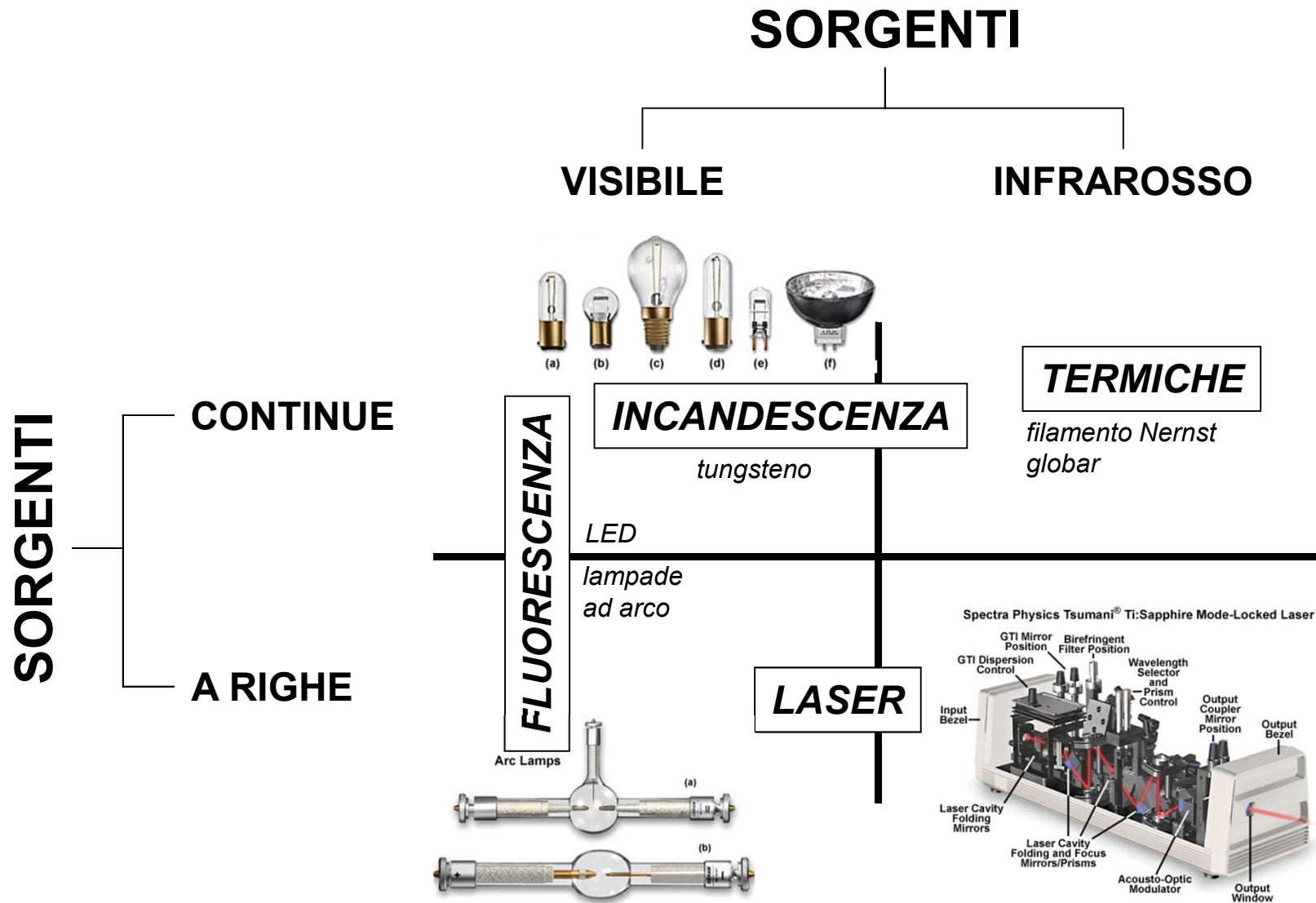


LED (Light-Emitting Diode)





Strumentazione in Spettroscopia Ottica



Strumentazione in Spettroscopia Ottica

D.Harvey, "Modern Analytical Chemistry", McGraw-Hill, 2000

Table 10.3 Common Sources of Electromagnetic Radiation for Spectroscopy

Source	Wavelength Region	Useful for
H ₂ and D ₂ lamp	continuum source from 160–380 nm	UV molecular absorption
tungsten lamp	continuum source from 320–2400 nm	Vis molecular absorption
Xe arc lamp	continuum source from 200–1000 nm	molecular fluorescence
Nernst glower	continuum source from 0.4–20 μm	IR molecular absorption
globar	continuum source from 1–40 μm	IR molecular absorption
nichrome wire	continuum source from 0.75–20 μm	IR molecular absorption
hollow cathode lamp	line source in UV/Vis	atomic absorption
Hg vapor lamp	line source in UV/Vis	molecular fluorescence
laser	line source in UV/Vis	atomic and molecular absorption, fluorescence and scattering

Abbreviations: UV: ultraviolet; Vis: visible; IR: infrared.

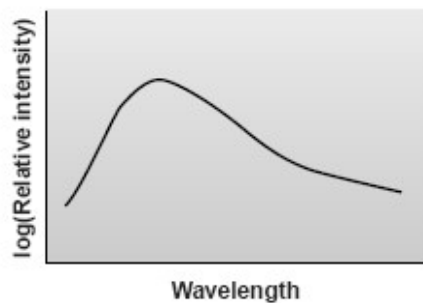


Figure 10.8
Emission spectrum from a typical continuum source.

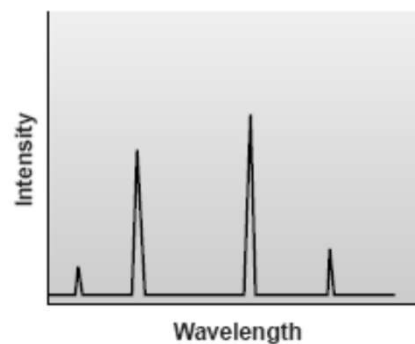
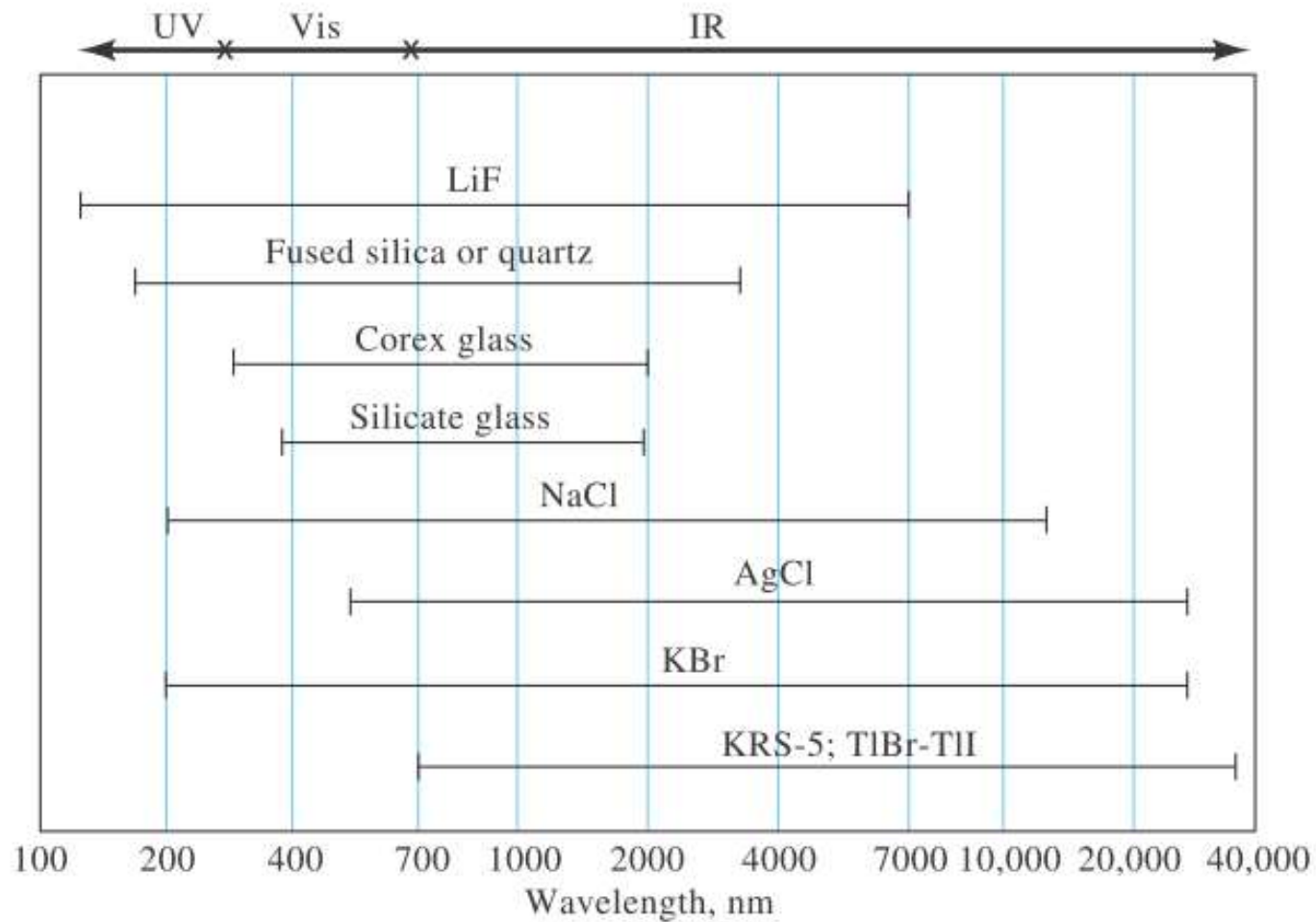


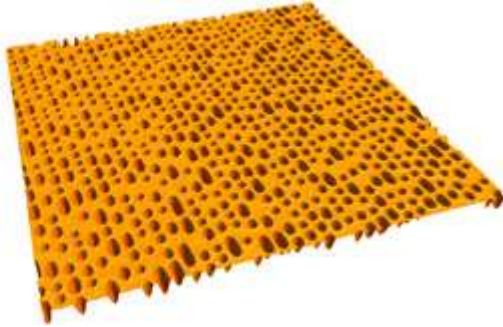
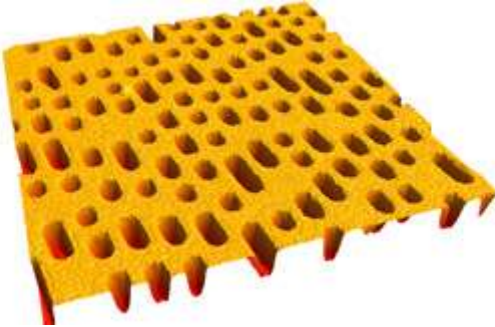
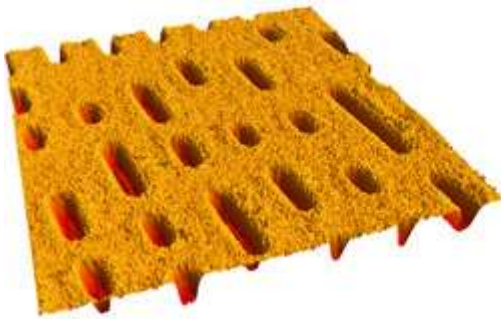
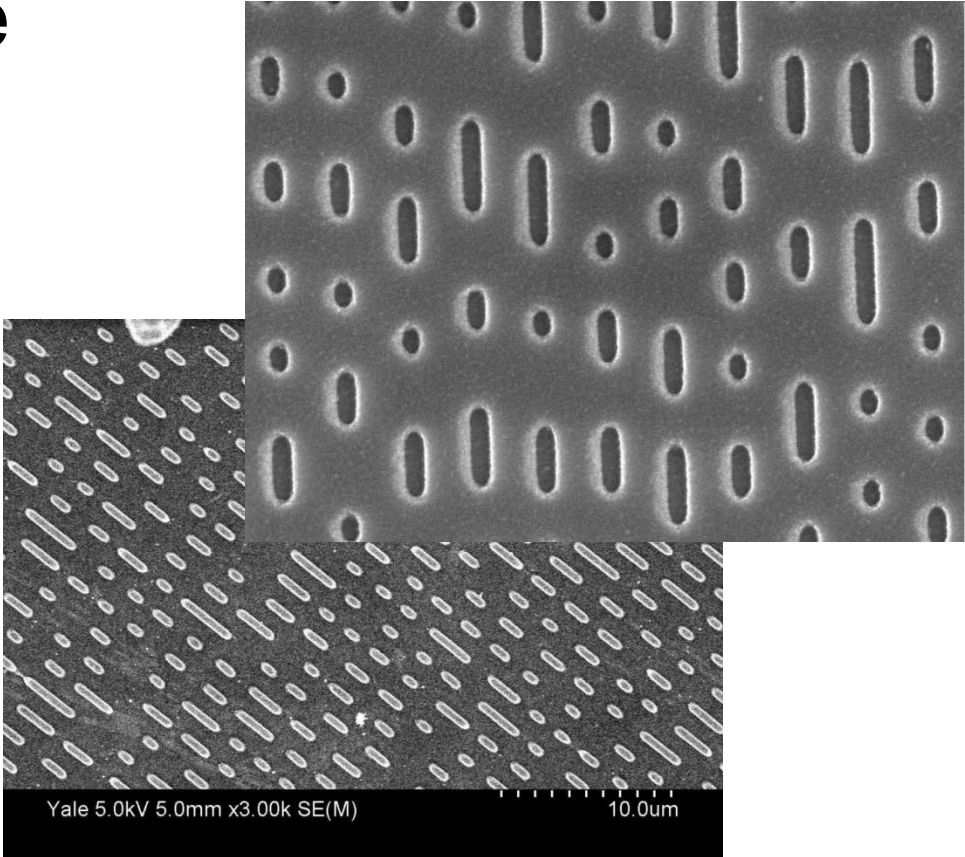
Figure 10.9
Emission spectrum from a typical line source.

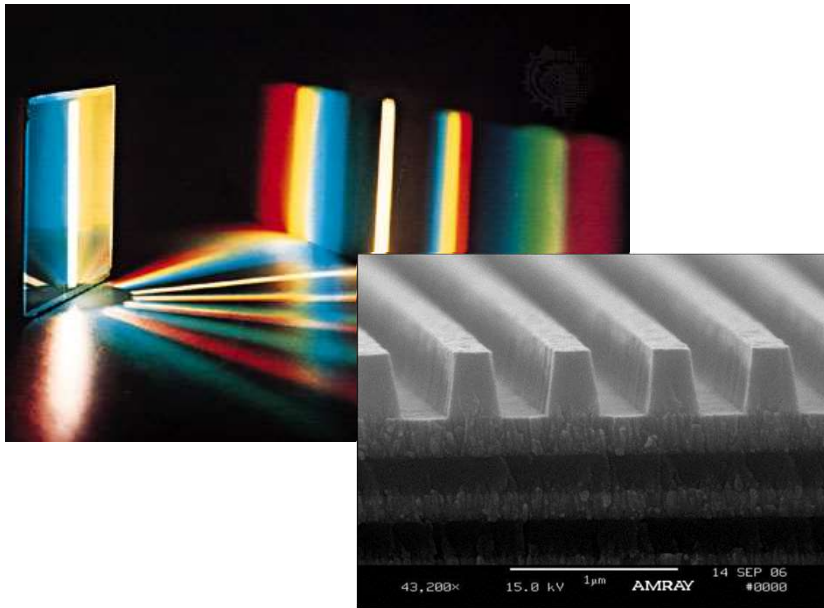
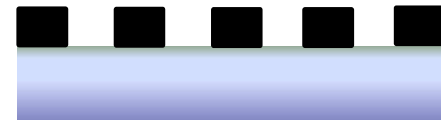
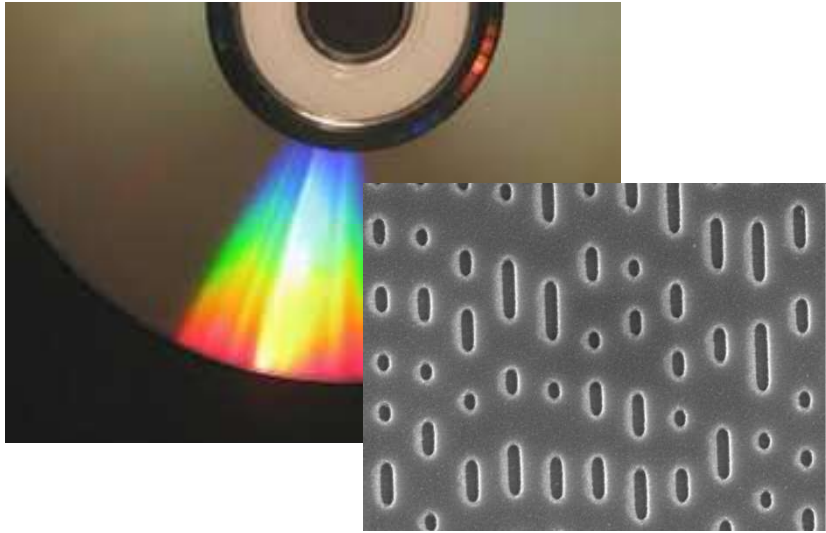
Strumentazione in Spettroscopia Ottica

**UTILIZZO MATERIALI ADATTI
(TRASPARENTI ALLA RADIAZIONE UTILIZZATA)**



Diffrazione della luce





Strumentazione in Spettroscopia Ottica

SELETTORI DI LUNGHEZZA D'ONDA

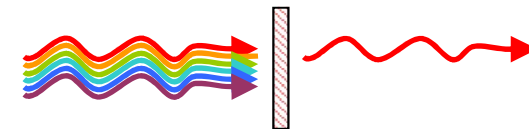
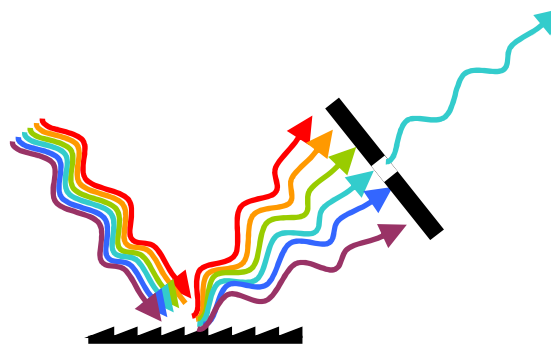
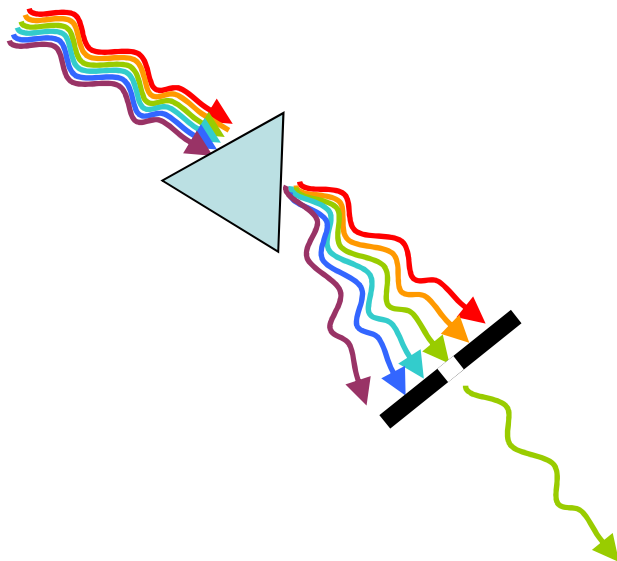
PRISMA

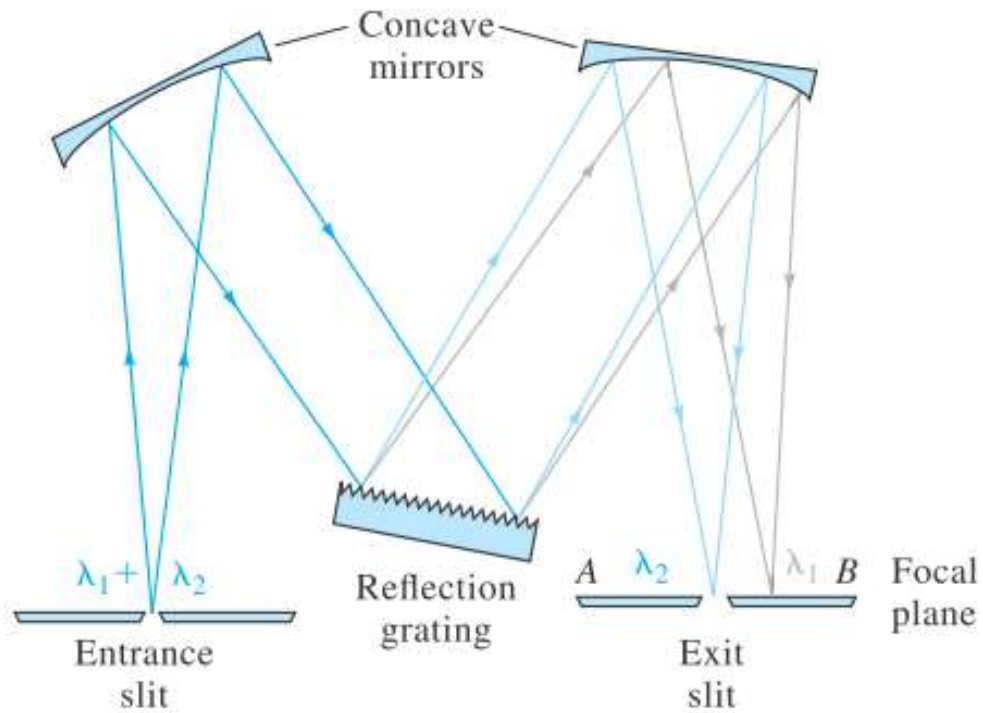


RETICOLI



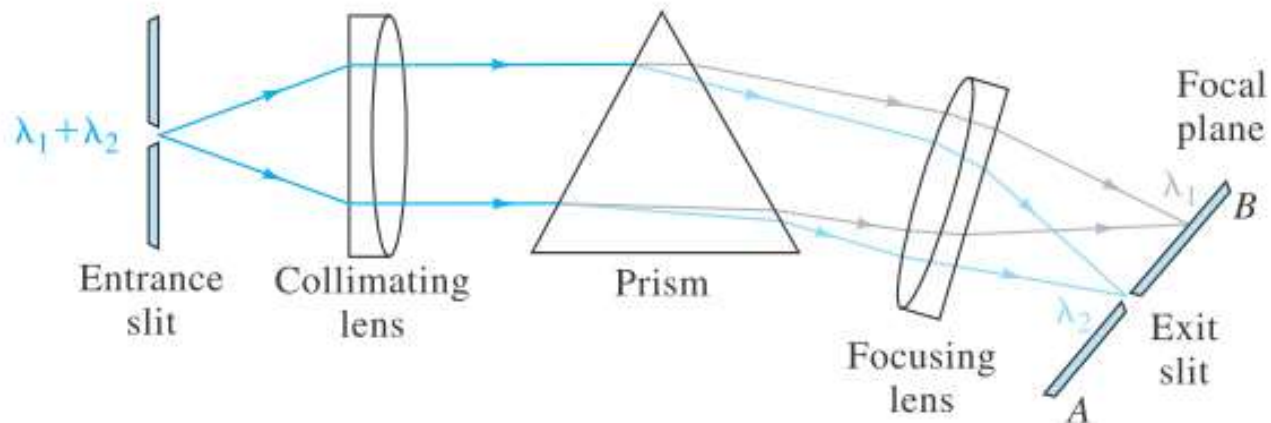
FILTRI





Monocromatore
a reticolo

(a)



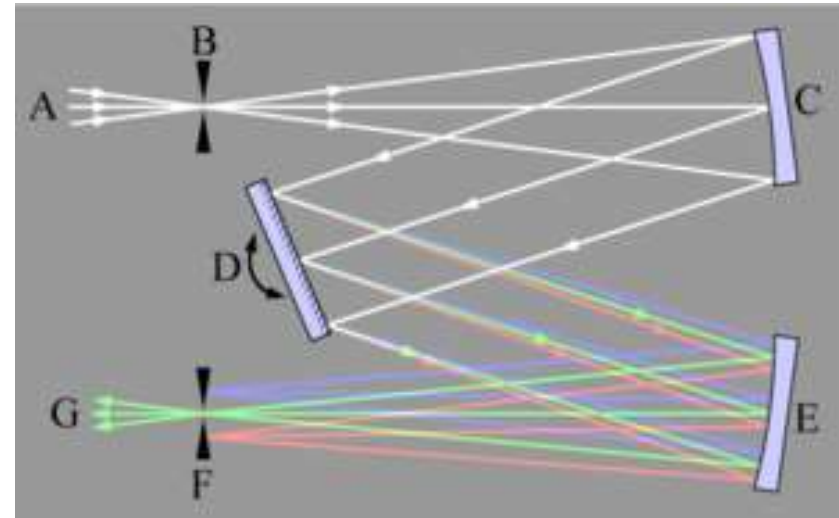
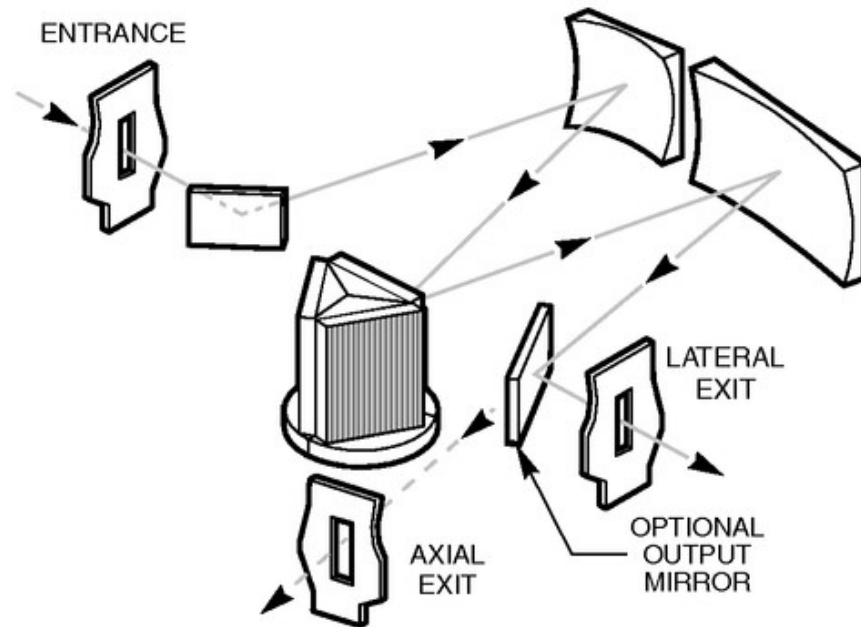
Monocromatore
a prisma

(b)

Strumentazione in Spettroscopia Ottica

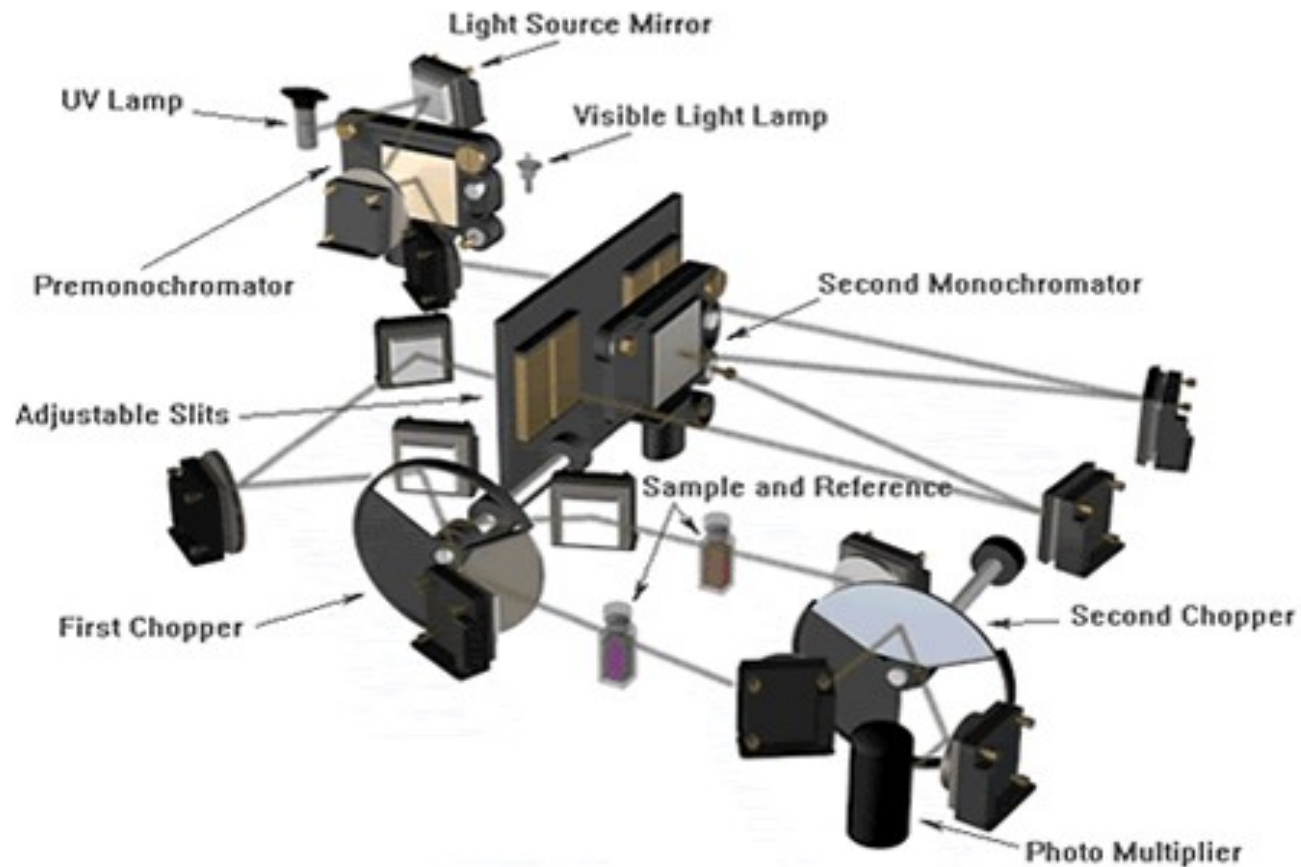
ESEMPI MONOCROMATORI A RETICOLO

Tipico monocromatore
(design "Czerny-Turner")



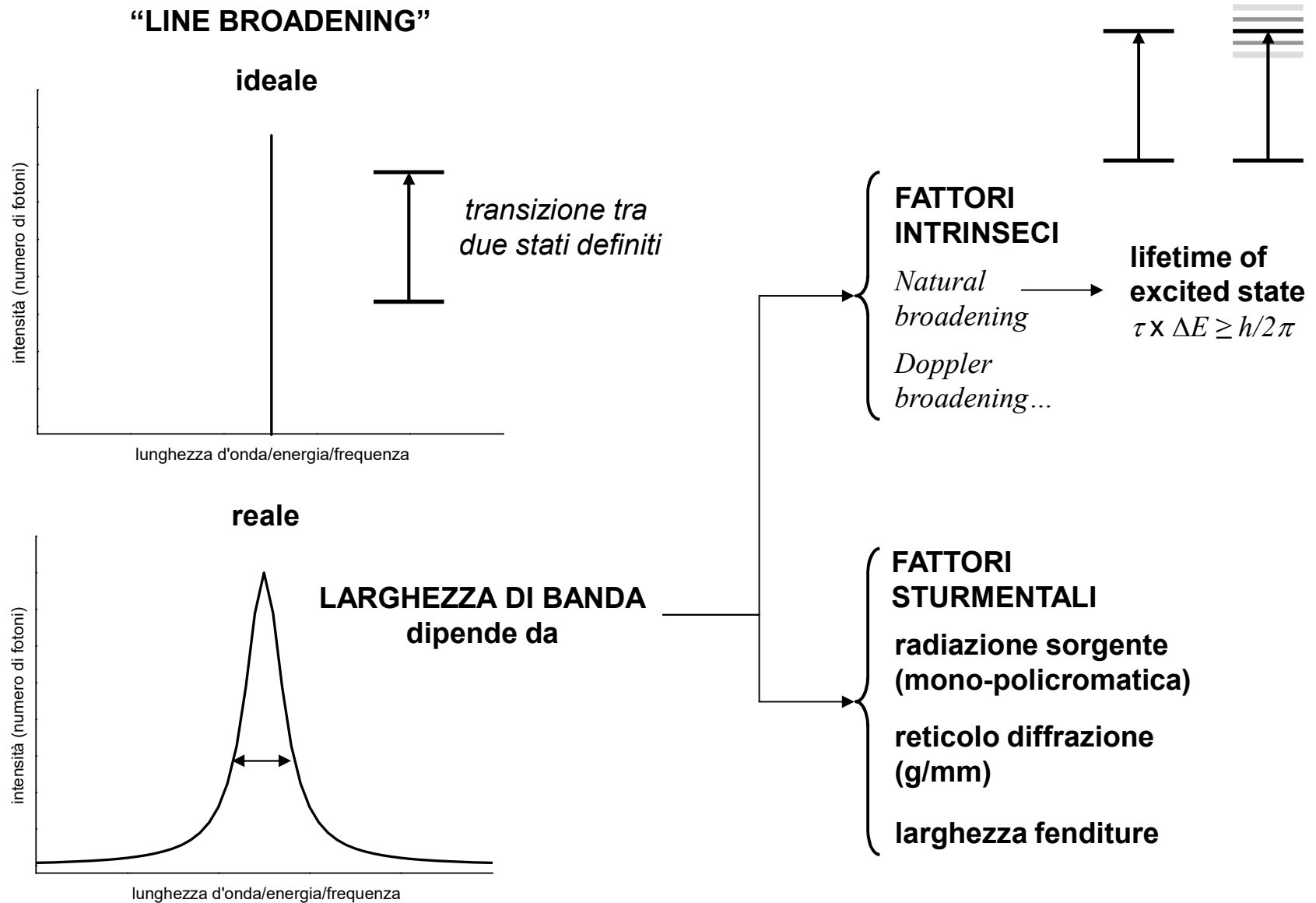
Strumentazione in Spettroscopia Ottica

ESEMPI MONOCROMATORI A RETICOLO



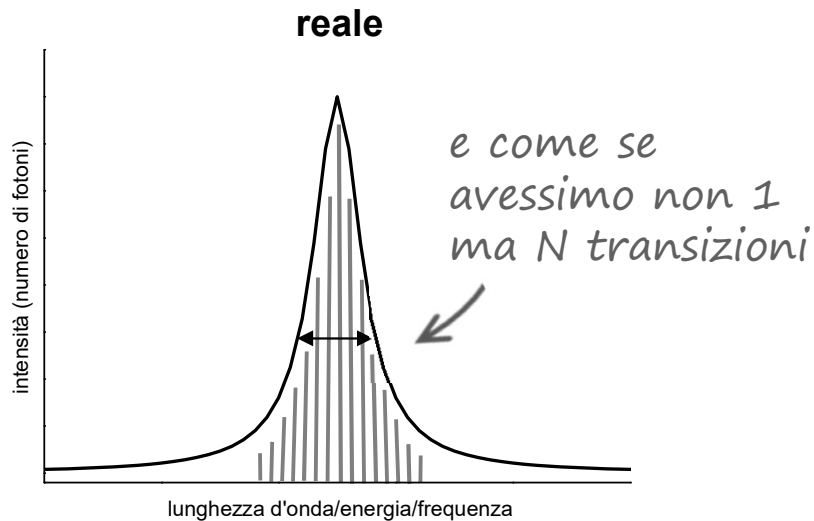
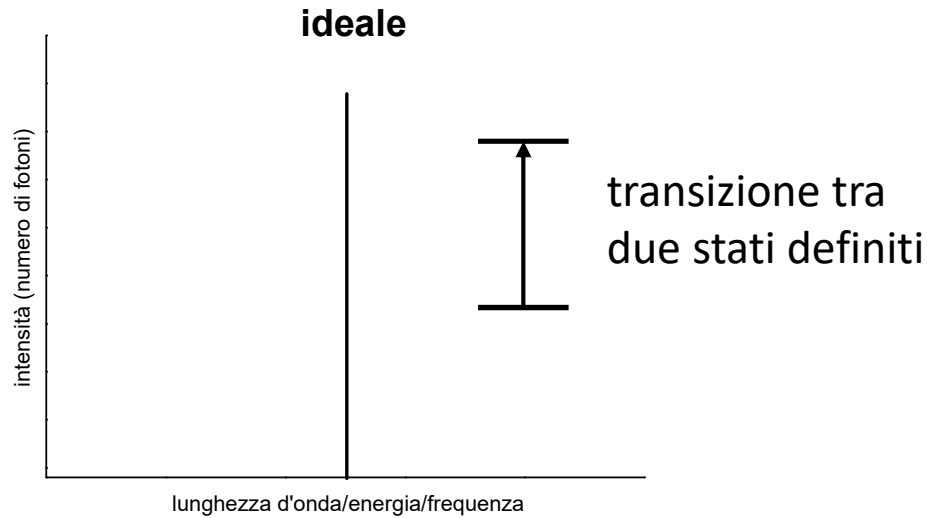
**Strumento reale per l'assorbimento UV-Vis
con monocromatore Czerny-Turner**

Strumentazione in Spettroscopia Ottica



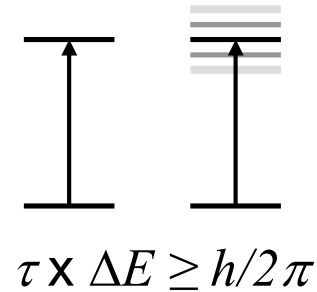
Larghezza di banda (line width)

“LINE BROADENING”



- 1) FATTORI INTRINSECI
- 2) FATTORI STRUMENTALI

Larghezza di banda (line width)



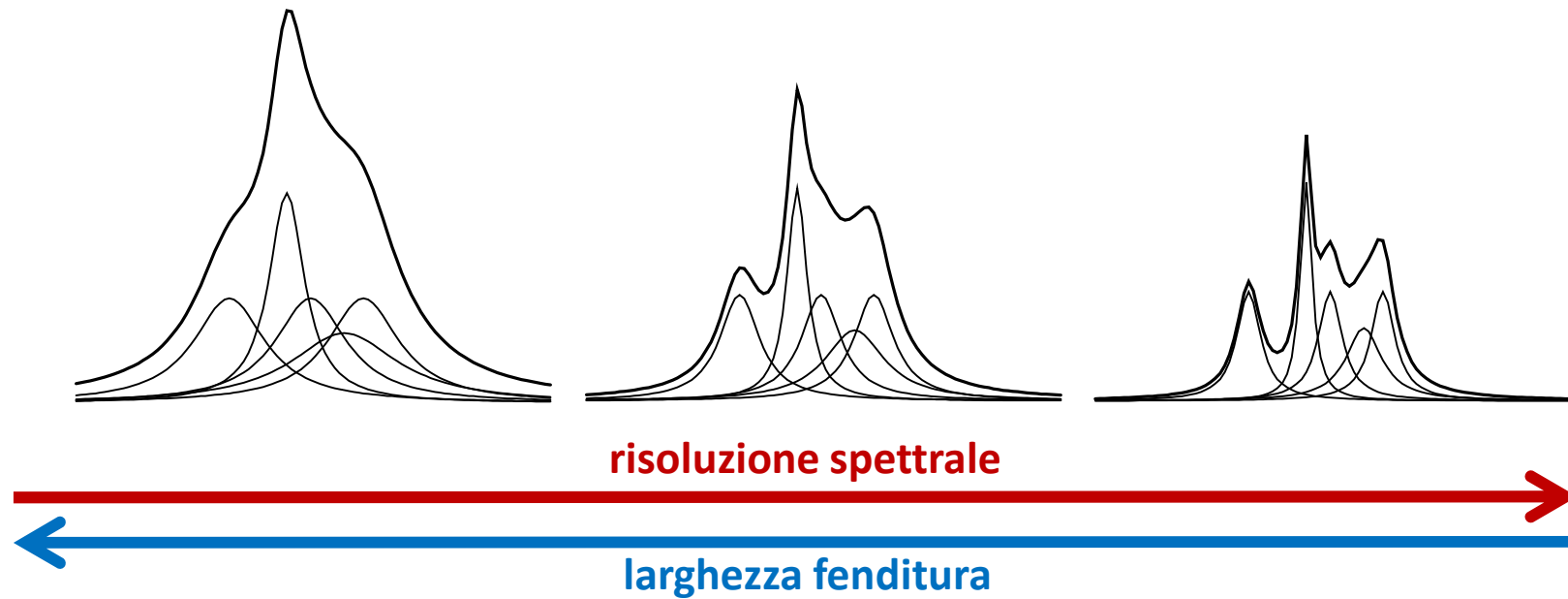
1) FATTORI
INTRINSECI →

- *natural broadening*
(principio di indeterminazione)
- *Doppler broadening*

2) FATTORI
STRUMENTALI →

- *radiazione sorgente*
(mono-policromatica)
- *reticolo diffrazione*
(l/mm)
- *larghezza fenditure*

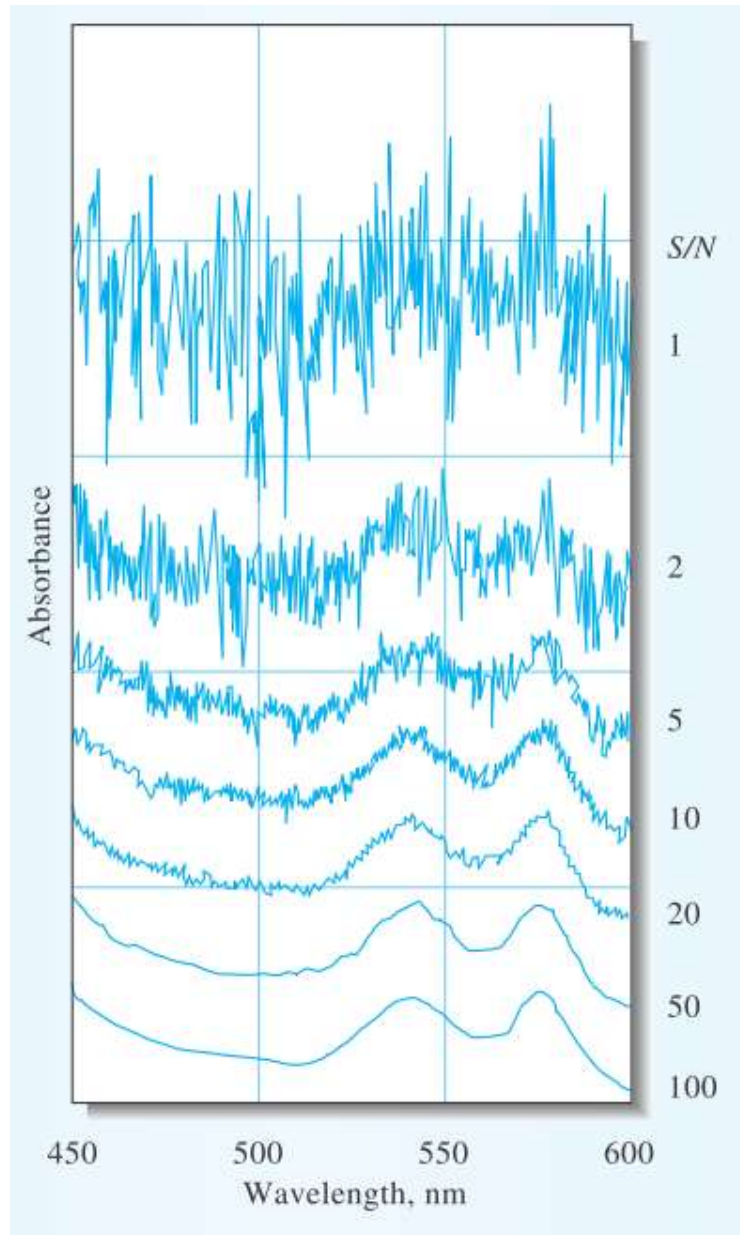
Larghezza di banda (line width)



2) FATTORI STRUMENTALI



- *radiazione sorgente (mono-policromatica)*
- *reticolo diffrazione (l/mm)*
- *larghezza fenditure*



S/N
(signal / noise)

rapporto
segnale/rumore

=

media / deviazione std.
dell'intensità del segnale

EFFETTI LARGHEZZA FENDITURA SU SPETTRO REALE

D.Harvey, "Modern Analytical Chemistry", McGraw-Hill, 2000

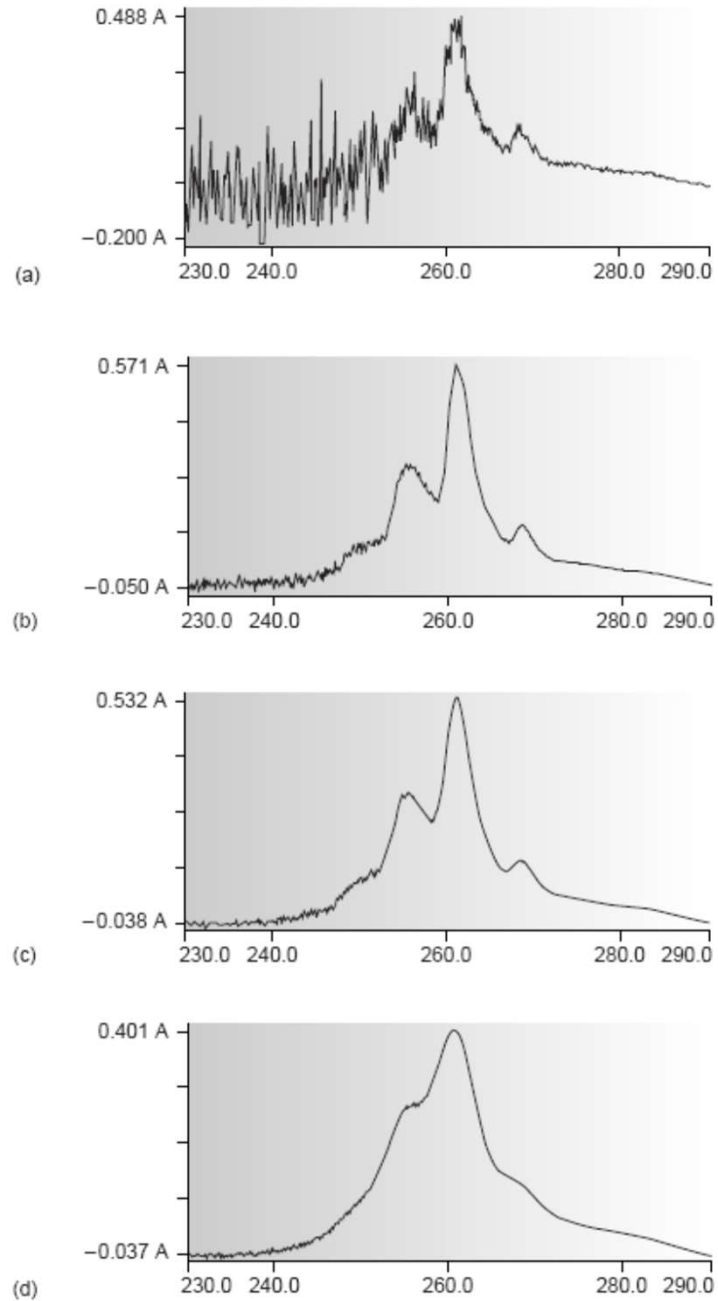
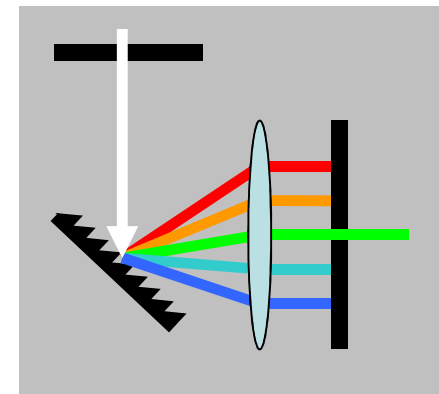
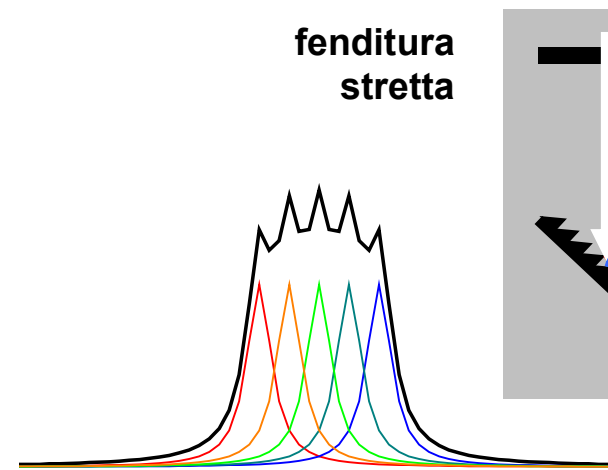
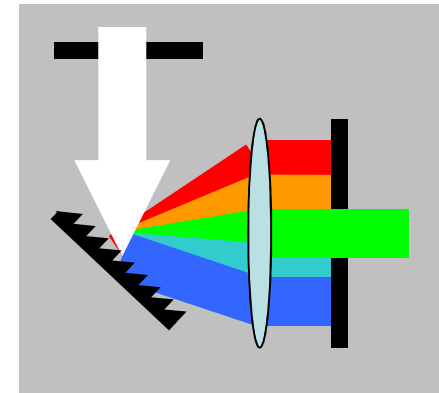
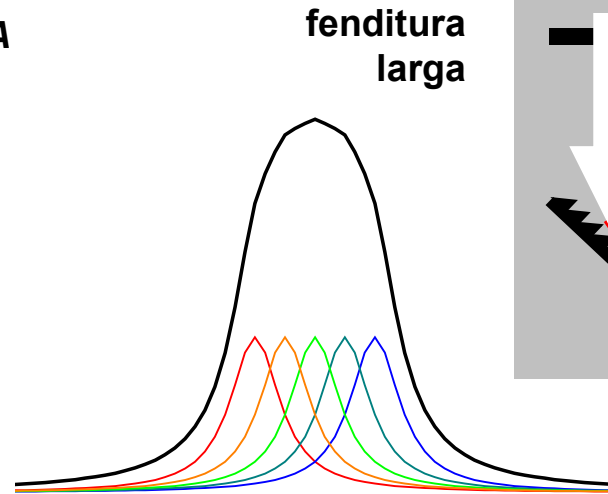
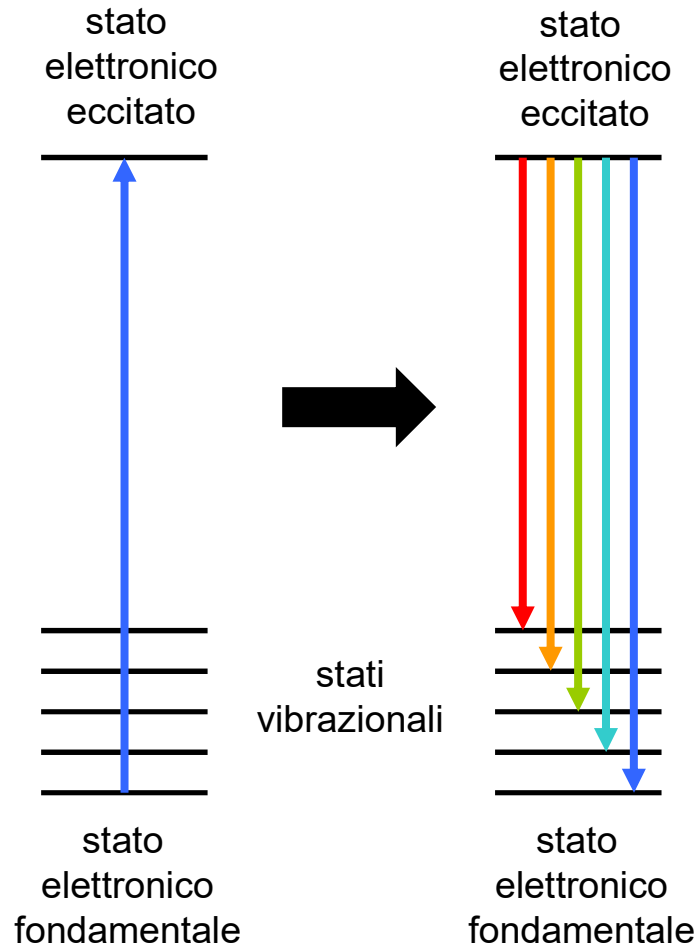


Figure 10.11

Effect of the monochromator's slit width on noise and resolution for the ultraviolet absorption spectrum of benzene. The slit width increases from spectrum (a) to spectrum (d) with effective bandpasses of 0.25 nm, 1.0 nm, 2.0 nm, and 4.0 nm.

Strumentazione in Spettroscopia Ottica

RISOLUZIONE: *ESEMPIO FLUORESCENZA*



Strumentazione in Spettroscopia Ottica

RIVELATORI (UV-VISIBILE)

Table 10.4 Characteristics of Transducers for Optical Spectroscopy

Detector	Class	Wavelength Range	Output Signal
phototube	photon	200–1000 nm	current
photomultiplier	photon	110–1000 nm	current
Si photodiode	photon	250–1100 nm	current
photoconductor	photon	750–6000 nm	change in resistance
photovoltaic cell	photon	400–5000 nm	current or voltage
thermocouple	thermal	0.8–40 μm	voltage
thermistor	thermal	0.8–40 μm	change in resistance
pneumatic	thermal	0.8–1000 μm	membrane displacement
pyroelectric	thermal	0.3–1000 μm	current

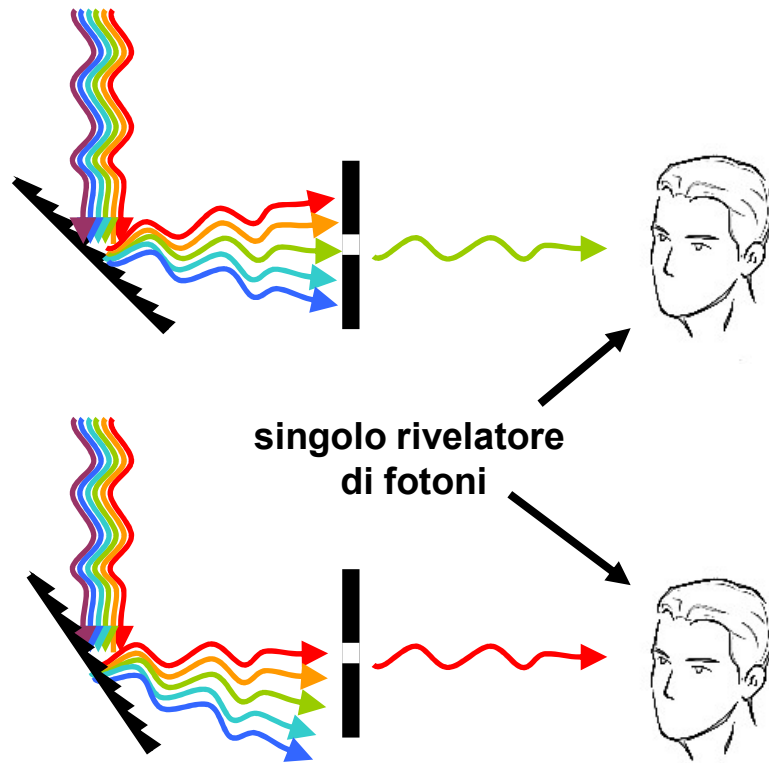
D.Harvey, "Modern Analytical Chemistry", McGraw-Hill, 2000

Strumentazione in Spettroscopia Ottica

RIVELATORI (UV-VISIBILE)

A CANALE SINGOLO
(una sola λ alla volta)

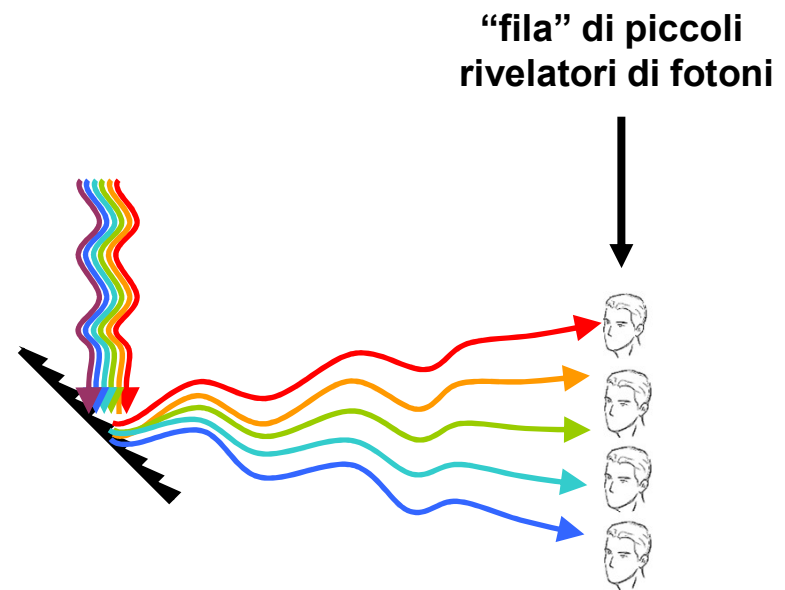
PMT
(PhotoMultiplier Tube)



A CANALE MULTIPLO
(più λ contemporaneamente)

CCD
(Charge Coupled Device)

MOLTO USATO

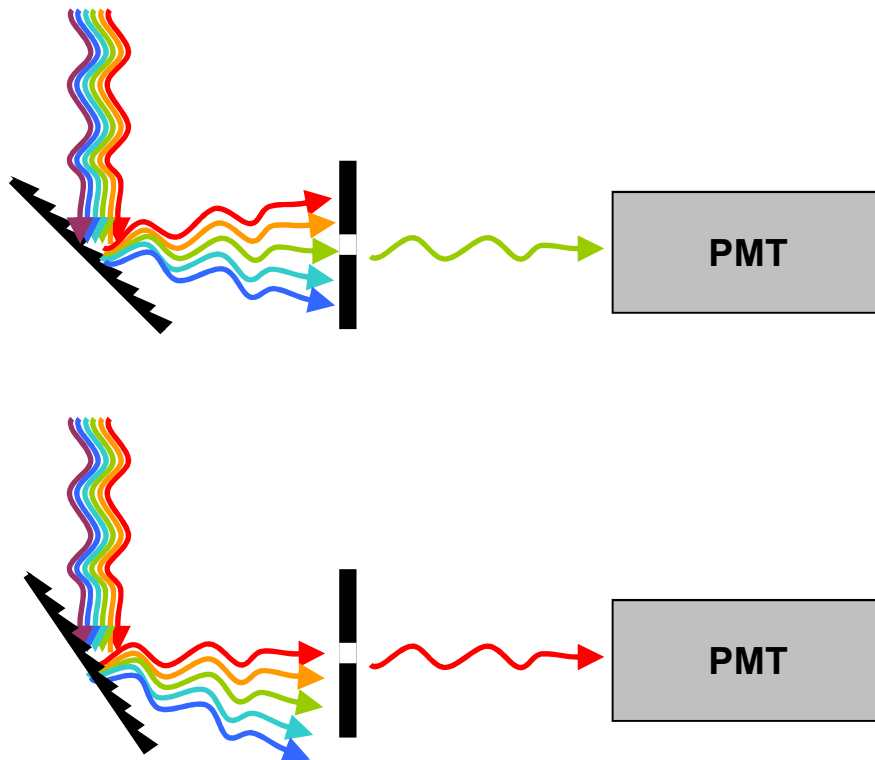


Strumentazione in Spettroscopia Ottica

RIVELATORI (UV-VISIBILE)

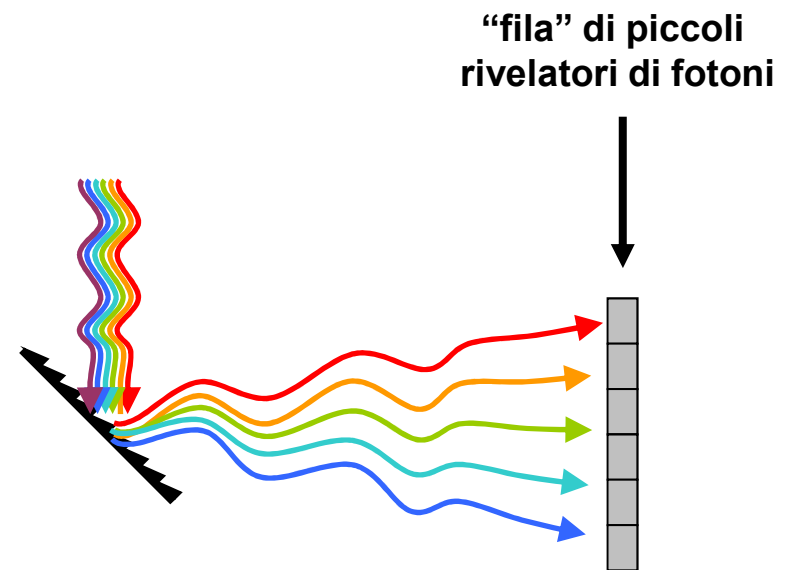
A CANALE SINGOLO
(una sola λ alla volta)

PMT
(PhotoMultiplier Tube)



A CANALE MULTIPLIO
(più λ contemporaneamente)

CCD
(Charge Coupled Device)



Strumentazione in Spettroscopia Ottica

RIVELATORI (IR)

RIVELATORI A FOTOCONDUCTIBILITA':
basati su semiconduttori la cui *resistenza*
varia a seconda dell'illuminazione con radiazione IR

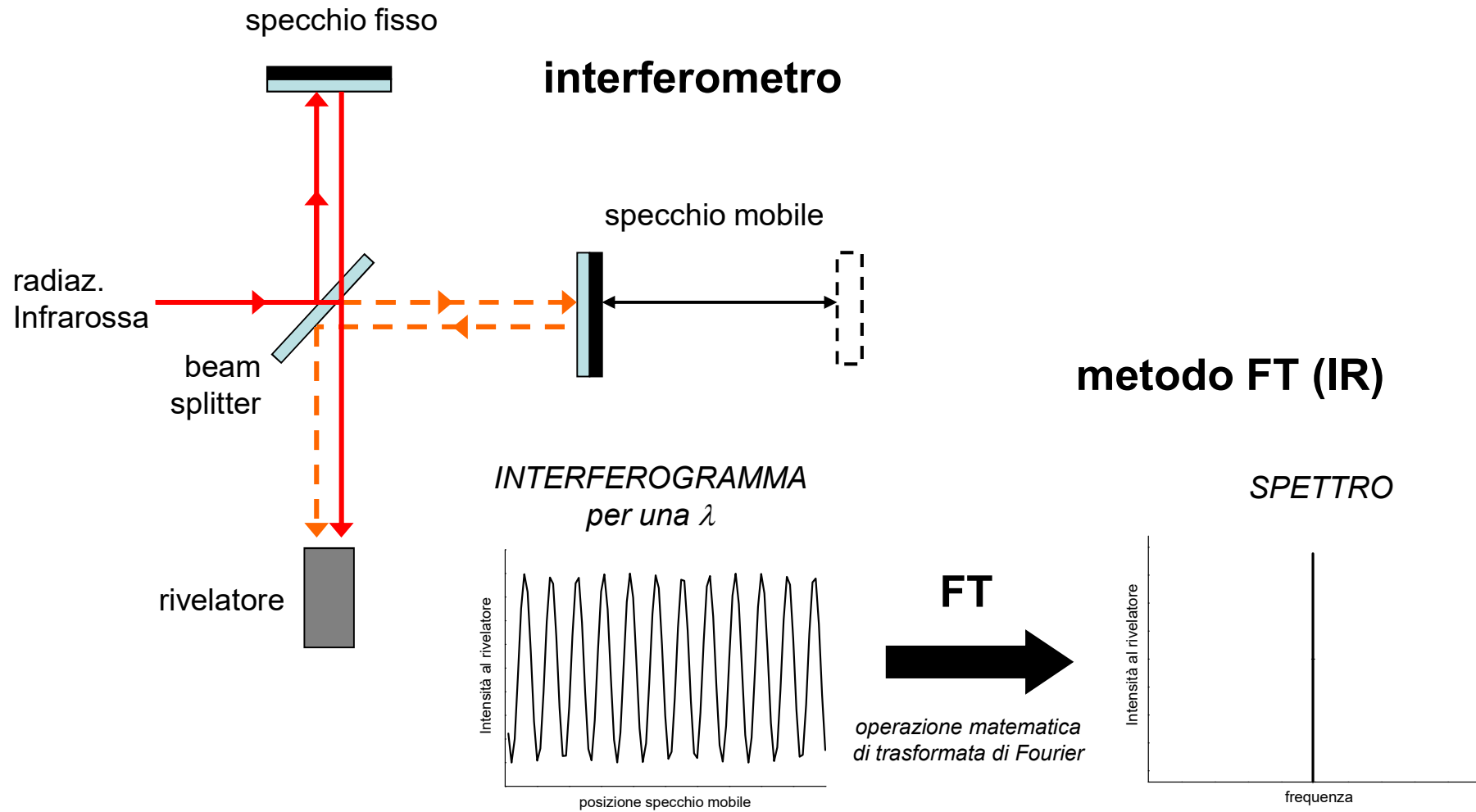
Esempi materiali utilizzati: PbS, HgCdTe

RIVELAZIONE RADIAZIONE INFRAROSSA DIFFICILE:

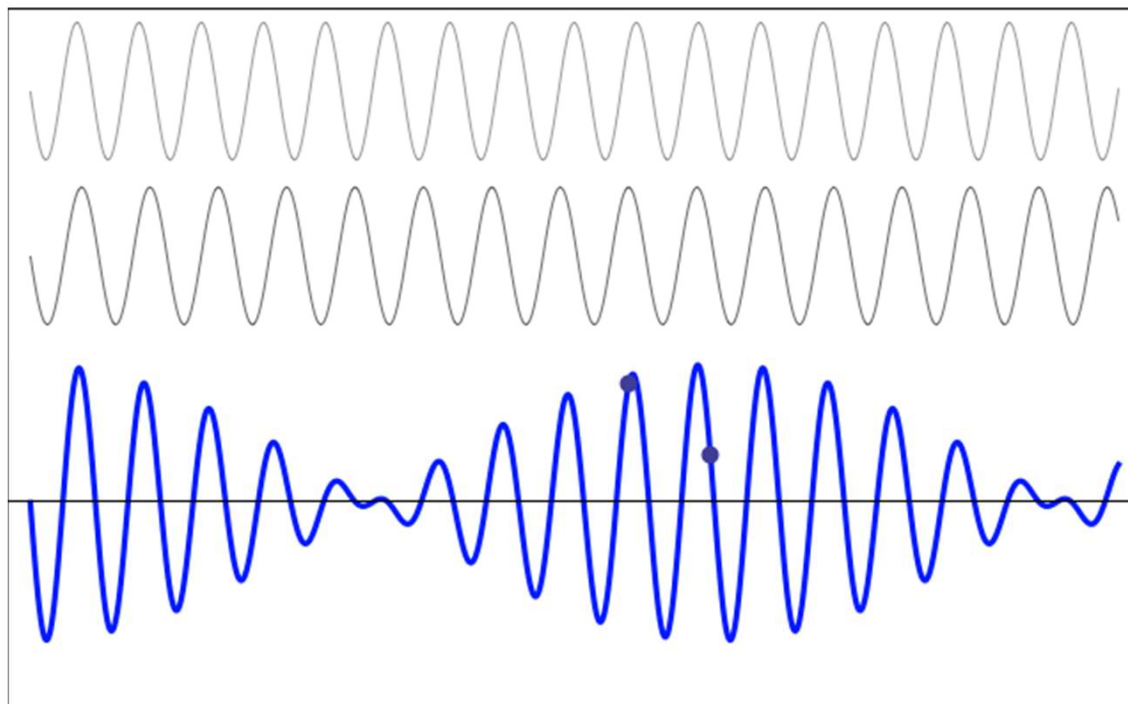
- *BASSA INTENSITA' SORGENTI IR*
- *BASSA ENERGIA FOTONI IR (no effetto fotoelettrico)*

Spettroscopia in TRASFORMATA DI FOURIER
(FT-IR ma anche FT-Raman)

Strumentazione in Spettroscopia Ottica

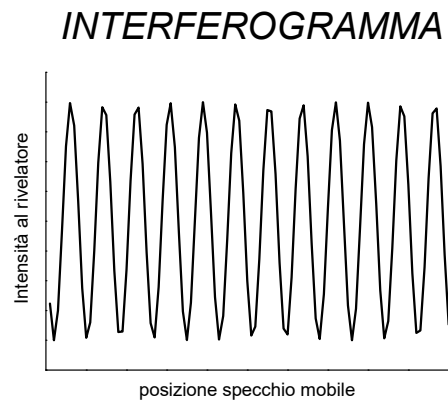


Fenomeni di interferenza

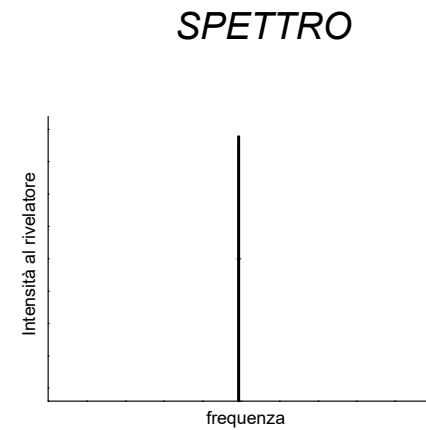


Strumentazione in Spettroscopia Ottica

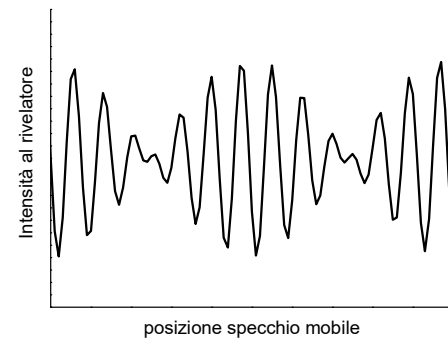
UNA λ
(monocromatica)



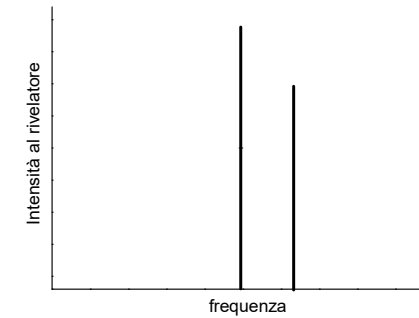
FT



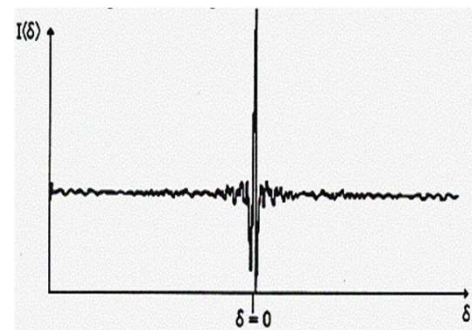
DUE λ
(bicromatica)



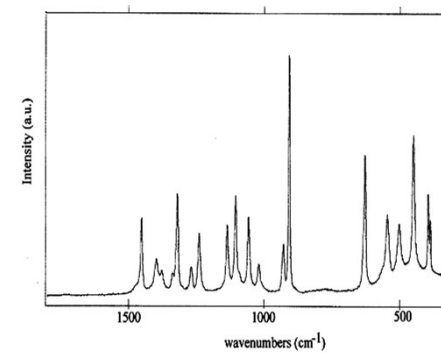
FT



MOLTE λ
(policromatica)



FT



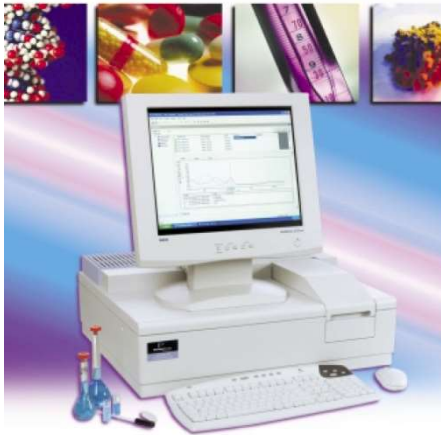
Strumentazione in Spettroscopia Ottica

Principali vantaggi METODO FT:

- vantaggio “di Jacquinot”
(maggiore intensità di radiazione al rivelatore)
- vantaggio di *multiplex*
(più lunghezze d'onda rivelate simultaneamente)

MOLTO UTILIZZATI IN IR E RAMAN
(spettroscopie con radiazione IR)

Strumentazione in Spettroscopia Ottica



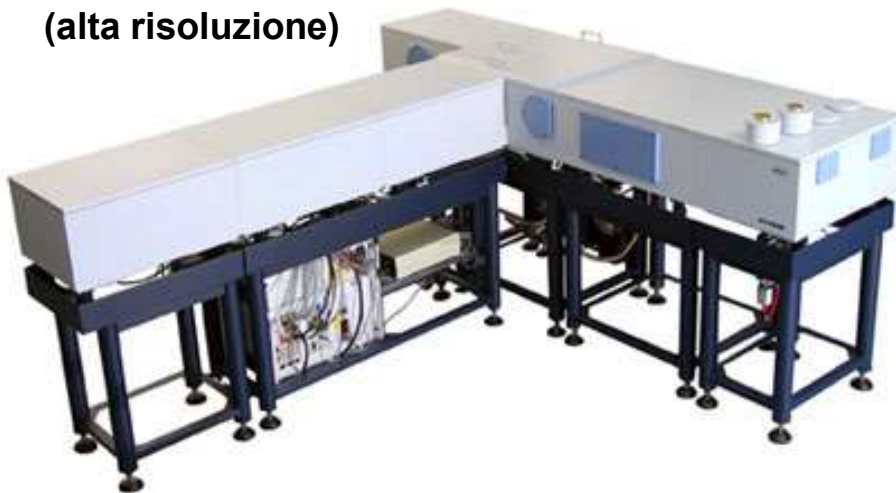
Spettrometri Abs UV-vis



Fluorimetro

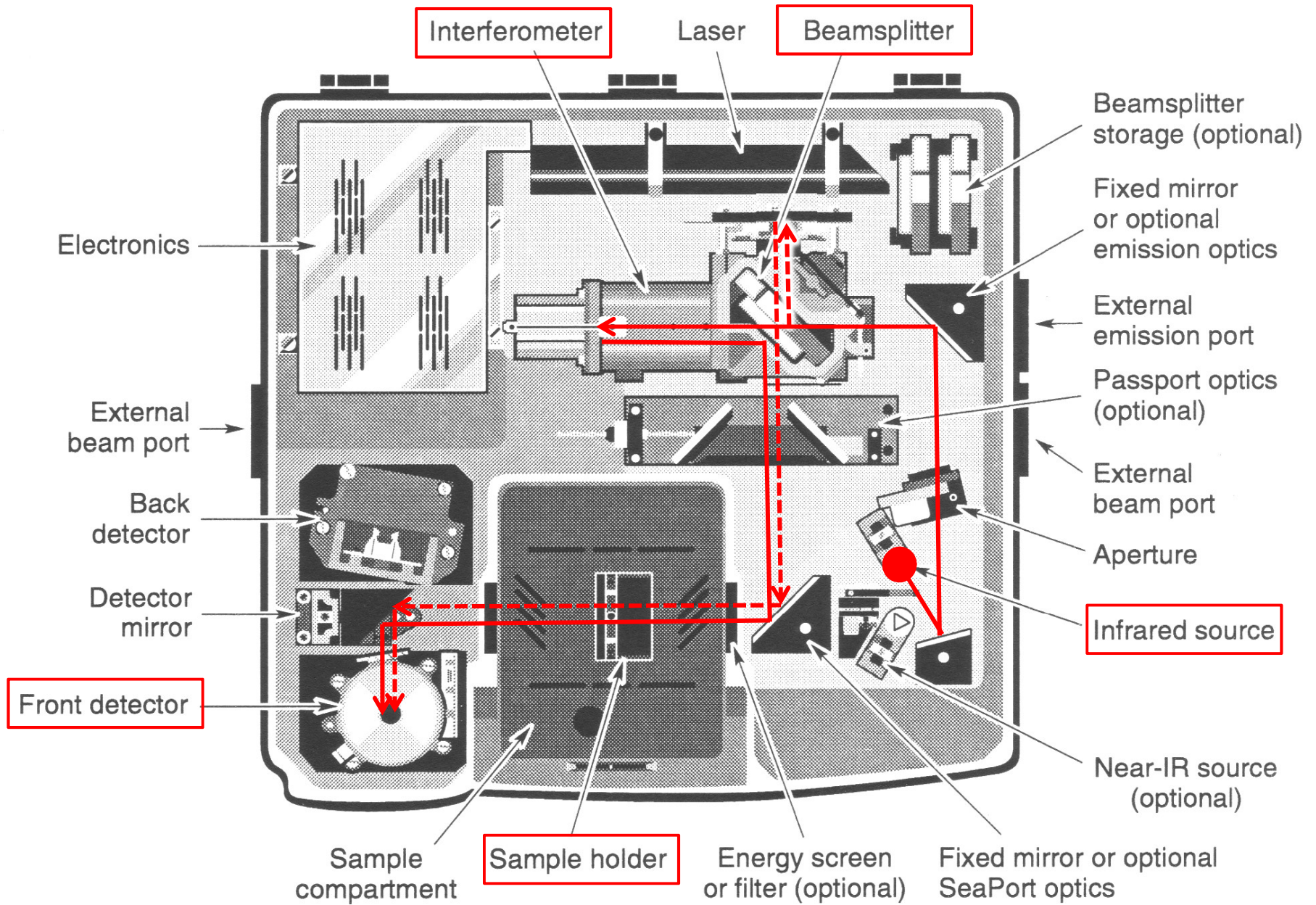


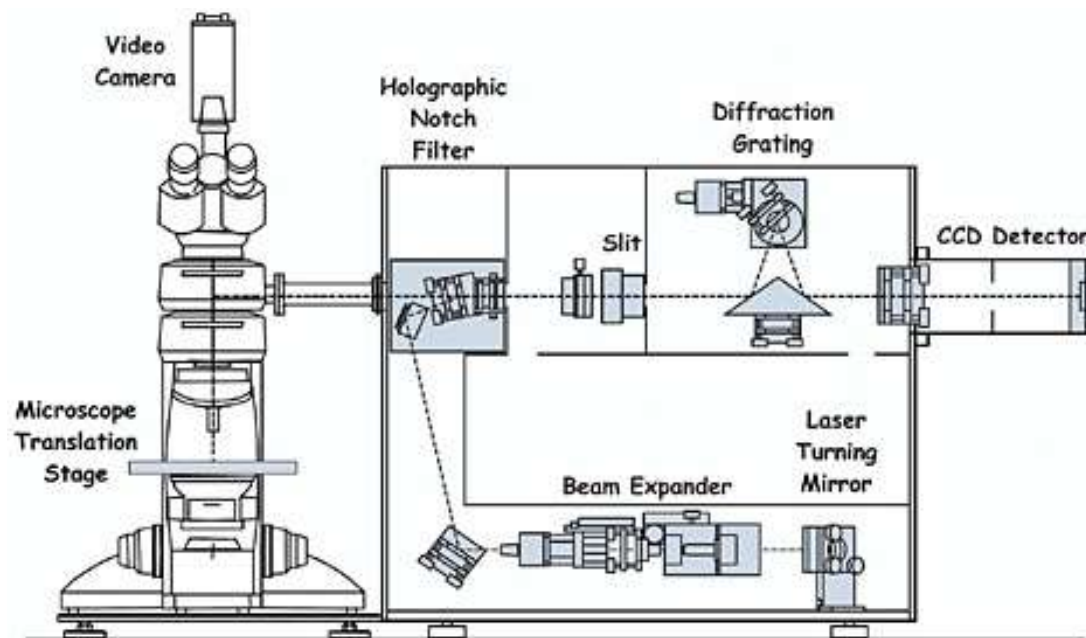
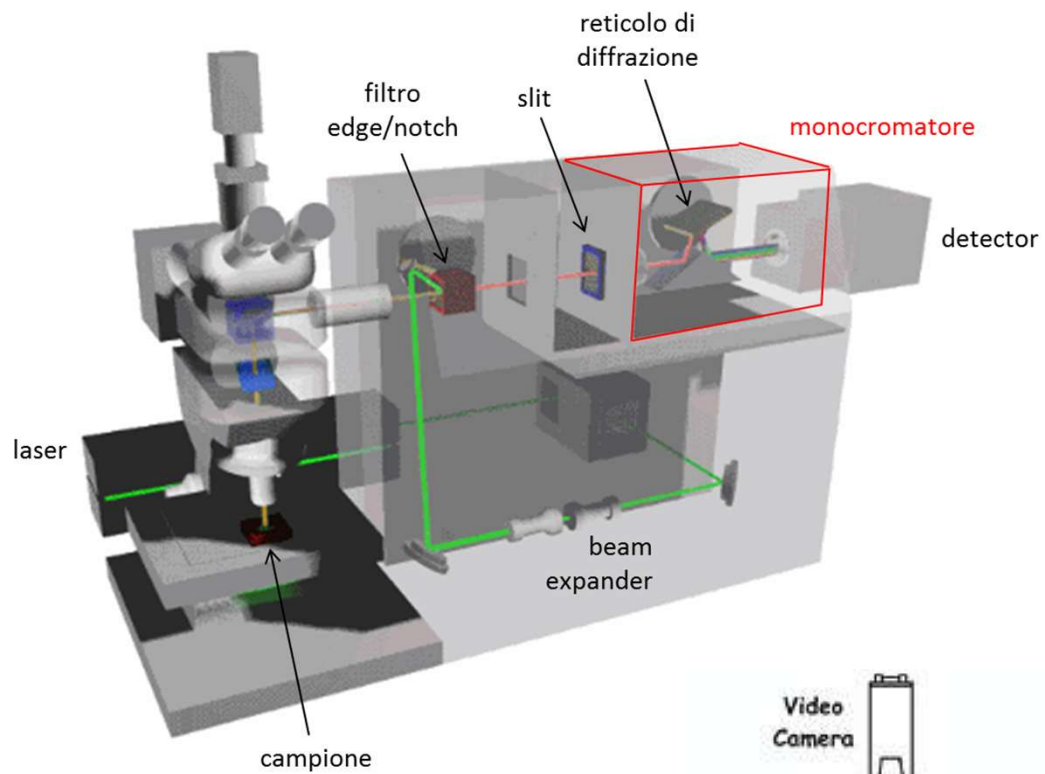
**FT-IR
(alta risoluzione)**

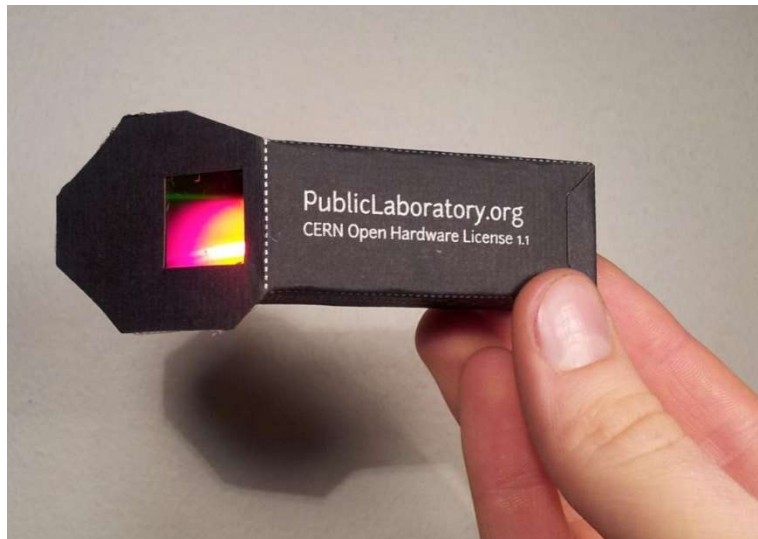
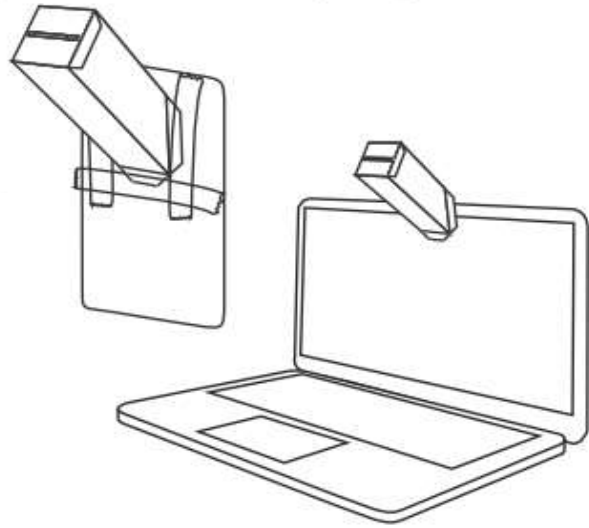


**FT-IR
(media risoluzione)**

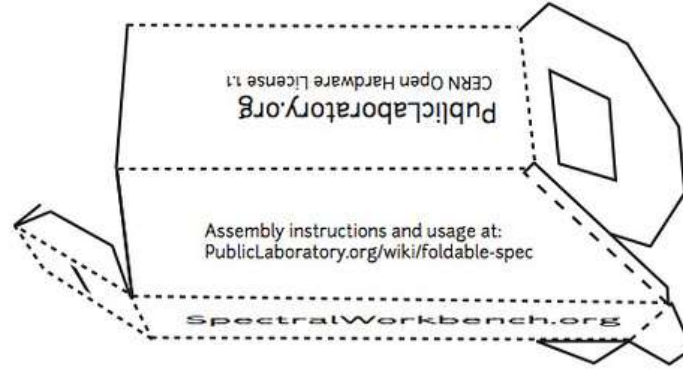
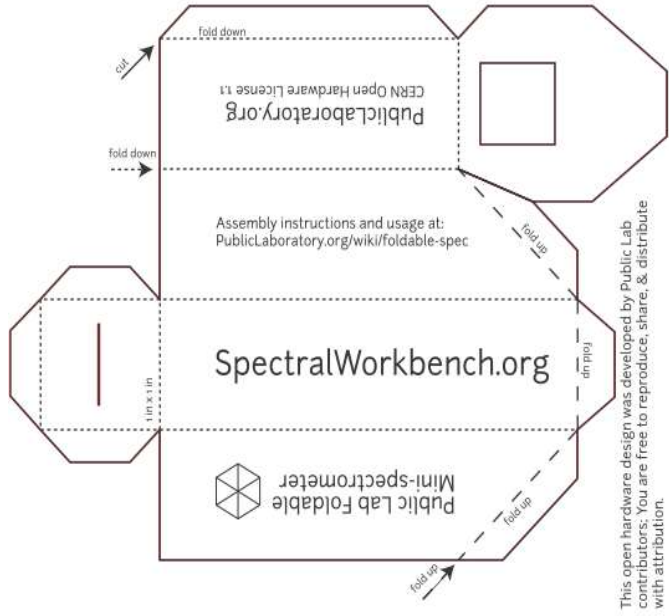


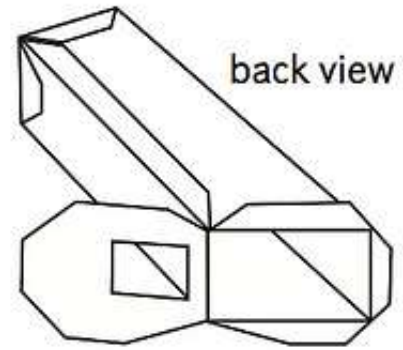
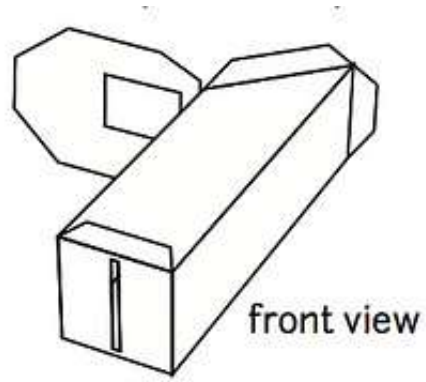


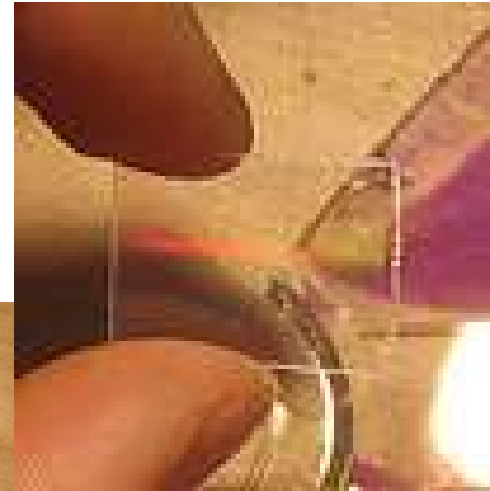
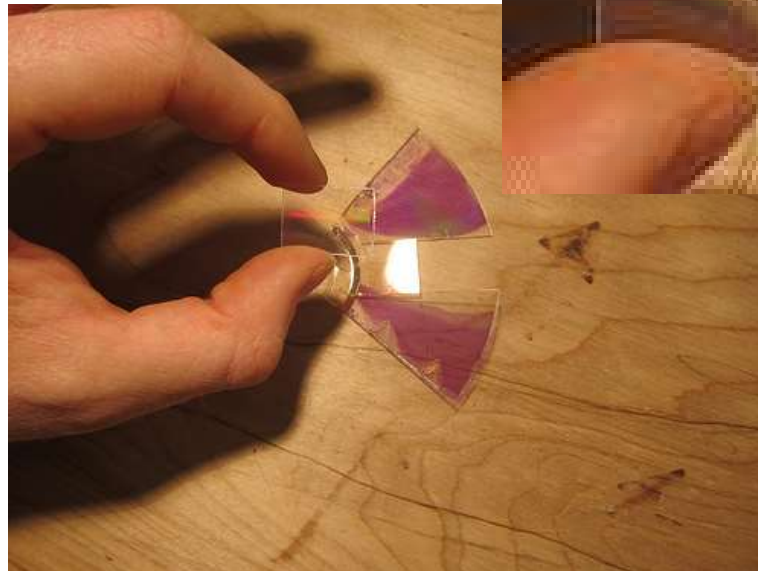
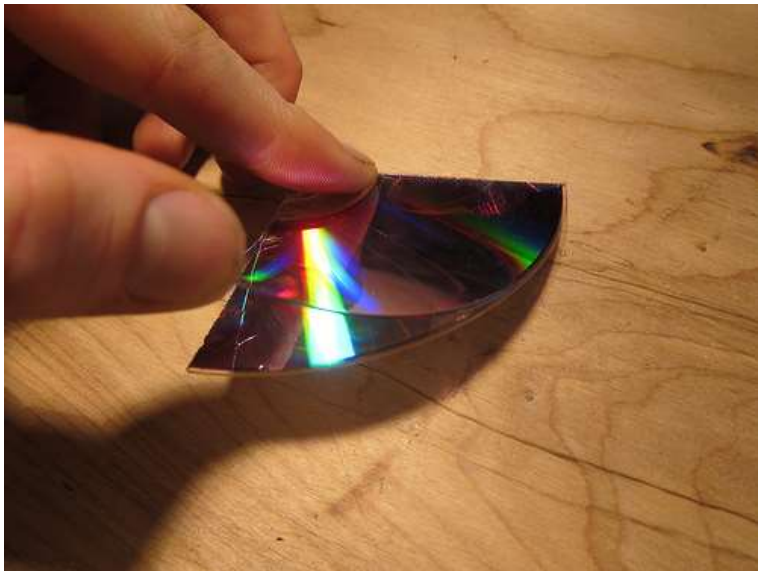
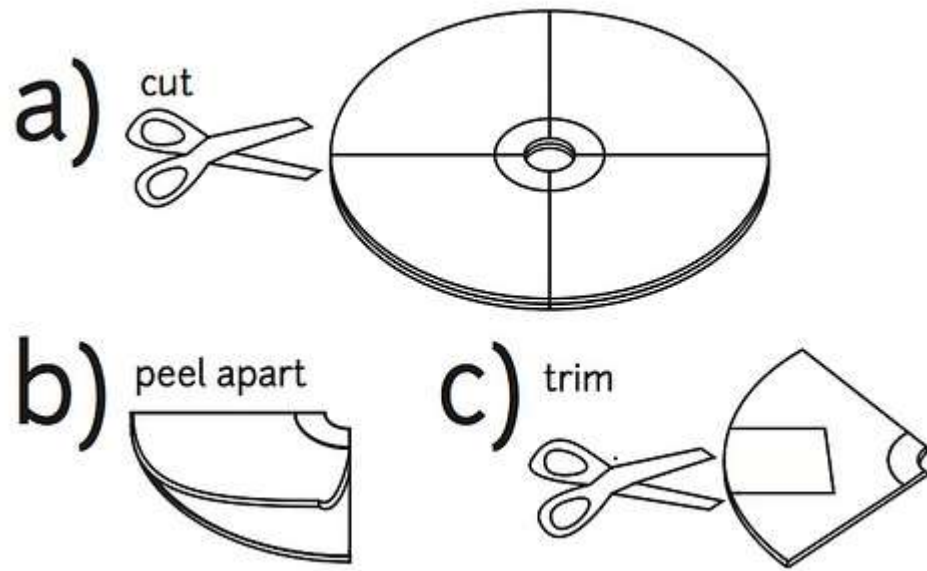


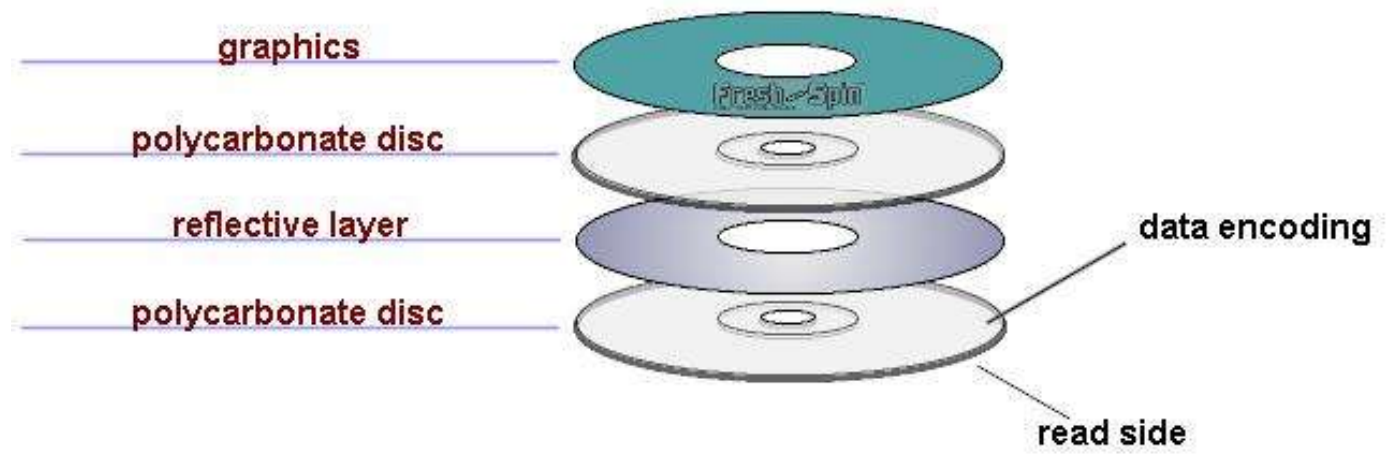
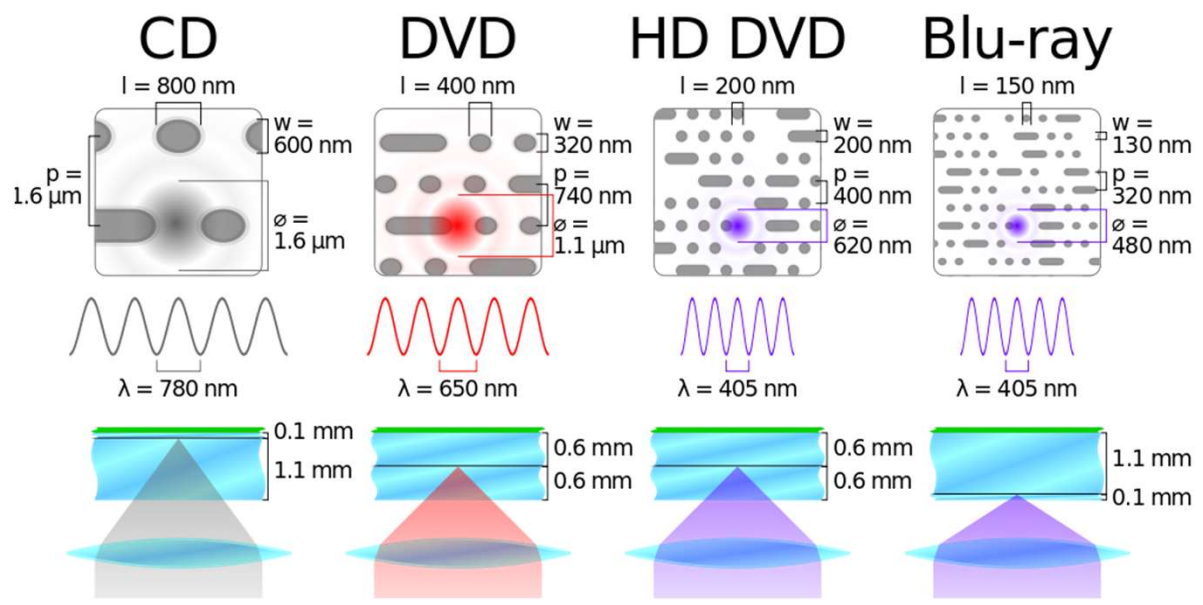
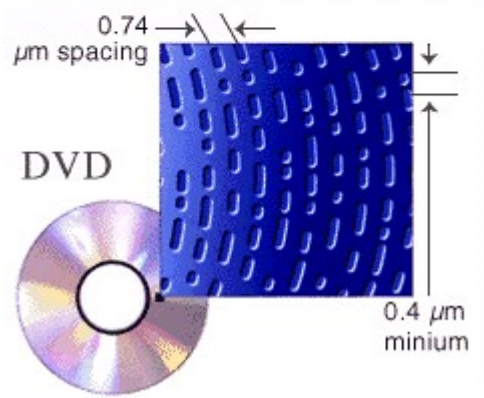
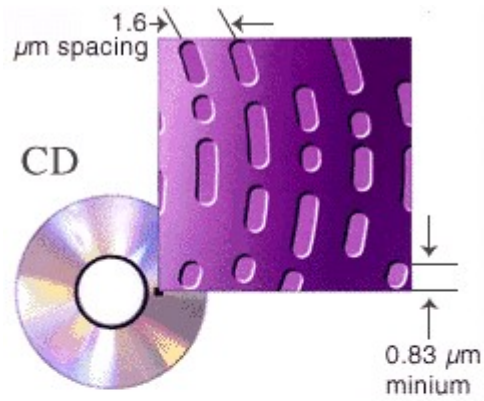


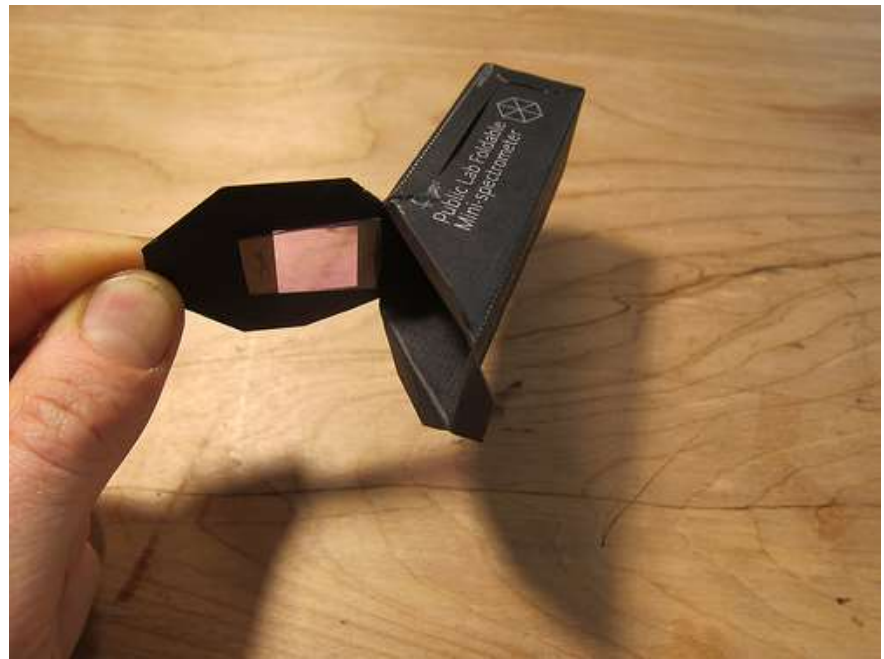
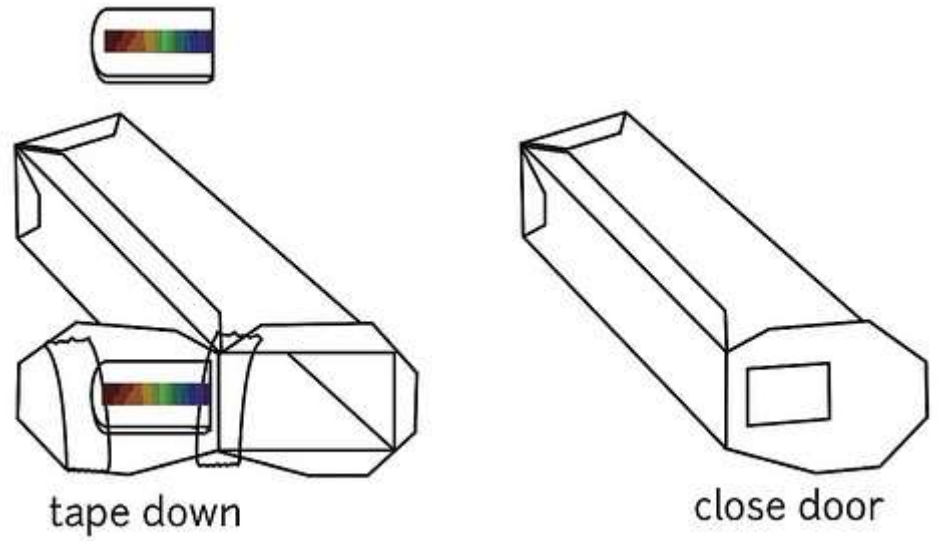
<https://publiclab.org/wiki/foldable-spec>



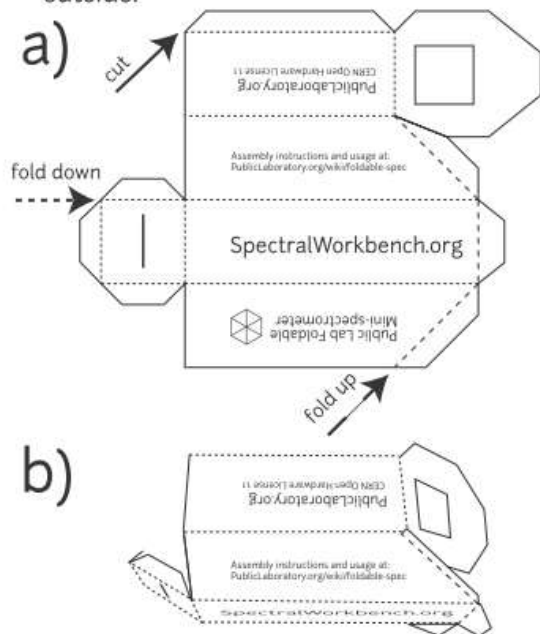




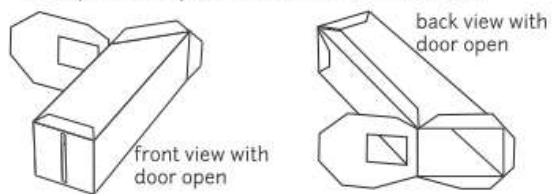




- 1. cut and fold**
Cut along the outer edge. Fold up or down as indicated by the dotted and dashed lines. All labels should stay on the outside.



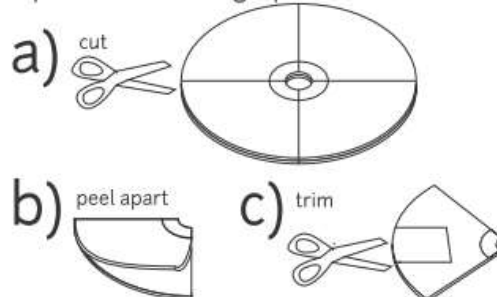
Except for the diffraction grating door, glue or tape all flaps down onto the outside.



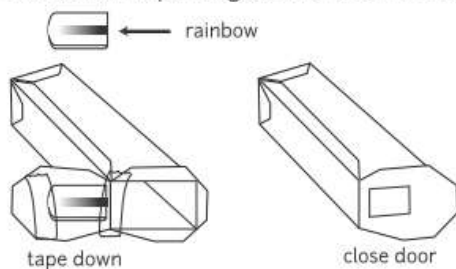
- 2. make a diffraction grating from a DVD-R**
A diffraction grating is a series of close slits that disperse light.



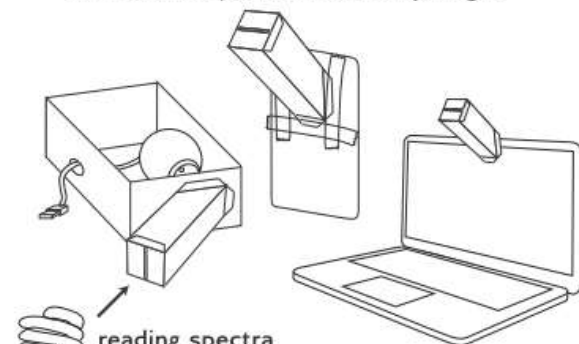
To make one from a DVD-R, split it into quarters, peel off the reflective layer and trim a small clean square out of the transparent layer. Try to pick a clean piece without fingerprints or scratches.



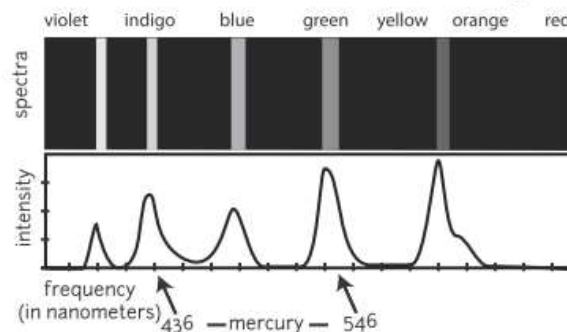
To work as a diffraction grating the DVD-R must be placed so that its grating is vertical, making a horizontal spectral rainbow. Tape your DVD piece to the inside of the spectrometer's door, then tape or glue the door closed.

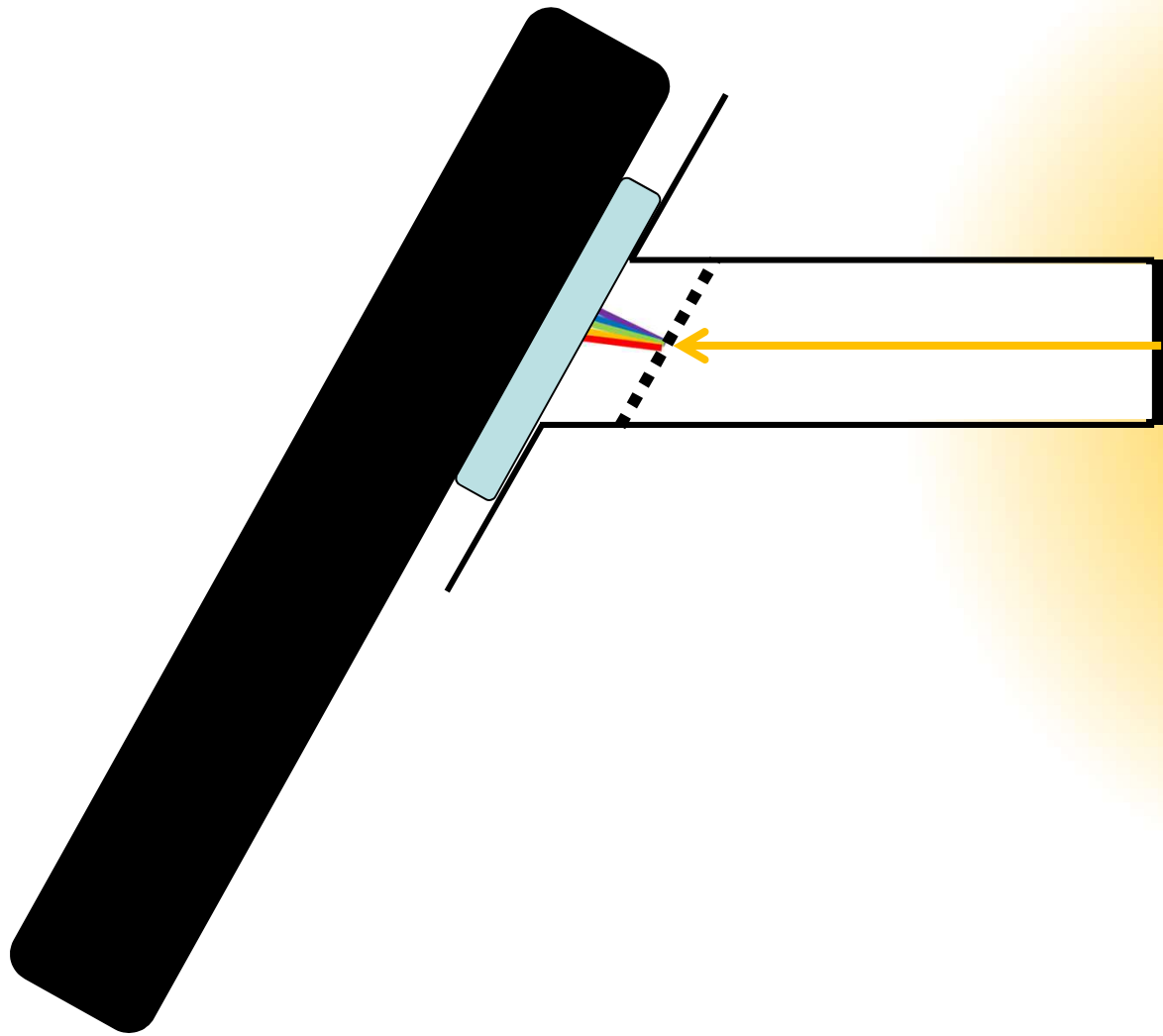


- 3. attach to a webcam, phone, or laptop**
The spectrometer can be mounted on a camera phone, laptop, or with the help of a box, attached to a webcam. Line up carefully so that the rainbow is in the middle of the image, and tape down firmly so that the spectrometer stays rigid.

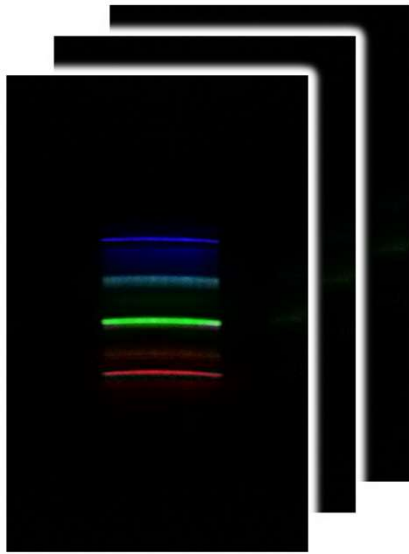


reading spectra
Every molecule emits only certain frequencies of light, and under the right conditions a spectrometer can detect these as rainbow bands. With two clear bands, the mercury in compact fluorescents makes calibration easy.

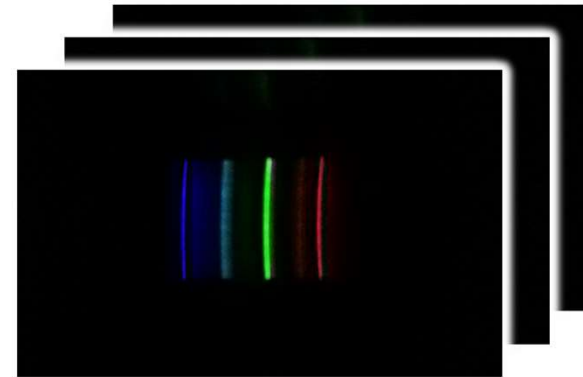
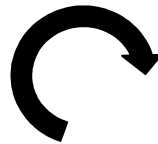




1. acquisire immagini a righe (spettri) con lo smartphone (*)



2. ruotare immagini in modo da avere righe verticali, rosso a dx



(*) ogni volta che si attacca lo spettrografo allo smartphone, la **prima immagine deve sempre essere presa da una lampadina a fluorescenza** (basso consumo)

3. caricare le immagini nella app online per **ritagliarle** e trasformarle in grafici INTENSITA' vs. PIXEL

1) upload

https://aloisbonifacio.shiny X
Sicuro | https://aloisbonifacio.shinyapps.io/specgraph/

image spectrum (uncalib)

SpecGraph 1.0

upload image with spectrum (.jpg)

Browse... 20160406_174256.jpg

Upload complete

y min

y max

x min

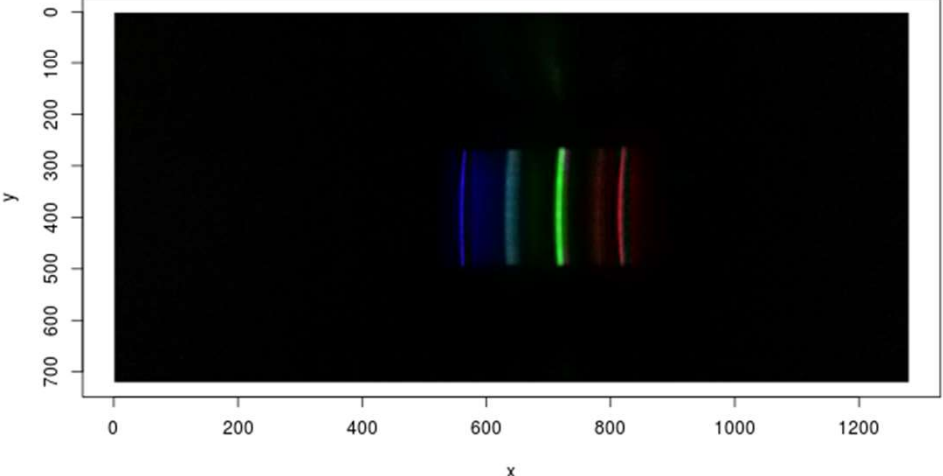
x max

SNR (peak picking) 30

HWS (peak picking) 50

download data

download image



The plot displays a spectrum with several vertical lines of different colors (blue, green, red) on a black background. The x-axis is labeled 'x' and ranges from 0 to 1200. The y-axis is labeled 'y' and ranges from 0 to 700.

https://aloisbonifacio.shinyapps.io/specgraph/

SpecGraph 1.0

upload image with spectrum (.jpg)

Browse... 20160406_174256.jpg

Upload complete

y min: 300

y max: 450

x min: 500

x max: 900

SNR (peak picking): 0

HWS (peak picking): 20

download data

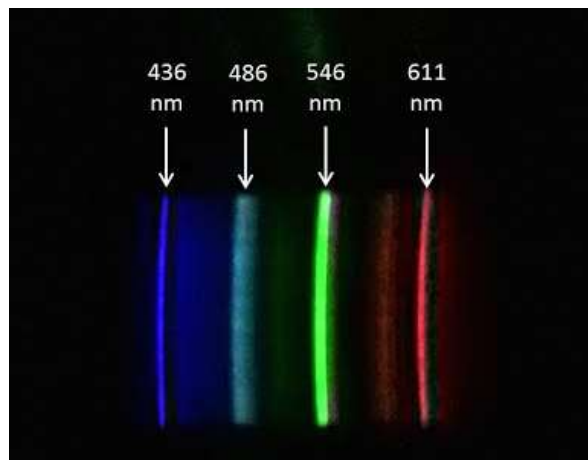
download image

image: spectrum (uncalib)

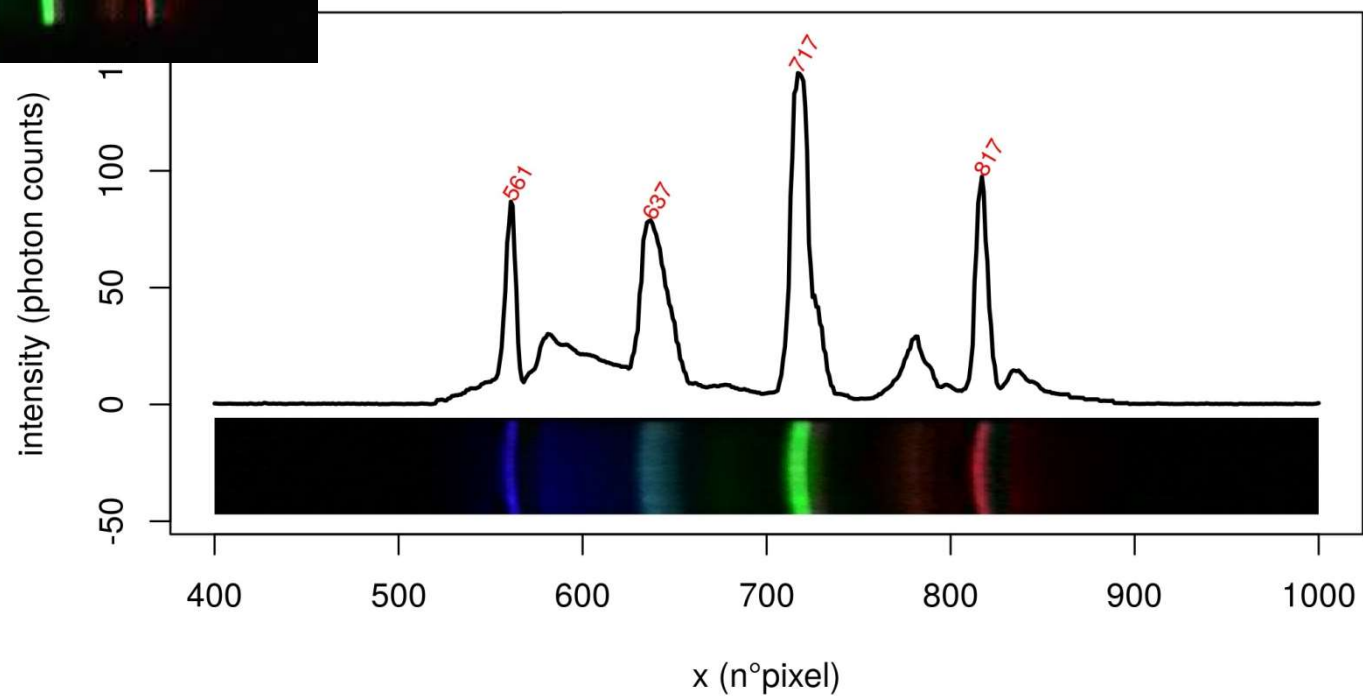
2) ritaglia



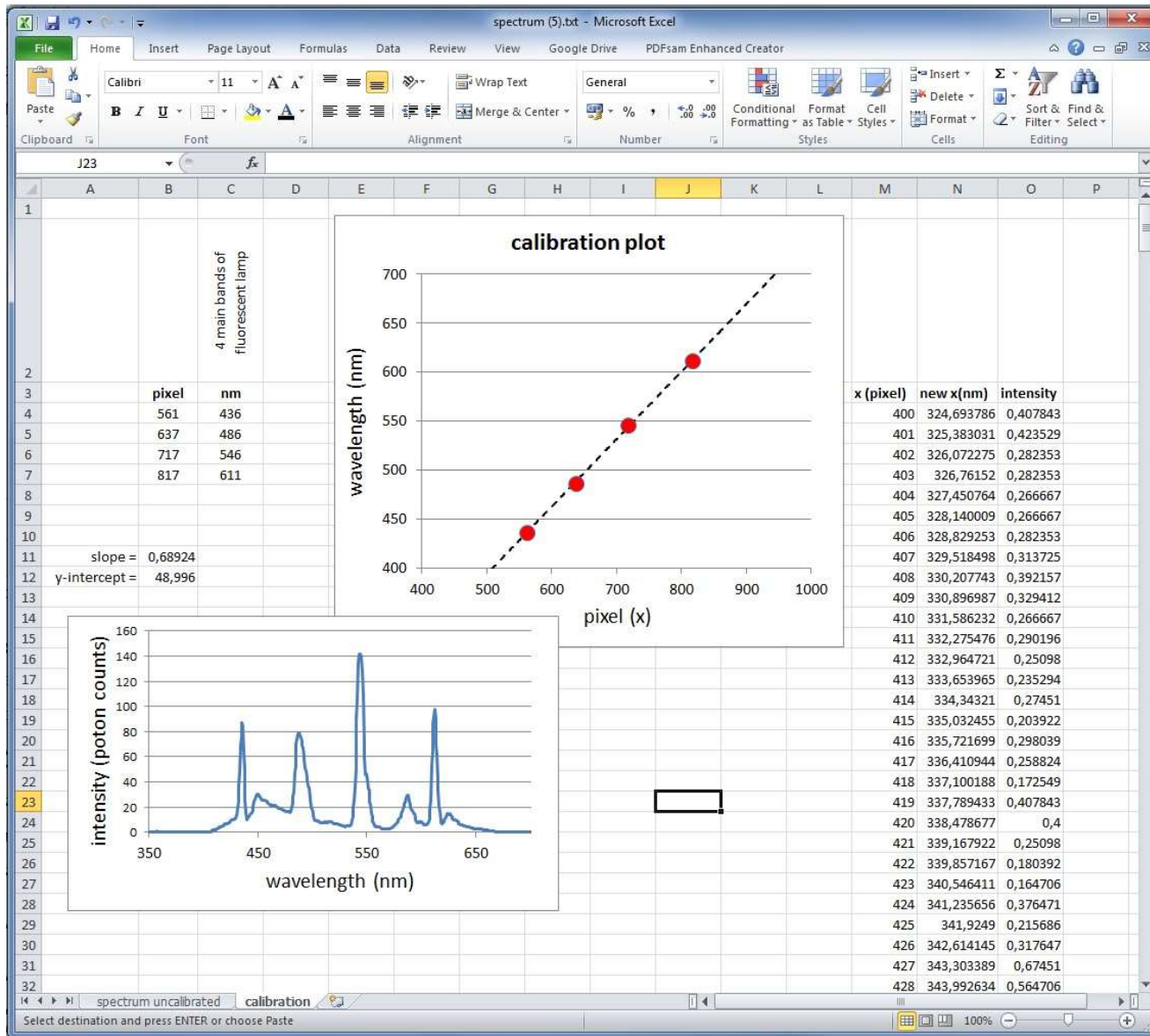
immagini (spettri) a righe



da immagine a spettro (x,y)
(app online)



4. calibrazione in Excel



$$\lambda(\text{nm}) = A \cdot x(\text{pixels}) + B$$

- trovare funzione (retta) che correla posizione pixel e lunghezza d'onda (nm) nello spettro di lampadina a fluorescenza
- usare parametri A e B trovati (pendenze ed intercetta) per trasformare le x (pixels) in lunghezza d'onda (nm) anche per altri spettri