Chapter 11. Atomic Spectroscopy

If *L, S* are good quantum #s

$$\Delta L = 0, \pm 1, \quad \Delta J = 0, \pm 1, \quad \Delta S = 0, \quad \Delta \ell = \pm 1 \longleftarrow$$

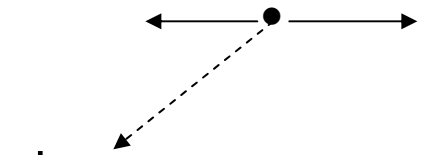
selection rules

H atom n = 1 $\rightarrow$ 2, 3, 4, … Lyman
n = 2 $\rightarrow$ 3, 4, 5, … Balmer
n = 3 $\rightarrow$ 4, 5, … Paschen

He $1s^2 \rightarrow$ *1s2p(^{1}P)* allowed
1s2s(^{1}S), 1s2s(^{3}S), 1s2p(^{3}P) forbidden

Atomic emission spectroscopy: can detect states with $n_{upper}/n_{lower} < 10^{-10}$

Doppler effect



frequency source

$$\omega = \omega_0 \sqrt{\frac{1 \pm v_z / c}{1 \mp v_z / c}}$$

ω_0: frequency if source is stationary

upper sign: approaching; blue shift lower sign: receding; red shift

used in astronomy to determine speed of stars and other objects in space

gas at finite *T*: all directions possible → Doppler broadening

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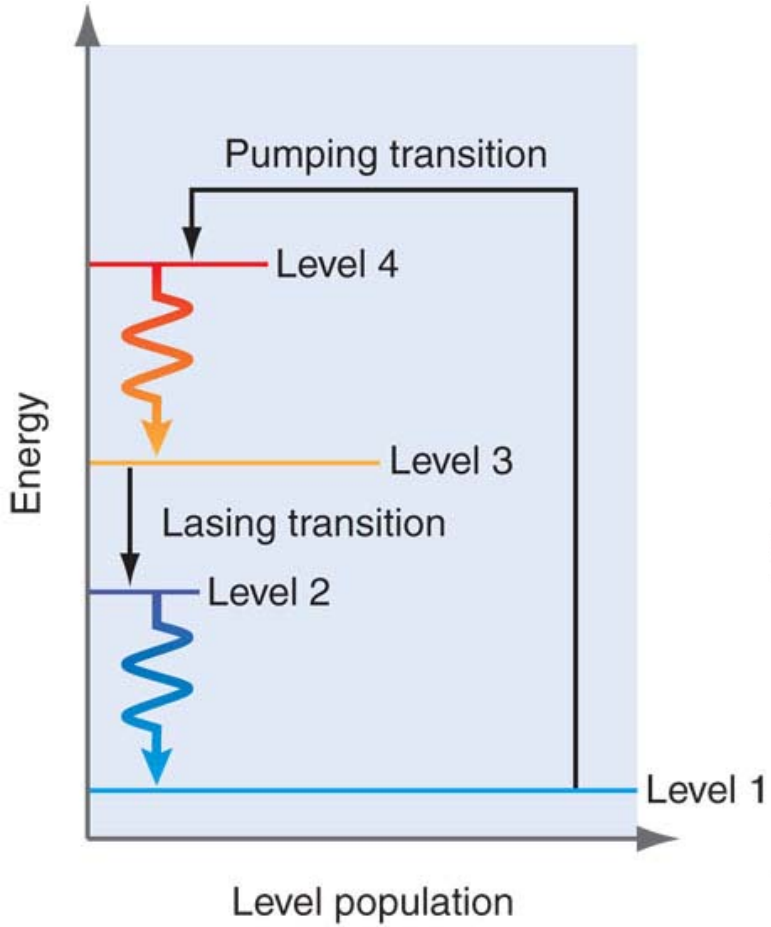
Operation of lasers $\frac{N_2}{N_1}$ ← Need a higher population in N_2 than N_1. Population inversion.

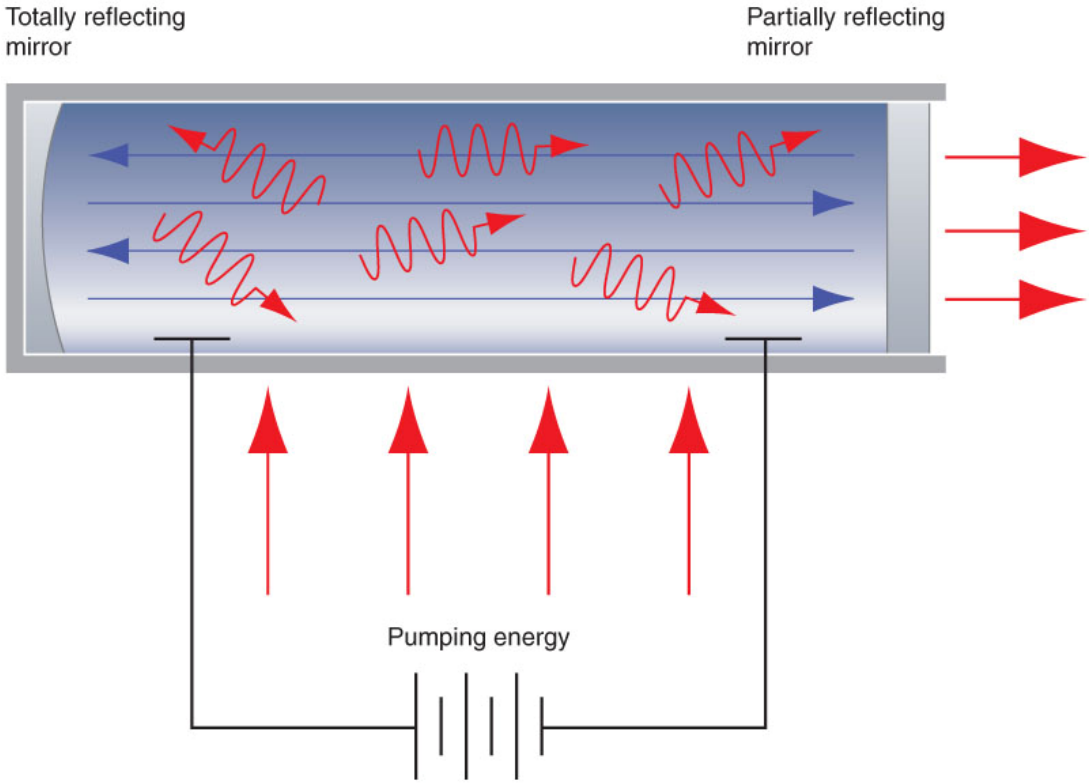


He Ne Laser

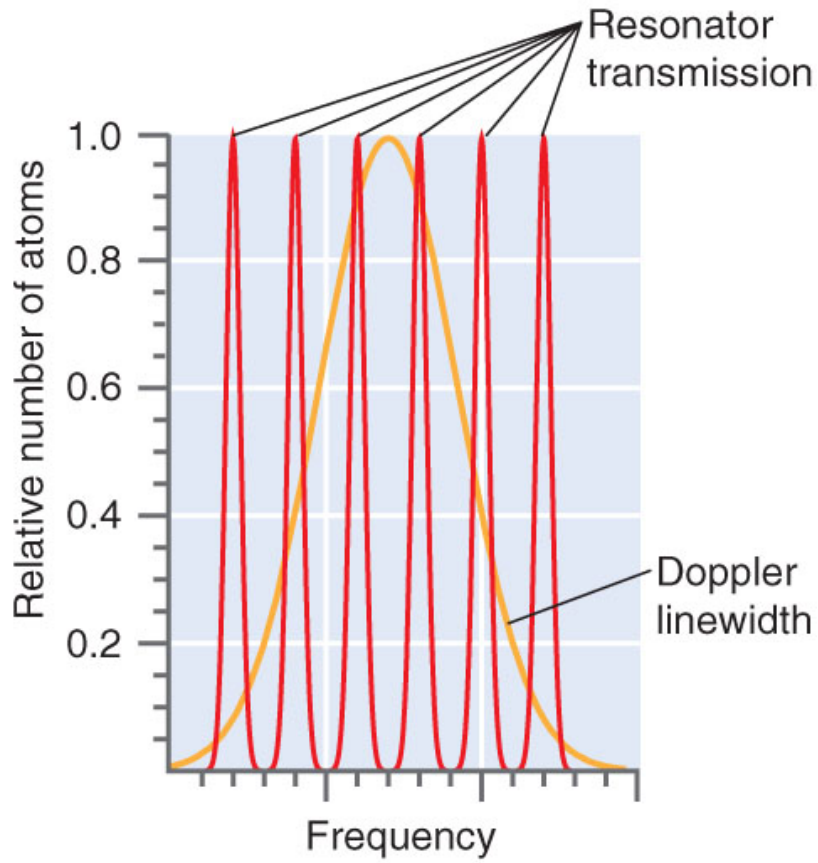
Pump *via* electrical discharge

If $k_{12} >> k_{23}$, $N_3 >> N_2 \rightarrow$ population inversion

Place in an optical resonator

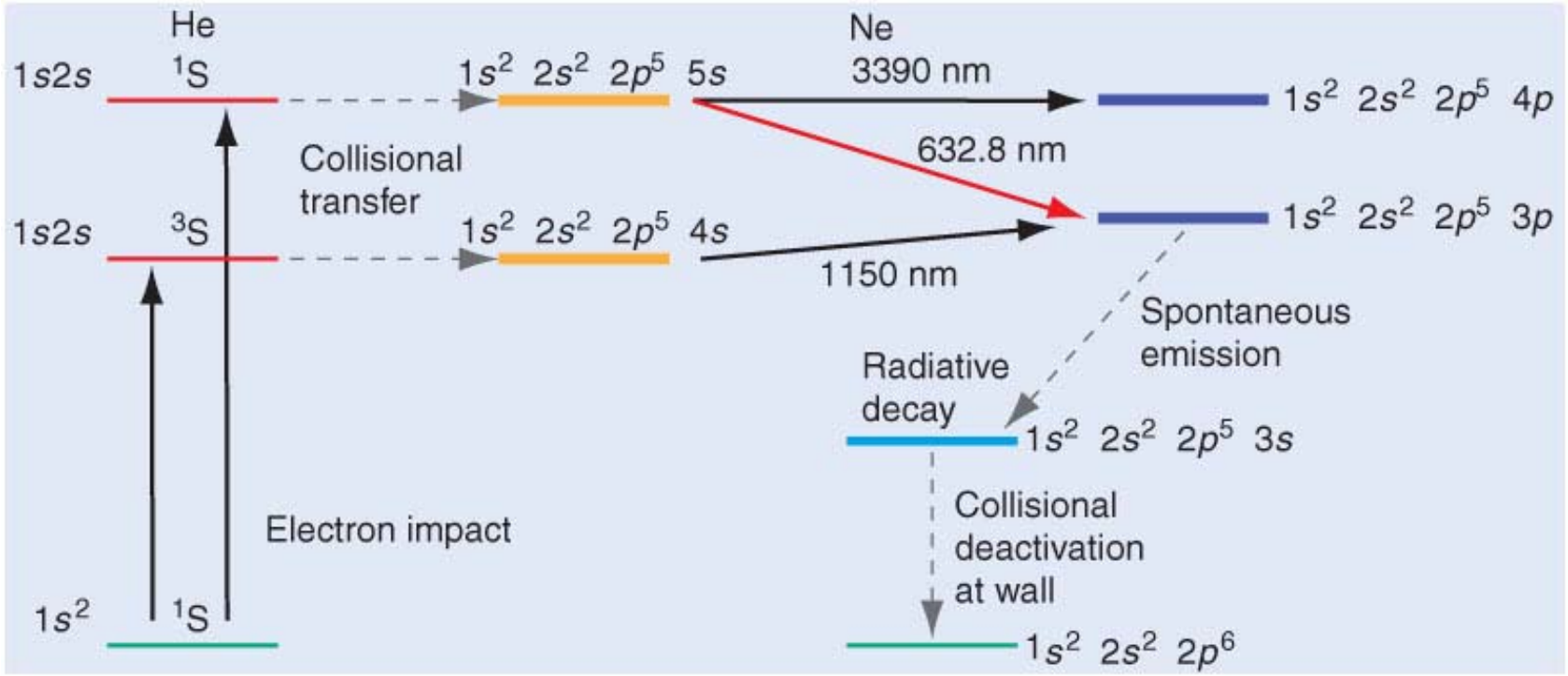


constructive interference $h\lambda = n\left(\frac{c}{\upsilon}\right) = 2d$



(a)

By use of amplification and filters, can limit the # of active modes to one.



632.8 nm line → red light

Auger spectroscopy:

x-ray photoelectron spectroscopy

energies of levels depends on chemical environments