

Chapter 11. Atomic Spectroscopy

If L, S are good quantum #'s

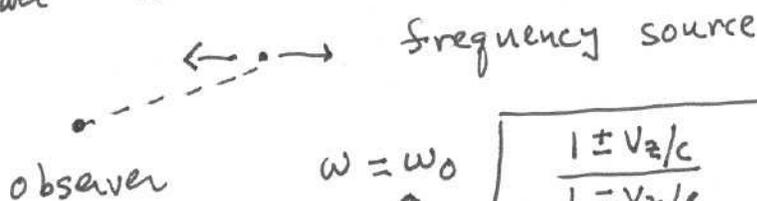
$$\Delta L = 0, \pm 1, \Delta J = 0, \pm 1, \Delta S = 0, \Delta \ell = \pm 1 \leftarrow \text{selection rules}$$

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

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

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

Doppler effect



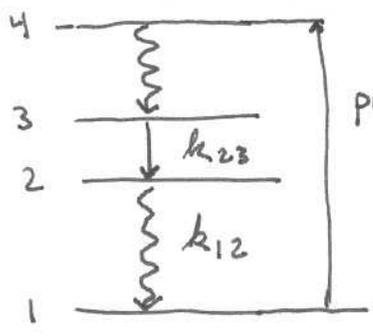
observer $\omega = \omega_0 \sqrt{\frac{1 \pm v_z/c}{1 \mp v_z/c}}$
 frequency of source is stationary

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

used in astronomy to determine speed of stars + other objects in space.

gas at finite T : all velocity directions possible \rightarrow Doppler broadening

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

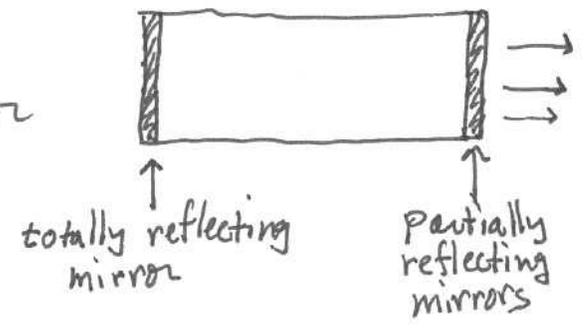


pump via electrical discharge

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

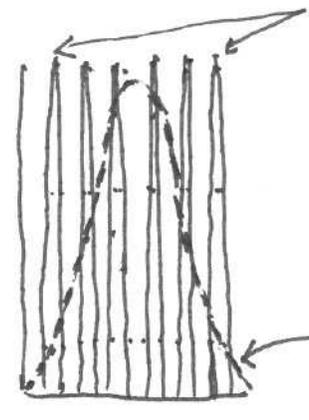
HeNe laser

Place in an optical resonator



constructive interference

$$n\lambda = 2d$$

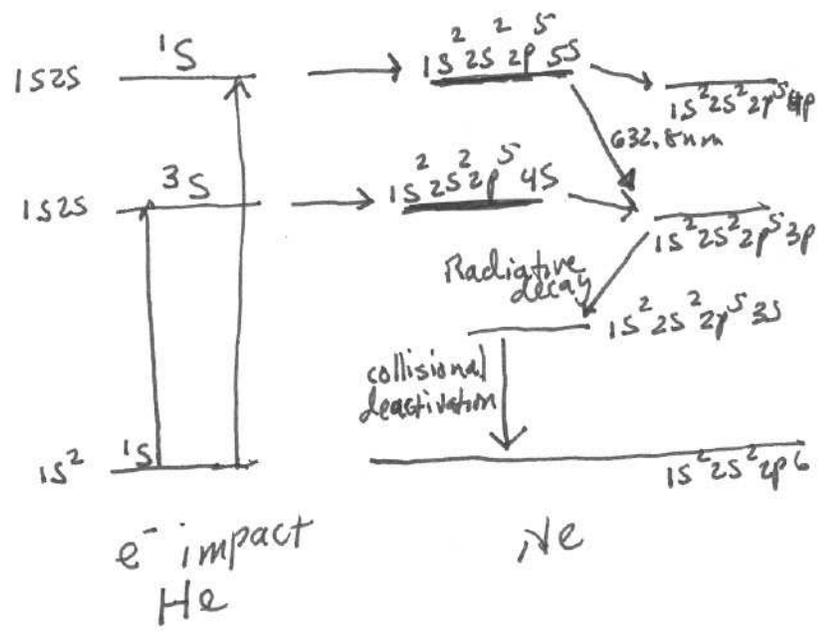


resonator frequencies within doppler linewidth

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

doppler linewidth

632.8 nm line \rightarrow red light



Auger spectroscopy: \rightarrow

X-ray photoelectron spectroscopy
energies of levels depend on chemical environments

