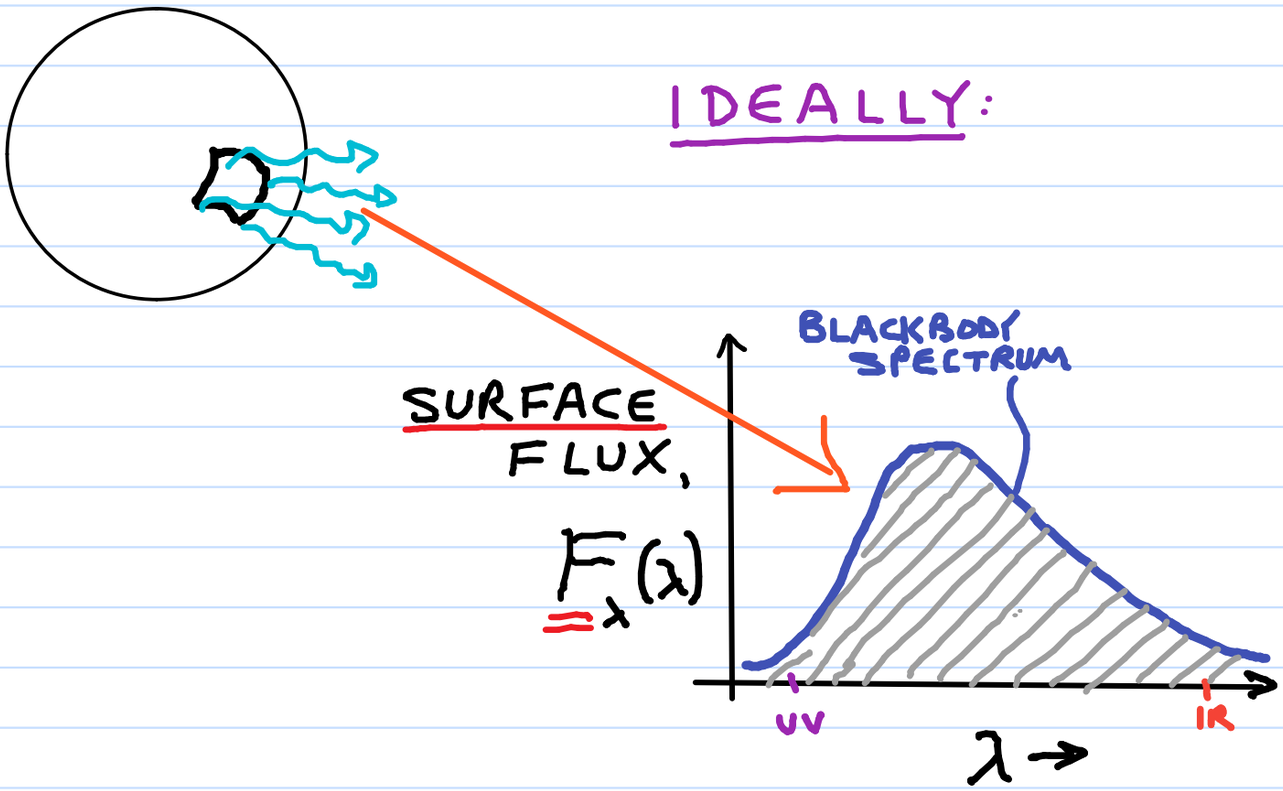
MODEL PARAMETERS (4)

WHAT TYPE OF STAR?

DETERMINES STRUCTURE

1) EFFECTIVE TEMPERATURE, T_{eff} (K)

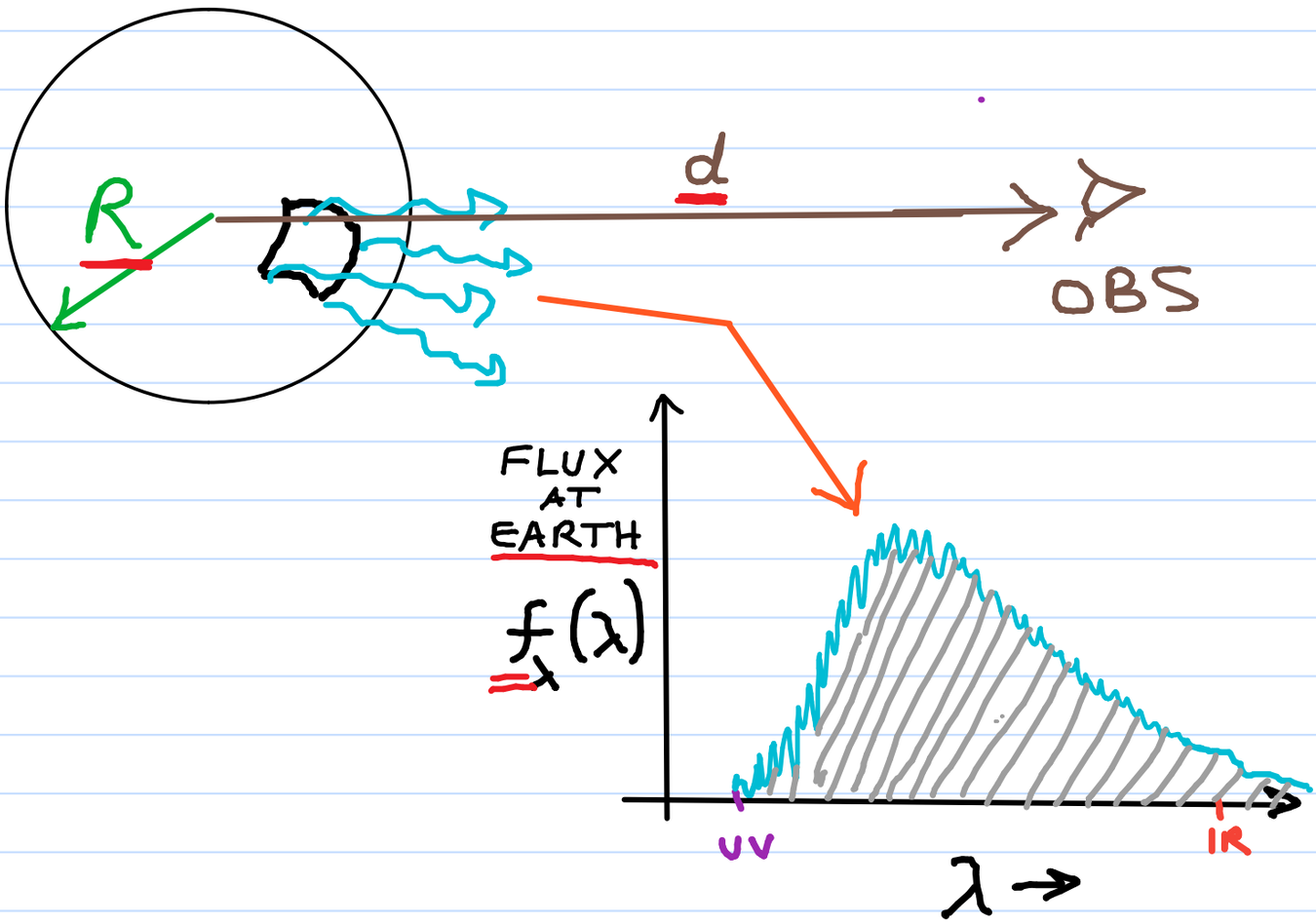
- EQUIVALENT SOLID SPHERICAL BLACKBODY SURFACE TEMPERATURE



BOLOMETRIC SURFACE FLUX, F (ergs/s/cm^2)

$$F = \int_0^\infty F_\lambda(\lambda)\, d\lambda$$

OBSERVATIONALLY:



BOLOMETRIC FLUX AT EARTH, f $(ergs/s/cm^2)$

$$f = \int_0^\infty f_\lambda(\lambda)\, d\lambda$$

$$F = \frac{d^2}{R^2} f$$

STEFAN-BOLTZMANN LAW OF BB RADIATION

$$F = \sigma T_{eff}^4$$

$$\Rightarrow T_{eff} = \left(\frac{F}{\sigma}\right)^{1/4}$$

$3200 < T_{eff} < 50000$ K

M5 STAR — O5 STAR

SUN: $T_{eff} = 5800$ K

- G2 V STAR

BROWN DWARFS (L, T, Y STARS):

$1000 < T_{eff} < 3000$ K

2) SURFACE GRAVITY, g (cm/s^2, $dynes/g$)

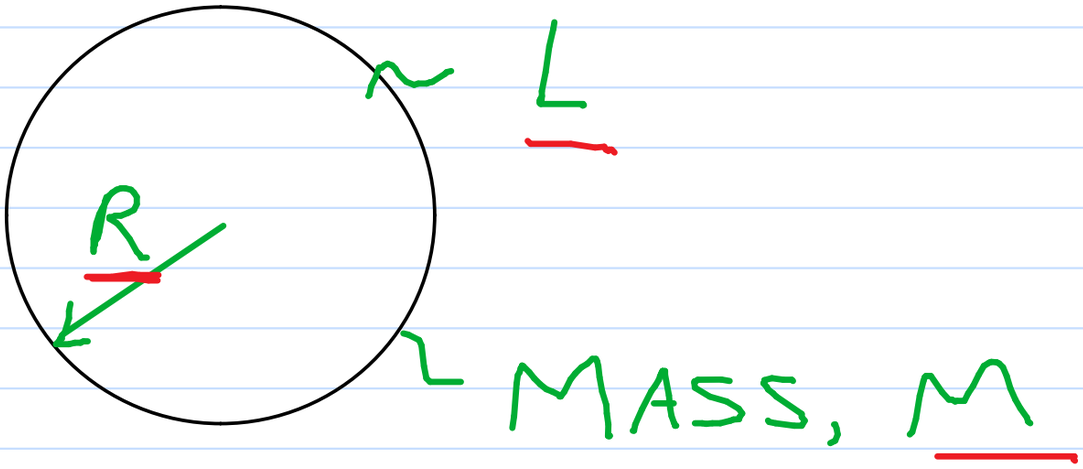
$$-0.5 < \log_{10}(g) < 5.5$$

SUPERGIANTS (L CLASS III) — SUB-DWARFS (L. CLASS VI)

SUN: $\log(g) = 4.44$ (G2 V STAR)

WHITE DWARFS (WD):

$$7.0 < \log(g) < 8.5$$



$$g = \frac{GM}{R^2}$$

BOLOMETRIC LUMINOSITY, L (erg/s)

$$L = \mathcal{F} \cdot 4\pi R^2$$
$$= \sigma T_{eff}^4 \cdot 4\pi R^2$$

BUT:

PLANE-|| MODEL

$\therefore$ $R = \infty$ (UNDEFINED)

$\therefore$ L UNDEFINED

BUT, T_{eff}, $\log(g)$ ARE DEFINED!

3) CHEMICAL COMPOSITION ("METALLICITY)

GENERALLY, FOR STARS & ISM, BY NUMBER OF PARTICLES:

- H: ~ 92 %
  He: $\gtrsim 7.8$ %
"METALS": $\lesssim 0.2$ %

- MOST ABUNDANT METALS:

O, C, N, Fe

INDEX ELEMENT BY ATOMIC NUMBER, Z

N_Z = NO. DENSITY OF ELEMENT Z (cm^{-3})

$$A(Z) \equiv \frac{N_Z}{N_H}$$

FOR DISK STARS (POP. I):

- FOR $4 < Z < 28$:
  - 4: Be
  - 28: Ni

$$10^{-9} < A(Z) < 10^{-3}$$

A_{12} SYSTEM:

$$A_{12}(Z) \equiv \log_{10}\left(\frac{N_Z}{N_H}\right) + 12$$

FOR DISK STARS (POP. I):

- FOR $4 < Z < 28$:

$$3 < A_{12}(Z) < 9$$

"ABUNDANCE", $\left[\frac{A_Z}{H}\right]$

OF ELEMENT Z:

$$\left[\frac{A_Z}{A_H}\right] \equiv \log_{10}\left\{\frac{\left(N_Z/N_H\right)}{\left(N_Z/N_H\right)_\odot}\right\}$$

$$= \log\left(\frac{N_Z}{N_H}\right) - \log\left(\frac{N_Z}{N_H}\right)_\odot$$

$$= A_{12}(Z) - A_{12}(Z)_\odot$$

"METALLICITY" $\approx \left\langle \left[\frac{A_Z}{H} \right] \right\rangle$

FOR SELECT ELEMENTS, Z

(Fe, Ti, Ca, Mg, Si, ...)

FOR DISK STARS (POP. I):

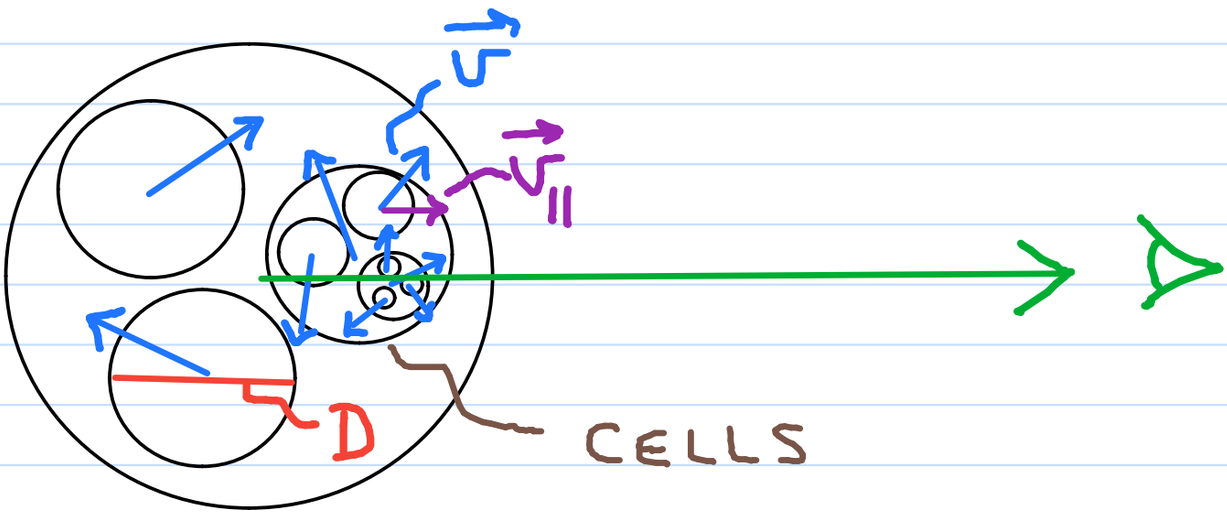
$$-2 < \left\langle \left[\frac{A_Z}{H} \right] \right\rangle < +0.3$$

-2: METAL-POOR

$+0.3$: METAL-RICH

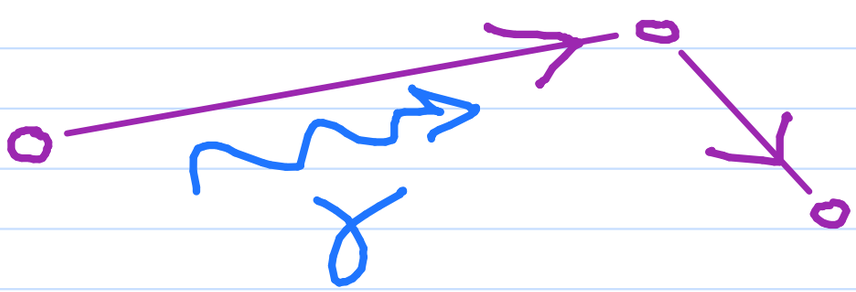
4) MICROTURBULENT VELOCITY DISPERSION

ξ_T (v_T) (Km/s)



TURBULENCE IS HEIRARCHICAL

PHOTON MEAN FREE PATH, ℓ_ν (cm)

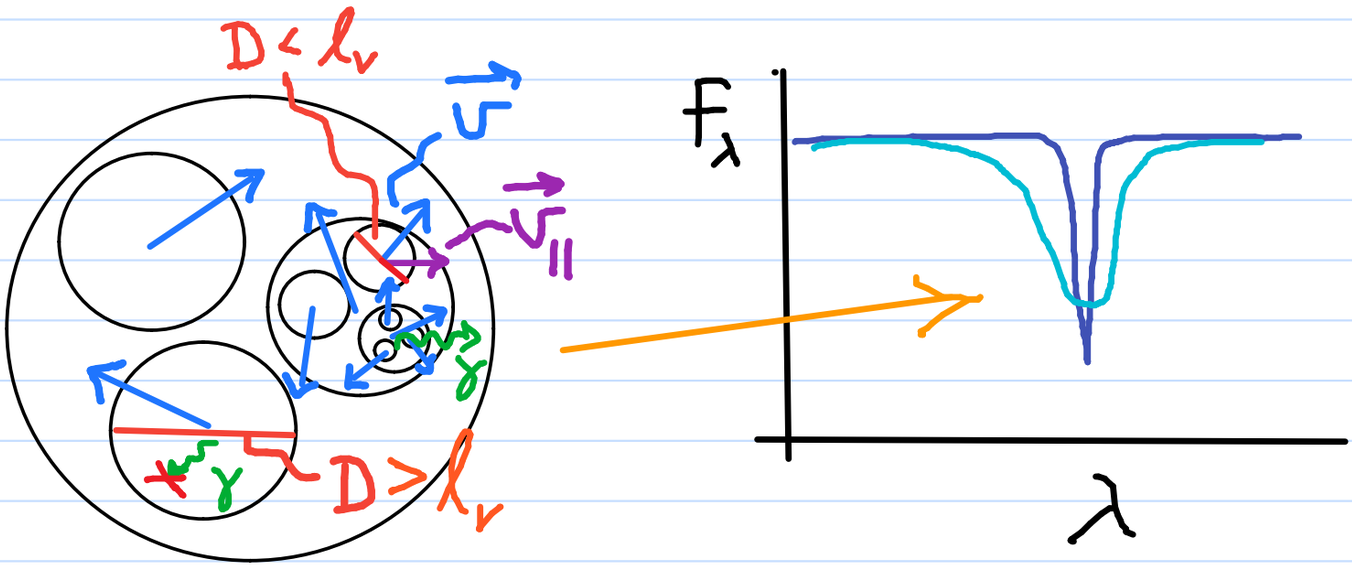


$D > l_v$: MACROTURBULENCE

→ SHIFTS SPECTRAL LINES

$D < l_v$: MICROTURBULENCE

→ BROADENS SPECTRAL LINES



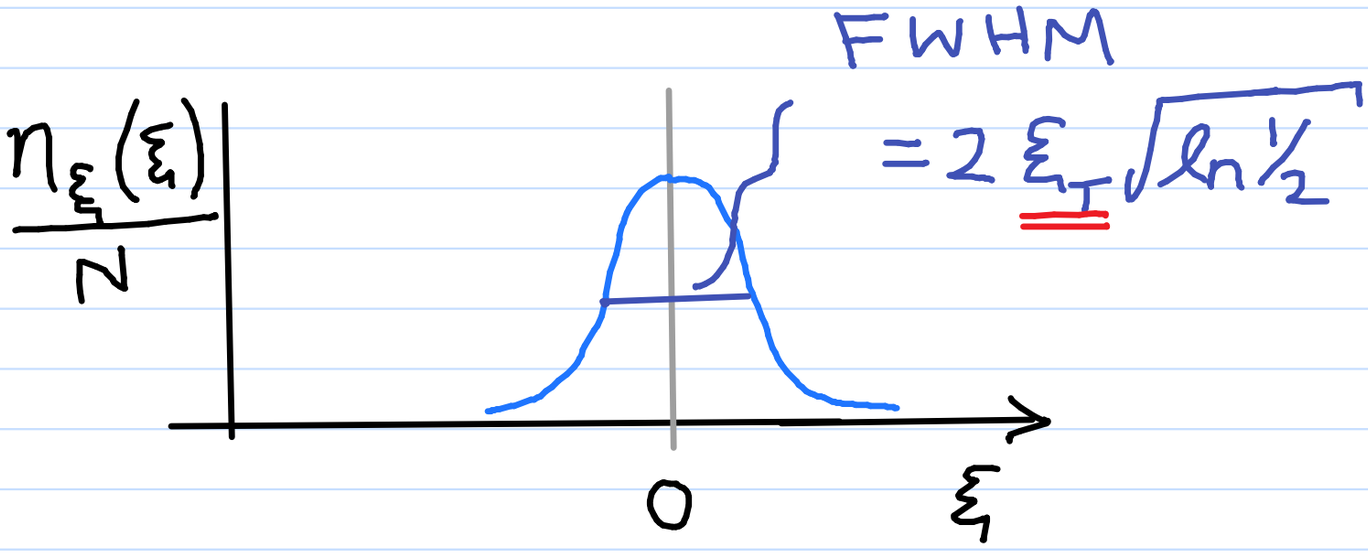
MICROTURBULENT LINE BROADENING

N = NO. MICROTURBULENT CELLS

$n_\xi(\xi)$ = NO. CELLS WITH LINE-OF-SIGHT VELOCITY, ξ

1D MAXWELL-BOLTZMANN (M-B) ξ DISTRIBUTION:

$$\frac{n_\xi(\xi)}{N} = \frac{1}{\sqrt{\pi}\,\xi_T} e^{-\xi^2/\xi_T^2}\, d\xi$$



FWHM $= 2\,\xi_I \sqrt{\ln \tfrac{1}{2}}$

$1 < \xi_T < 8$ Km/s

SUN — SUPERGIANTS