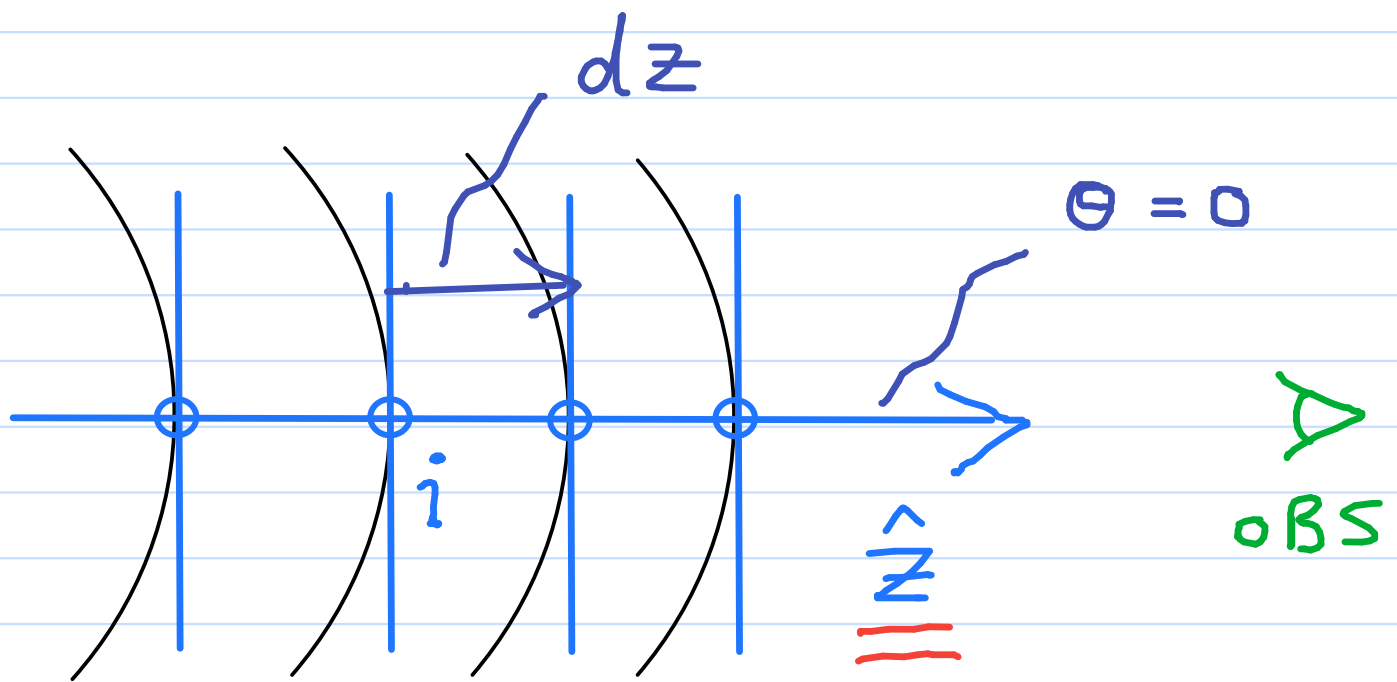


STELLAR ATMOSPHERIC STRUCTURE

RUTTEN ch.7

GRAY ch.9

PLANE-|| GEOMETRY:



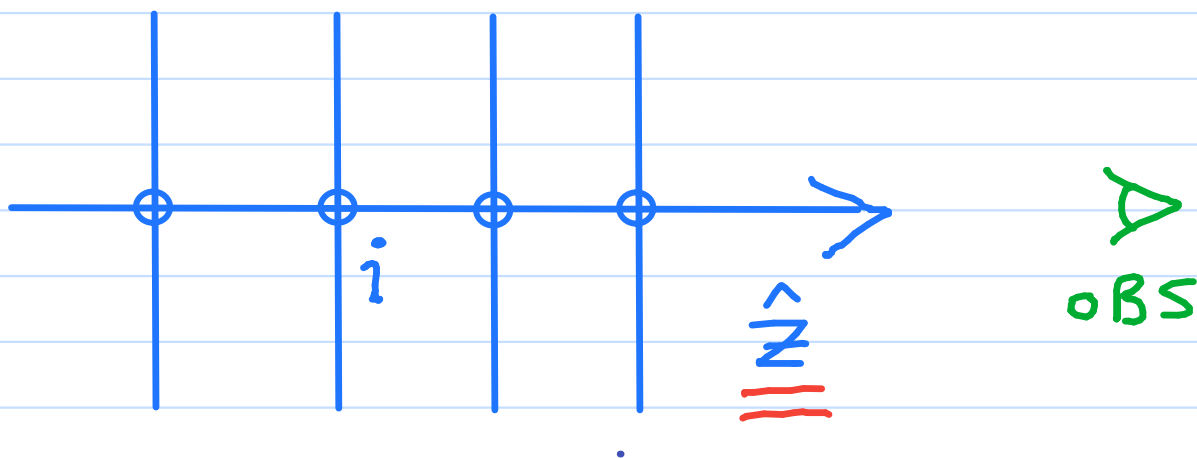
- LOCALLY FLAT

- 1D GEOMETRY

- HEIGHT z

- \hat{z} IS RADIAL (POLAR)

STELLAR ATMOSPHERIC STRUCTURE



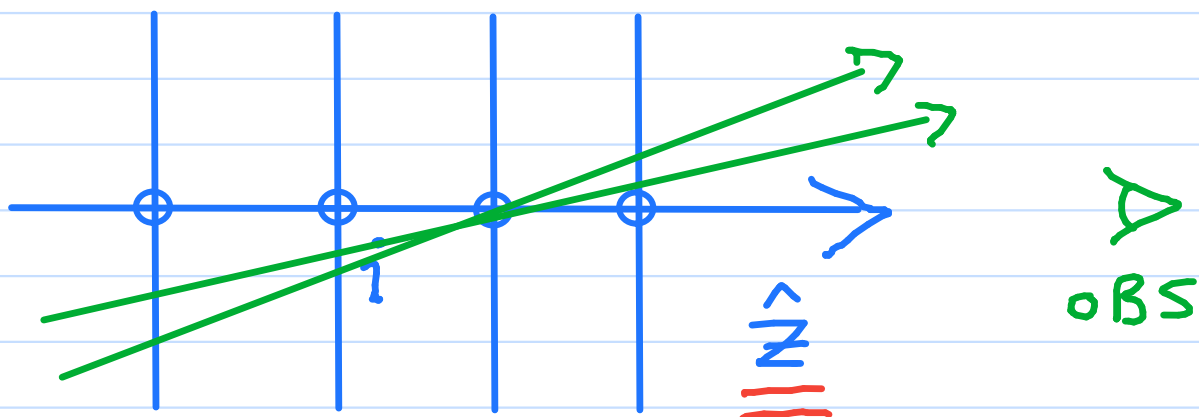
GAS:

$$T_{\text{KIN}}(z), P_{\text{gas}}(z), P_e(z), \rho(z), \\ \mu(z), \dots \\ K_{\lambda}(z, \lambda), \tau_{\lambda}(z, \lambda), \dots$$

K = EXTINCTION COEFFICIENT
(OPACITY)

τ = OPTICAL DEPTH

STELLAR ATMOSPHERIC STRUCTURE



RADIATION:

$$B_\nu(z, \nu), P_{\text{RAD}}(z), \\ F_\nu(z, \nu), j_\nu(z, \nu), \dots$$

B = PLANCK f_ν (BLACKBODY (BB) SPECTRUM)

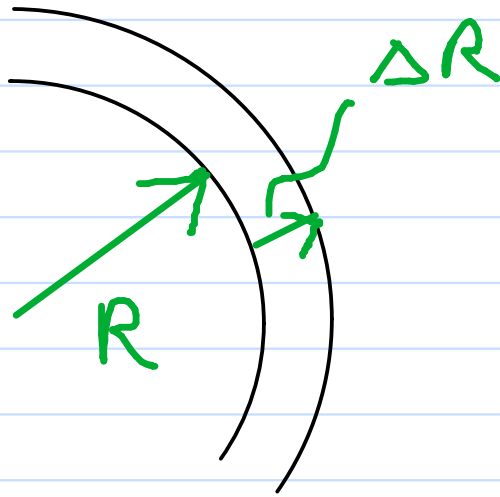
F = PHYSICAL FLUX

j = GAS EMISSIVITY

MODELLING ASSUMPTIONS

& APPROXIMATIONS (8)

1) PLANE-|| GEOMETRY



- APPROXIMATELY VALID IF $\frac{\Delta R}{R} \ll 1$.

⇒ LATE-B TO M MAIN SEQUENCE
(MS) STARS (L CLASS V)

2) HORIZONTAL HOMOGENEITY

$$F(x, y, z) = F(\underline{z})$$

⇒ NO HORIZONTAL STRUCTURE

eg. SUN SPOTS,

CONVECTION CURRENTS

1D MODEL:

ASSUMPTIONS 1) & 2)

TOGETHER

AXI-SYMMETRY ABOUT

\hat{z} -AXIS:

$$f(\theta, \phi) = f(\theta)$$

3) 3D CHEMICAL HOMOGENEITY

- NO VERTICAL CHEMICAL
STRATIFICATION

4) STASIS

(STATISTICAL EQUILIBRIUM (SE))

$$\Rightarrow \frac{d\langle n_i \rangle}{dt} = 0$$

- n_i = ATOMIC E-LEVEL POPULATION

NO LARGE-AMPLITUDE OR
SHORT-PERIOD PULSATORS

5) HYDROSTATIC EQUILIBRIUM (HSE)

$$a_z(z) = 0$$

$$\therefore \underline{F_{NET,z}}(z) = 0, \text{ ALL } z$$

⇒ NO LARGE-AMPLITUDE OR
SHORT-PERIOD PULSATORS

NO MASSIVE STELLAR
WINDS

6) THERMAL EQUILIBRIUM

$$\frac{dT_{\text{KIN}}}{dt} = 0$$

$$\frac{dT_{\text{RAD}}}{dt} = 0$$

⇒ NO SOURCES OR SINKS OF
ENERGY IN ATMOSPHERE

7) ENERGY TRANSPORT BY
RADIATION & CONVECTION ONLY

⇒ NO CONDUCTION, PRESSURE
WAVES, OR MHD WAVES

∴ NO CHROMOSPHERE
OR CORONA

8) LOCAL THERMODYNAMIC EQUILIBRIUM (LTE)

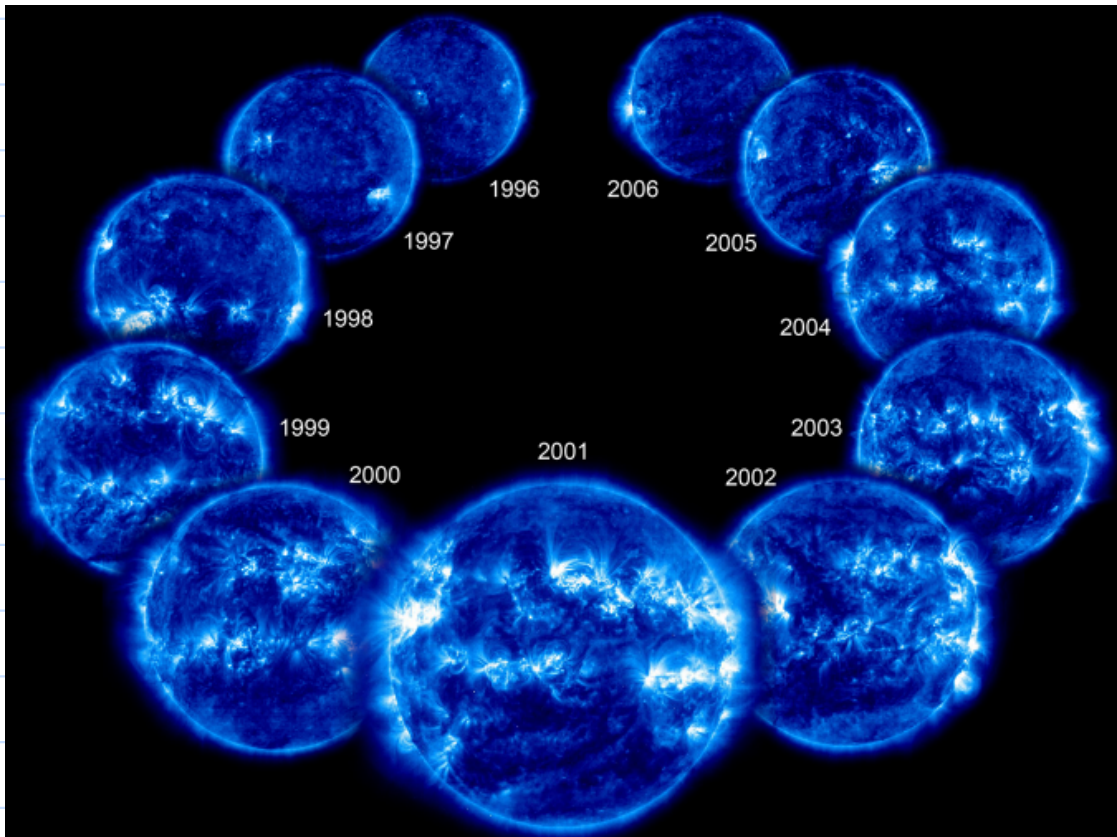
$$T_{\text{IONIZATION}} = T_{\text{EXCITATION}} \\ = T_{\text{RADIATION}} = T_{\text{KINETIC}}$$

ASSUMPTIONS 1-8 RULE OUT
ALL STARS

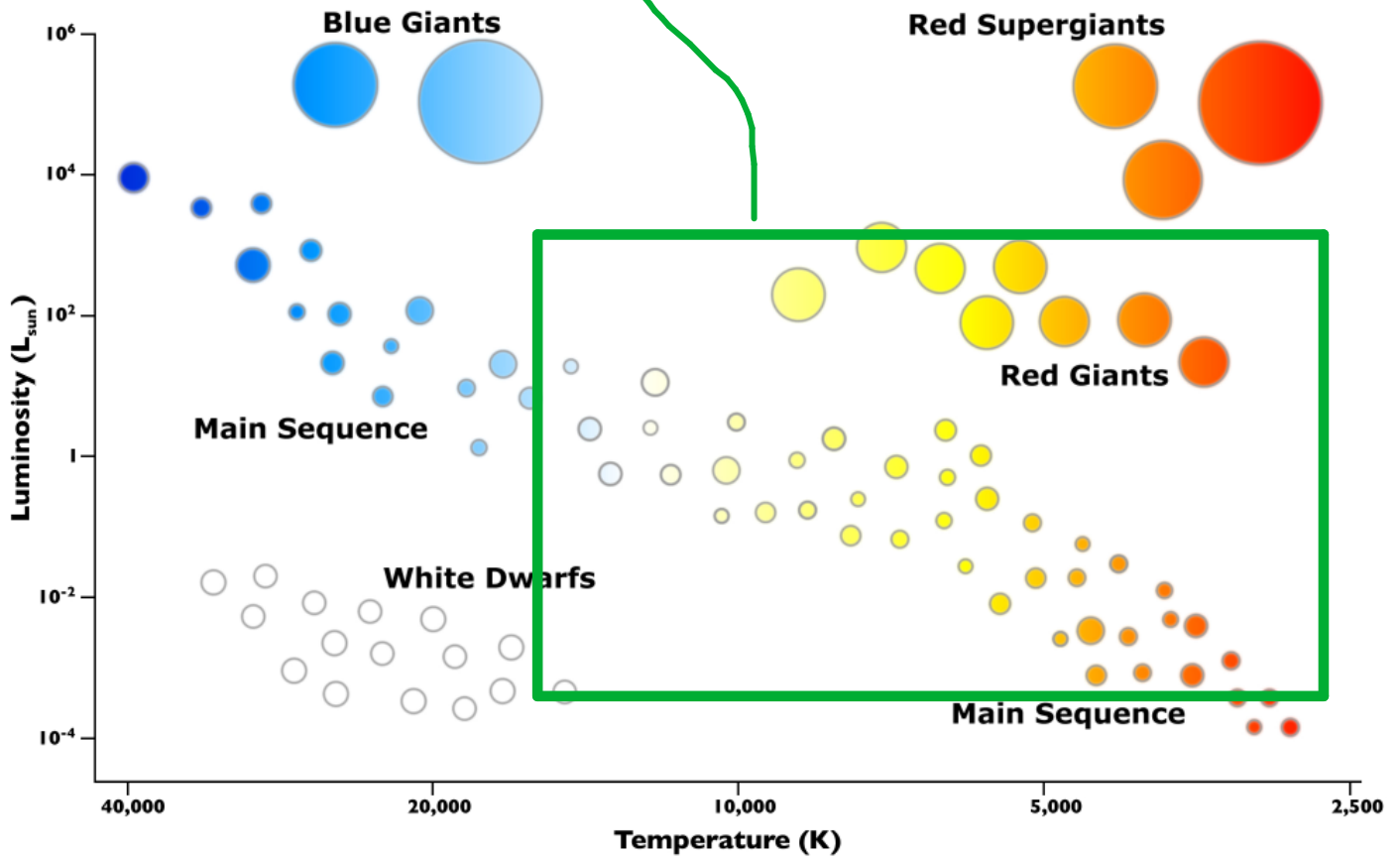
BUT

REASONABLE FOR MANY STARS

Eg. SUN (IMAGE CREDIT: SOHO)



REGION OF
GREATEST VALIDITY



HR DIAGRAM

IMAGE CREDIT: LAS CUMBRES
OBSERVATORY SPACEBOOK