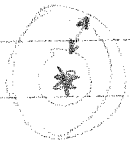


pressure oscillations (p-modes)



fundamental p-mode: radial "breathing" oscillation

$$\lambda = 2r_*$$

asymmetric oscillations

first overtone mode: simultaneously, some in while other out

$$\frac{3}{4}\lambda = 2r_*$$

sinusoidal oscillation



big oscillations driven by κ -mechanism instability which occurs when opacity \uparrow rather than \downarrow when $T \uparrow$. This can happen across ionization edges, the important one here being $\text{He}^+ \rightarrow \text{He}^{++}$

Acts like steam engine:

steam \leftrightarrow radiation
piston \leftrightarrow layer
valve \leftrightarrow opacity

layer sinks by gravity



so it heats up (and contracts)



layer becomes more opaque, trapping radiation below it and hence building up pressure



layer bounces from pressure, rises, expands, & cools so opacity drops. — as a result, pressure support from below is lost and cycle repeats

Only happens in stars with radial structure such that He^+ transition occurs near enough to atmosphere to make a difference (no substantial pressure "above" layer). This leads to instability strip in CMD

~~$P \propto \rho \propto Q$~~

$$P \langle \rho \rangle^{1/2} = Q$$

($G\rho$)^{1/2} dynamical time

pulsation constant

Fixed T_{eff}

$\rho \downarrow$ as $L \uparrow$ so $P \uparrow$