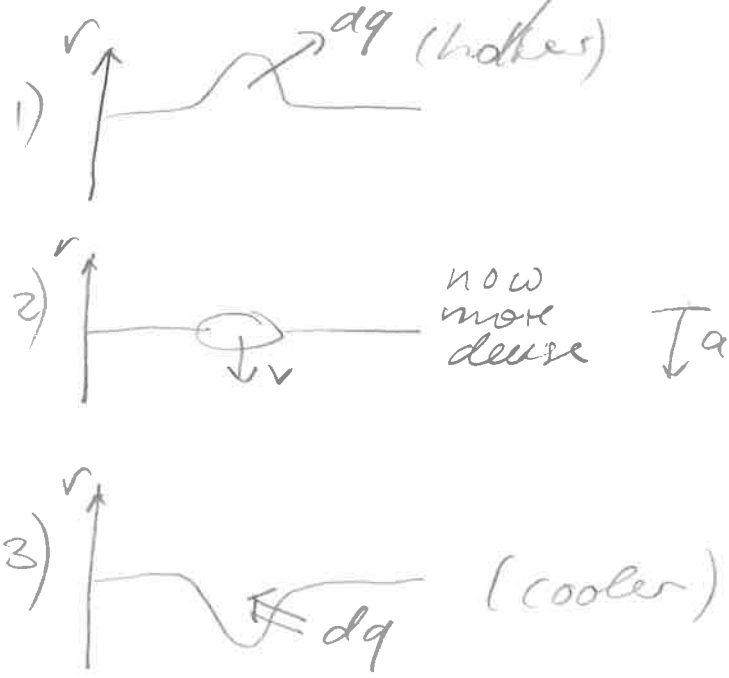
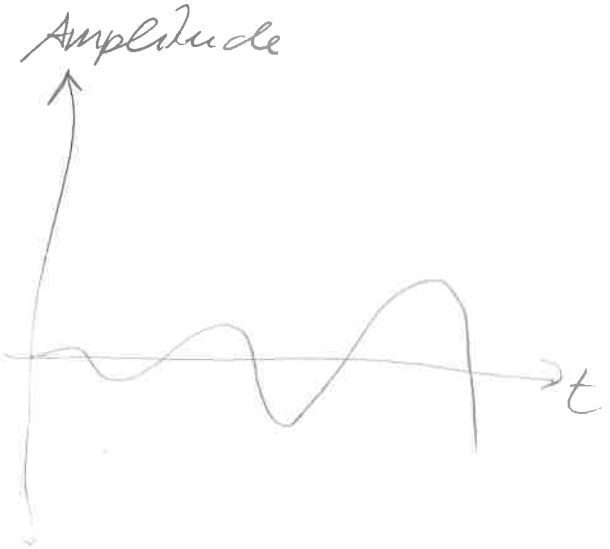
Semiconvection

Stabilised by composition gradient
→ oscillatory instability (secular)





eventually: enough energy in oscillation for a full turnover!

→ layer formation

→ effective transport of heat

but composition trapped in layer

(composition diffusivity $\sim 10^6 \times$ smaller than that of heat

because mean free path of photon $\gg$ ions

$$\tau_{diff} = \ell^2 / D$$

• on long time scale: merging of layers

Thermohaline Convection

20/03/2010-2-

↔ salt finger instability
observed in ocean

hot + heavy above light + cool medium

obs: ocean heated on top → water evaporates
but salt is left behind

→ $\mu \uparrow$ but $T \downarrow$ (gradients $\uparrow \downarrow$)

→ cooling at interface with cold water below hot salty water

→ high density → sinks

fingers cool more efficiently

Stellar Applications:

- accretion in binary stars
- ^3He burning

$$^3He + {}^3He \rightarrow p + p + {}^4He$$

Q:
- derive μ change
- compare μ on both sides
what will happen?

Regimes of Stability

SC: $\nabla_{RAD} < \nabla_{ad} + \frac{\varphi}{\delta}\nabla_\mu$ & $\nabla_{RAD} > \nabla_{ad}$ | $\nabla_{ad} < \nabla_{rad} < \nabla_{ad} + \frac{\varphi}{\delta}\nabla_\mu$

TH: $\nabla_{rad} < \nabla_{ad} + \frac{\varphi}{\delta}\nabla_\mu$ & $\frac{\varphi}{\delta}\nabla_\mu < 0$ | $\nabla_{rad} - \nabla_{ad} < \frac{\varphi}{\delta}\nabla_\mu < 0$

C: $\nabla_{rad} > \nabla_{ad} + \frac{\varphi}{\delta}\nabla_\mu$ ✓

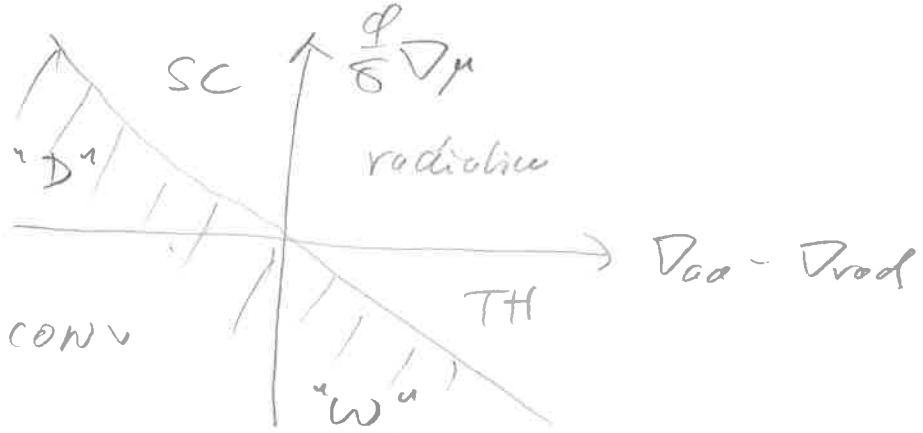
WC (C) & $\nabla_{ad} - \nabla_{rad} > 0$ | $0 > \nabla_{rad} - \nabla_{ad} > \frac{\varphi}{\delta}\nabla_\mu$

→ forced heat transport by comp against S gradient!

CD: (C) & $\frac{\varphi}{\delta}\nabla_\mu > 0$ | $\nabla_{rad} - \nabla_{ad} > \frac{\varphi}{\delta}\nabla_\mu > 0$

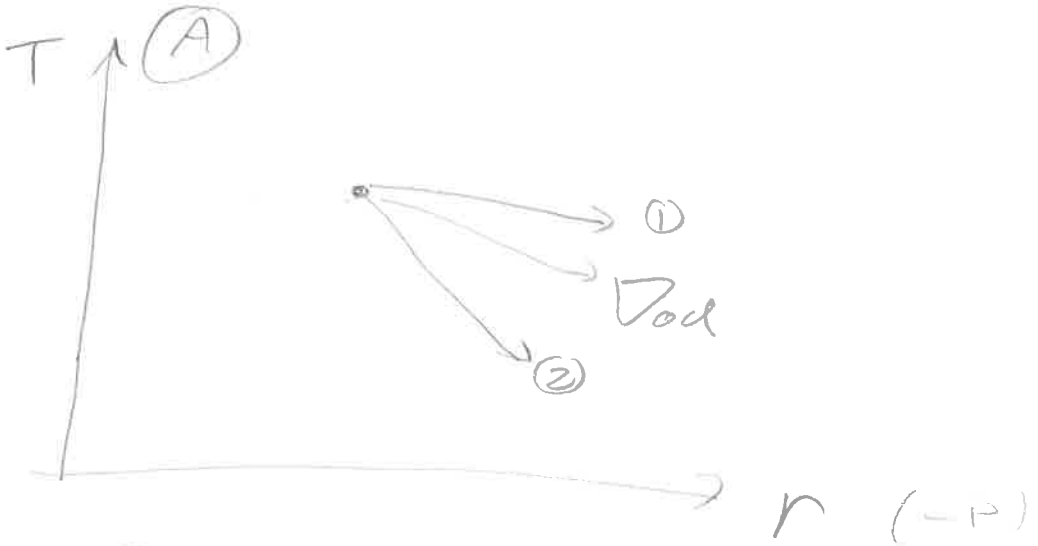
R: $\frac{\varphi}{\delta}\nabla_\mu > 0$ & $\nabla_{ad} - \nabla_{rad} > 0$

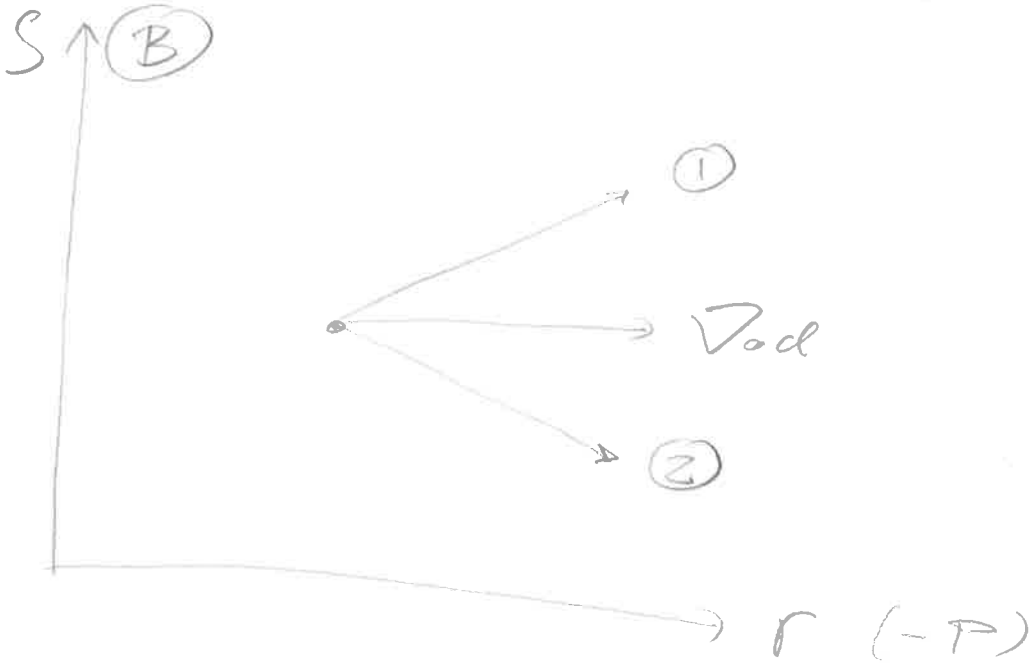
(reg. conv): $\frac{\varphi}{\delta}\nabla_\mu < 0$ & $\nabla_{ad} - \nabla_{rad} < 0$



Q: indicate Schwarzschild criterion in this diagram!

Adiabatic Gradient





Q: which of these (①, ②) are <u>STABLE</u> (or unstable) to convection for each of the cases (A) and (B) ?

A1 B1