$\boxed{\text{May 8, 2012}}$

Why is $\left|\frac{dP}{PK0 + PK1}\right| < 10^{-5}$ the convergence criterion in that first for-loop in atmos.F? Why does being "done" depend on agreement b/w <u>pressure</u> values, instead of b/w density or opacity values?

(5.30) $$\frac{dP}{dr} = -\frac{GM_*}{R_*^2} \cdot \rho$$

Are we basically trying to tweak the outer κ, ρ, and P values such that $\frac{dP}{dr} = 0$?

(5.31) $$\frac{dP}{d\tau} = \frac{g}{\kappa_R}$$

$$dP = \frac{g}{\kappa_R} d\tau \rightarrow \text{want both of these to} = 0 \text{?}$$

(1) $dP = PK0 - PK1$ $\quad \cancel{\frac{g}{\kappa_R} d\tau}$

(2) $\frac{g}{\kappa_R} d\tau \rightarrow \frac{G0\, d\tau}{\kappa_{R0}} - \frac{G1\, d\tau}{\kappa_{R1}}$

- We "know" (guess) P_{out}, which is the value of P at the $\tau = 0$ surface (?).
- We have an eqn. that tells us TK0; i.e., the temperature @ the $\tau = 10^{-3}$ surface.

- From those 2 "knowns," we want to calculate P at the $\tau = 10^{-3}$ surface.

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- let's rewrite eqns. (1) & (2) in (perhaps?) more suggestive terms:

$$GO = \frac{-GM_\star}{R_\star^2}\rho_0$$

$$G1 = -\frac{GM_\star}{R_\star^2}\rho_1$$

$$dP = d\tau\left[\frac{GO}{\kappa_{R0}} - \frac{G1}{\kappa_{R1}}\right] = \frac{-GM_\star d\tau}{R_\star^2}\left[\frac{\rho_0}{\kappa_0} - \frac{\rho_1}{\kappa_1}\right]$$

$$(3)\quad \boxed{dP = PK0 - PK1 = -\frac{GM_\star d\tau}{R_\star^2}\left[\frac{\rho_0}{\kappa_0} - \frac{\rho_1}{\kappa_1}\right]}$$

$$(4)\quad \boxed{PK0 - PK1 \sim \frac{\rho_0}{\kappa_0} - \frac{\rho_1}{\kappa_1}}$$

$$(5)\quad \boxed{\begin{array}{l} PK0 \sim \frac{\rho_0}{\kappa_0} \\ PK1 \sim \frac{\rho_1}{\kappa_1}\end{array}}$$

$$dP = PK0 - PK1$$

$$\frac{dP}{PK0+PK1} = \frac{\frac{\rho_0}{\kappa_0} - \frac{\rho_1}{\kappa_1}}{\frac{\rho_0}{\kappa_0} + \frac{\rho_1}{\kappa_1}} \rightarrow \frac{dP}{\frac{1}{2}\,\mathrm{avg}(PK0, PK1)}$$

$$= \frac{\frac{\rho_0\kappa_1 - \rho_1\kappa_0}{\cancel{\kappa_0\kappa_1}}}{\frac{\rho_0\kappa_1 + \rho_1\kappa_0}{\cancel{\kappa_0\kappa_1}}} = \frac{\rho_0\kappa_1 - \rho_1\kappa_0}{\rho_0\kappa_1 + \rho_1\kappa_0}$$

③

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$$(6) \quad \boxed{\frac{dP}{PKO + PK1} = \frac{\rho_0 \kappa_1 - \rho_1 \kappa_0}{\rho_0 \kappa_1 + \rho_1 \kappa_0}}$$

definition of optical depth (τ) is:

$$\tau = \int -\kappa \rho \, dr$$

$$\frac{d\tau}{dr} = -\kappa \rho$$

For the outermost point, where $d\tau = 0$ (and $\tau = 10^{-3}$) we want $\frac{dP}{d\tau} = 0$.

$$\frac{dP}{d\tau} = \frac{g}{\kappa_R}$$

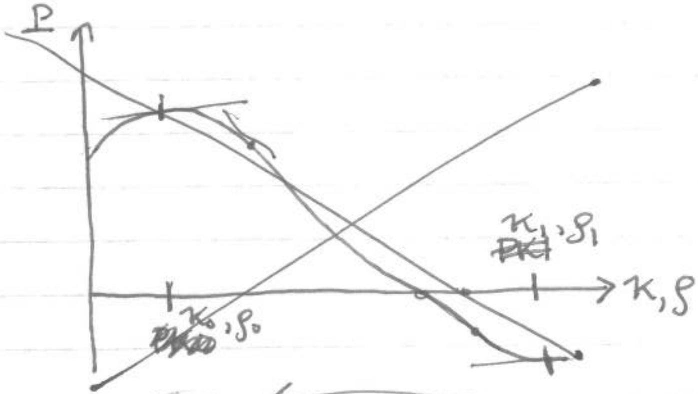
$$dP\left(\frac{\kappa_R}{g}\right) = d\tau = \text{"}0\text{"} \leftarrow \text{or really, } 10^{-5} \text{... sort of... I guess?...}$$

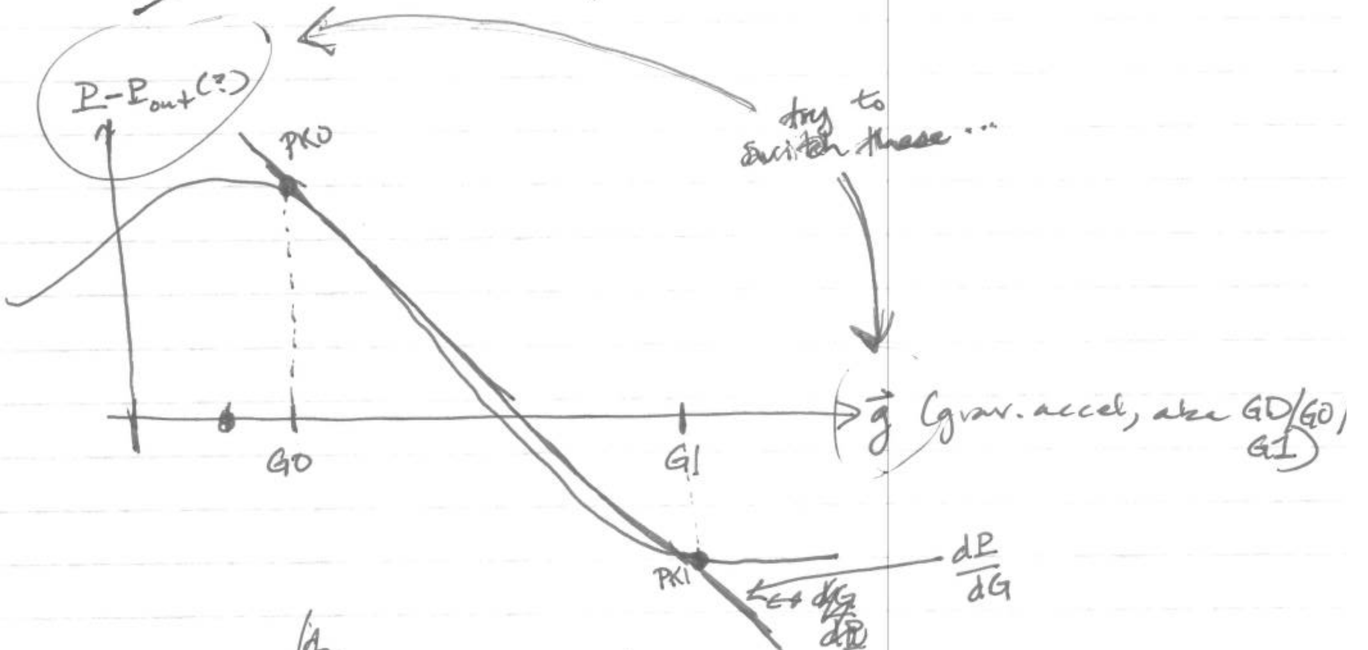
$$dP = d\tau \left(-\frac{GM_\star}{R_\star^2}\right)\left(\frac{\rho_0}{\kappa_0} - \frac{\rho_1}{\kappa_1}\right)$$

$$d\tau = -\frac{R_\star^2}{GM_\star}\left[\frac{1}{\frac{\rho_0}{\kappa_0} - \frac{\rho_1}{\kappa_1}}\right] dP$$

5/8/2012

My mental image of what's happening w/ these P (pressure) iterations: some kind of Newton's method/root finding





$$dP = -\frac{G0}{dG/dP} \rightarrow \frac{|G0|}{|dG|} \simeq 1 \text{ ?!}$$

$$\rightarrow \boxed{\frac{|PK0|}{|dP|} \simeq 1 \text{ ?!}}$$

I still don't understand why this step is valid.

Wait, that makes no sense! You'd never get convergence

this does seem to be upheld by the debugAtmosProbe.txt results: $dP \simeq \frac{1}{2} PK0$

⑤

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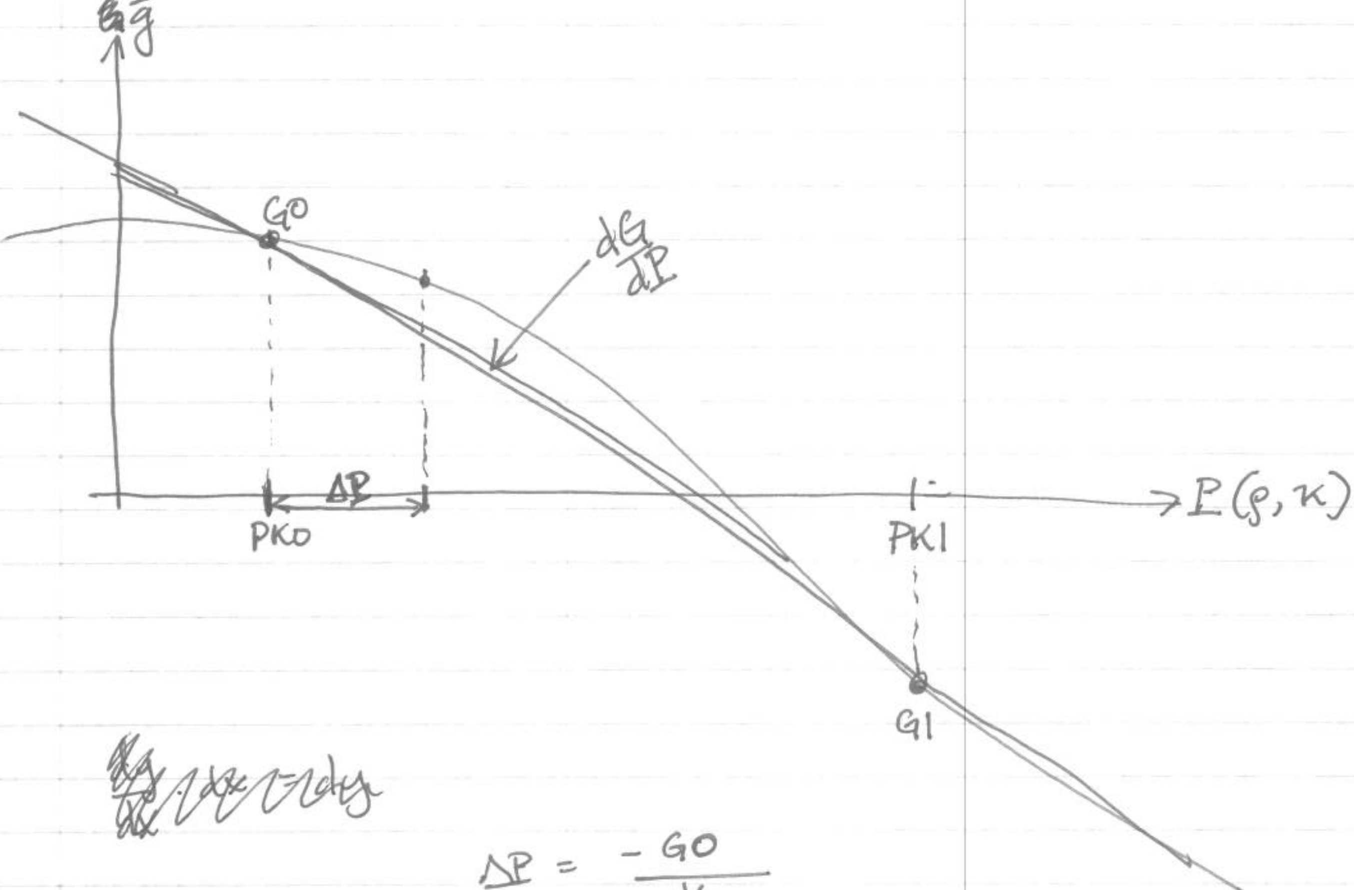

$$\Delta P = \frac{-G0}{\frac{dG}{dP}}$$

I need to just <u>plot</u> how the PK0, PK1 & etc. values change throughout the iteration/convergence process to get a handle on exactly what's going on, here.