[tex124] Latent heat and response functions

Consider a discontinuous transition between phases 1 and 2 of a simple fluid. The latent heat is $L(T)$ and the coexistence curve is $p = p(T)_{\text{coex}}$.

(a) Show that the rate at which the latent heat changes along the transition curve depends on the heat capacity $C_p$ and the thermal expansivity $\alpha_p$ of the coexisting two phases as follows:

$$\left( \frac{dL}{dT} \right)_{\text{coex}} = C^{(2)}_p - C^{(1)}_p + L(T) \left[ \frac{1}{T} - \frac{V_2 \alpha^{(2)}_p - V_1 \alpha^{(1)}_p}{V_2 - V_1} \right].$$

(b) Simplify this expression when phase 2 is a classical ideal gas, in which case we have $V_2 \gg V_1$, $\alpha^{(2)}_p \gg \alpha^{(1)}_p$, and an explicit result for the $T$-dependence of $\alpha^{(2)}_p$.

Solution: