① $\frac{T - T_c}{T_c} = R(1-\theta^2)$ $\qquad \frac{\mu - \mu_c}{\mu_c} = h_0 R^{\beta\delta} h(\theta)$

$\frac{n - n_c}{n_c} = m_0 R^{\beta} \theta$ Claim is that $\left(\frac{\partial P}{\partial \mu}\right)_T = n$ with

$$P - P_c = [\mu(R,\theta) - \mu_c] n(R,\theta) - m_0 h_0 \mu_c n_c R^{2-\alpha} g(\theta)$$

The independent variables are $R$ and $\theta$.

Calculate $dP$ and divide by $d\mu$ with $T$ fixed.

$$\frac{dT}{T_c} = (1-\theta^2) dR - 2R\theta\, d\theta = 0$$

$$d\mu = h_0 \mu_c \left[ \beta\delta R^{\beta\delta - 1} h(\theta) dR + R^{\beta\delta} h'(\theta) d\theta \right]$$

$$= h_0 \mu_c \left\{ \beta\delta R^{\beta\delta-1} h(\theta) \left[ \frac{2R\theta d\theta}{1-\theta^2} \right] - R^{\beta\delta} h'(\theta) d\theta \right\}$$

$$= \frac{h_0 \mu_c R^{\beta\delta}}{1-\theta^2} \left[ 2\beta\delta\theta h(\theta) - (1-\theta^2) h'(\theta) \right] d\theta$$

$$dn = m_0 n_c \left[ \beta R^{\beta-1} \theta dR + R^{\beta} d\theta \right]$$

$$= m_0 n_c \left\{ \beta R^{\beta-1} \theta \left[ \frac{2R\theta d\theta}{1-\theta^2} \right] + R^{\beta} d\theta \right\} =$$

$$= \frac{m_0 n_c R^{\beta}}{1-\theta^2}\left[2\beta\theta^2 + (1-\theta^2)\right] d\theta$$

$$dP = n\,d\mu + (\mu - \mu_c)\,dn - m_0 h_0 \mu_c n_c \Big[(2-\alpha) R^{1-\alpha} g(\theta)\, \underset{\substack{\uparrow \\ \frac{2R\theta\, d\theta}{1-\theta^2}}}{dR}$$

$$+ R^{2-\alpha} g'(\theta)\, d\theta\Big]$$

$$= n\,d\mu + h_0 \mu_c R^{\beta\delta} h(\theta)\, dn - \frac{m_0 h_0 \mu_c n_c R^{2-\alpha}}{1-\theta^2} \cdot$$

$$\cdot \left[2(2-\alpha)\,\theta\, g(\theta) + (1-\theta^2) g'(\theta)\right] d\theta$$

To have $\left(\frac{\partial P}{\partial \mu}\right)_T = n$ requires that $g(\theta)$ satisfies

$$0 = R^{\beta\delta} h(\theta) \left[\frac{m_0 n_c R^{\beta}}{1-\theta^2}\right]\left[2\beta\theta^2 + (1-\theta^2)\right] d\theta$$

$$- \frac{m_0 n_c R^{2-\alpha}}{1-\theta^2}\left[(1-\theta^2) g'(\theta) + 2(2-\alpha)\theta\, g(\theta)\right] d\theta$$

Use $\alpha + 2\beta + \gamma = 2$ and $\beta(\delta - 1) = \gamma$ to get

$\beta(\delta + 1) = 2 - \alpha$ so the $R$'s drop out.

We require that

$$0 = (1 + 2\beta\theta^2 - \theta^2)h(\theta) - (1-\theta^2)g'(\theta) + 2(2-\alpha)\theta g(\theta)$$

$$\Rightarrow \boxed{(1-\theta^2)g'(\theta) + 2(2-\alpha)\theta g(\theta) = (1+2\beta\theta^2 - \theta^2)h(\theta)}$$