

$$\psi \approx U_0 + \psi_0 - \frac{N\gamma\theta^2}{6k^2} \left(1 + \frac{x \coth x}{2} \right) - \frac{N\gamma^2\theta^3}{4k^4} \left(1 + \frac{x \coth x}{2} \right) (x \coth x + 1)$$