$$C_p = 1 - \frac{V^2}{V_\infty^2} = 1 - \left(\frac{u}{V_\infty}\right)^2 - \left(\frac{v}{V_\infty}\right)^2$$

a) Source: $u = V_\infty + \frac{\Lambda}{2\pi}\frac{x}{x^2+y^2}$

$v = \frac{\Lambda}{2\pi}\frac{y}{x^2+y^2}$

dominant; much smaller for large x

Along $-x$, $y=0$: $C_p = 1 - \frac{u^2}{V_\infty^2} = 1 - \left(\frac{V_\infty}{V_\infty} - \frac{\Lambda}{2\pi V_\infty}\frac{1}{x}\right)^2 = \boxed{\frac{\Lambda}{\pi V_\infty}\frac{1}{x}} - \left(\frac{\Lambda}{2\pi V_\infty}\right)^2\frac{1}{x^2}$

Along y, $x=0$: $C_p = 1 - \left(\frac{V_\infty}{V_\infty}\right)^2 - \left(\frac{\Lambda}{2\pi V_\infty}\right)^2\frac{1}{y^2} = -\left(\frac{\Lambda}{2\pi V_\infty}\right)^2\frac{1}{y^2}$

b) Vortex: $u = V_\infty + \frac{\Gamma}{2\pi}\frac{y}{x^2+y^2}$

$v = \frac{\Gamma}{2\pi}\frac{-x}{x^2+y^2}$

dominant

Along $-x$, $y=0$: $C_p = 1 - \left(\frac{V_\infty}{V_\infty}\right)^2 - \left(\frac{\Gamma}{2\pi V_\infty}\right)^2\frac{1}{x^2} = -\left(\frac{\Gamma}{2\pi V_\infty}\right)^2\frac{1}{x^2}$

Along y, $x=0$: $C_p = 1 - \left(\frac{u}{V_\infty}\right)^2 = 1 - \left(\frac{V_\infty}{V_\infty} + \frac{\Gamma}{2\pi V_\infty}\frac{1}{y}\right)^2 = \boxed{-\frac{\Gamma}{\pi V_\infty}\frac{1}{y}} - \left(\frac{\Gamma}{2\pi V_\infty}\right)^2\frac{1}{y^2}$

c) Doublet: $\phi = V_\infty x + \frac{\kappa}{2\pi}\frac{x}{x^2+y^2}$

$u = \frac{\partial\phi}{\partial x} = V_\infty + \frac{\kappa}{2\pi}\frac{y^2-x^2}{(x^2+y^2)^2}$

$v = \frac{\partial\phi}{\partial y} = \frac{\kappa}{2\pi}\frac{-2xy}{(x^2+y^2)^2}$

Along $-x$, $y=0$: $C_p = 1 - \left(\frac{u}{V_\infty}\right)^2 = 1 - \left(\frac{V_\infty}{V_\infty} - \frac{\kappa}{2\pi V_\infty}\frac{1}{x^2}\right)^2 = \frac{\kappa}{\pi V_\infty}\frac{1}{x^2} - \left(\frac{\kappa}{2\pi V_\infty}\right)^2\frac{1}{x^4}$

Along y, $x=0$: $C_p = 1 - \left(\frac{u}{V_\infty}\right)^2 = 1 - \left(\frac{V_\infty}{V_\infty} + \frac{\kappa}{2\pi V_\infty}\frac{1}{y^2}\right)^2 = \frac{-\kappa}{\pi V_\infty}\frac{1}{y^2} - \left(\frac{\kappa}{2\pi V_\infty}\right)^2\frac{1}{y^4}$

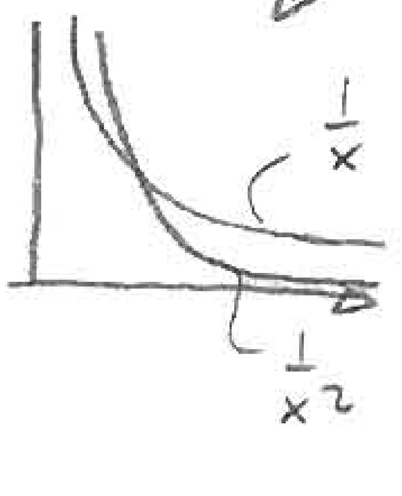
The C_p fields decrease with distance as follows:

Source: $\sim\frac{1}{y^2}$ (along y), $\sim\frac{1}{x}$ (along $-x$)

Vortex: $\sim\frac{1}{y}$ (along y), $\sim\frac{1}{x^2}$ (along $-x$)

Doublet: $\sim\frac{1}{y^2}$ (along y), $\sim\frac{1}{x^2}$ (along $-x$)

Far away the $\frac{1}{x}$ and $\frac{1}{y}$ terms dominate ($\frac{1}{x^2}$ and $\frac{1}{y^2}$ die off much faster)



A lifting airfoil has a nonzero Γ, so it looks mostly like a vortex far away. Largest C_p is above & below.