Group velocity near a broad transition

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Solution: *The real part is,*

$$n_r = \mathrm{Re}\, n = 1 - \frac{4\pi\rho\Gamma\Delta}{k_0^3(4\Delta^2+\Gamma^2)} \ .$$

The group velocity is,

$$v_g = \frac{1}{\frac{dk}{d\omega}\Big|_{\omega=\bar\omega}} = \frac{1}{\frac{d}{d\omega}\frac{\omega n(k)}{c}\Big|_{\omega=\bar\omega}} = \frac{1}{\frac{d}{d\omega}\left(\frac{\omega}{c} - \frac{\omega}{c}\frac{4\pi\rho\Gamma\Delta}{k_0^3(4\Delta^2+\Gamma^2)}\right)\Big|_{\omega=\bar\omega}}$$
$$= \frac{c}{1 - \frac{4\pi\rho\Gamma}{k_0^3}\frac{-4\omega_0(\omega-\omega_0)^2+(2\omega-\omega_0)\Gamma^2}{[4(\omega-\omega_0)^2+\Gamma^2]^2}\Big|_{\omega=\bar\omega}} \ .$$

The profile of the group velocity shows two poles.