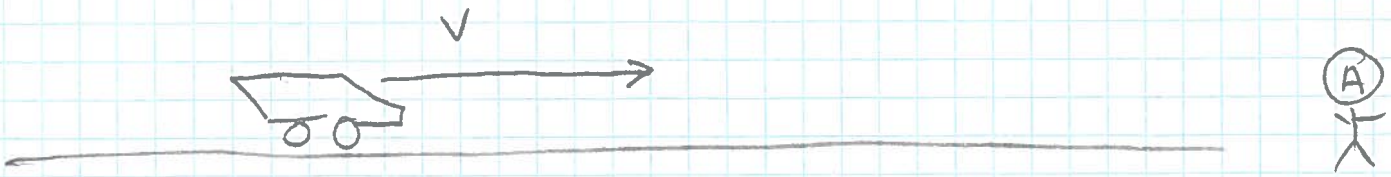

A car travels at speed V to the East along road. It emits radio waves of frequency $f = 2.4$ GHz.

Suppose $v = 0.7c$. What are frequencies measured by police officers A (to East) and B (to South)?

$$A: \quad f' = f\frac{\sqrt{1+v/c}}{\sqrt{1-v/c}} = 2.38\, f = 5.7\ \text{GHz}$$

$$B: \quad f' = f\frac{1}{\gamma} = f\sqrt{1-\frac{v^2}{c^2}} = 0.71\, f = 1.7\ \text{GHz}$$

If car travels at a small relativistic speed, $v \ll c$, then

$$A: \quad f' = f\frac{\sqrt{1+v/c}}{\sqrt{1-v/c}} = f\left(1+\frac{v}{c}\right)^{1/2}\left(1-\frac{v}{c}\right)^{-1/2}$$

$$\approx f\left(1+\tfrac{1}{2}\tfrac{v}{c}\right)\left(1+\tfrac{1}{2}\tfrac{v}{c}\right) \approx f\left(1+\frac{v}{c}\right)$$

$$B: \quad f' = f\frac{1}{\gamma} = f\sqrt{1-\frac{v^2}{c^2}} = f\left(1-\frac{v^2}{c^2}\right)^{1/2} \approx f\left(1-\tfrac{1}{2}\frac{v^2}{c^2}\right)$$

So the <u>difference</u> in frequency

$$|\Delta f| = |f' - f| = \begin{cases} \approx f\frac{v}{c} & \text{for A} \quad \underline{\text{bigger}} \\ \approx f\left(\frac{1}{2}\frac{v^2}{c^2}\right) & \text{for B} \end{cases}$$