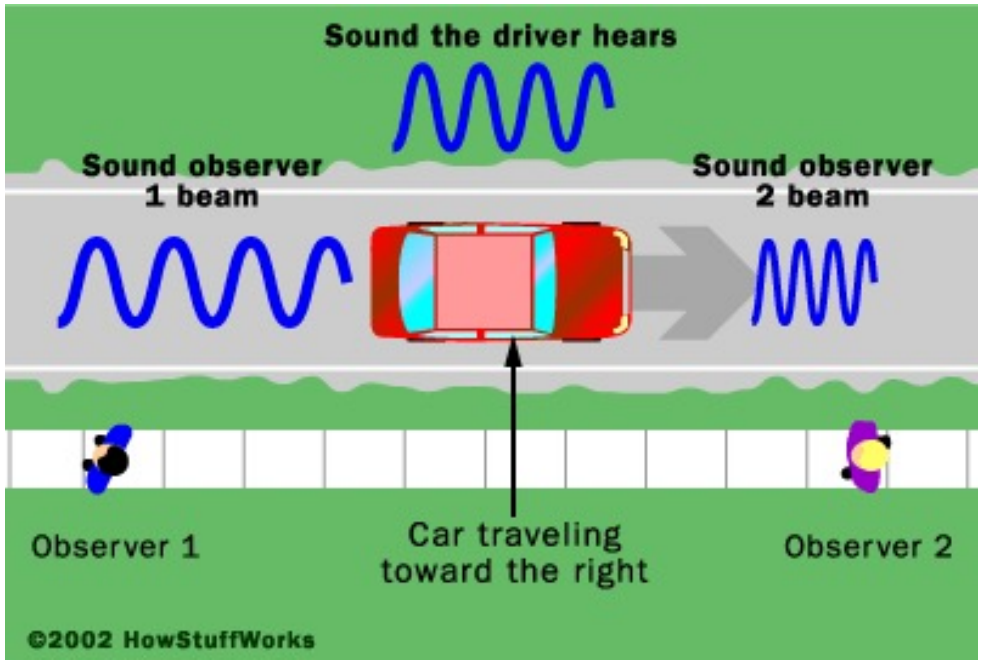
Radar Physics

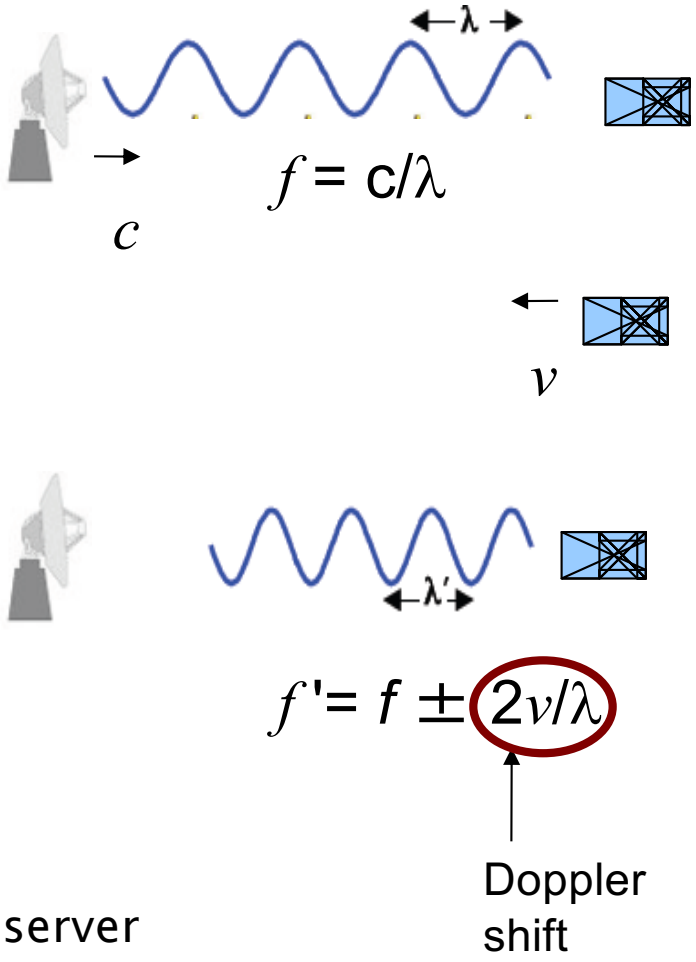
Anthea J. Coster

Outline

Doppler

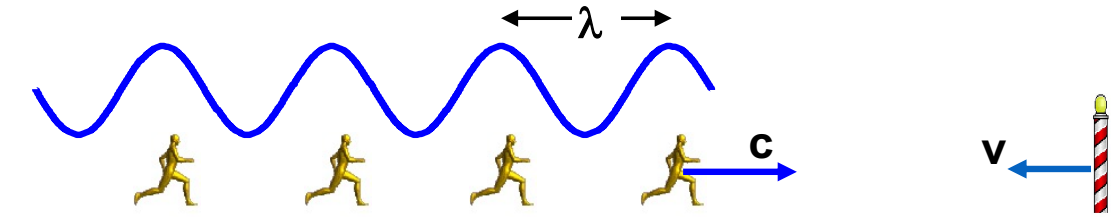
Moving target: Doppler



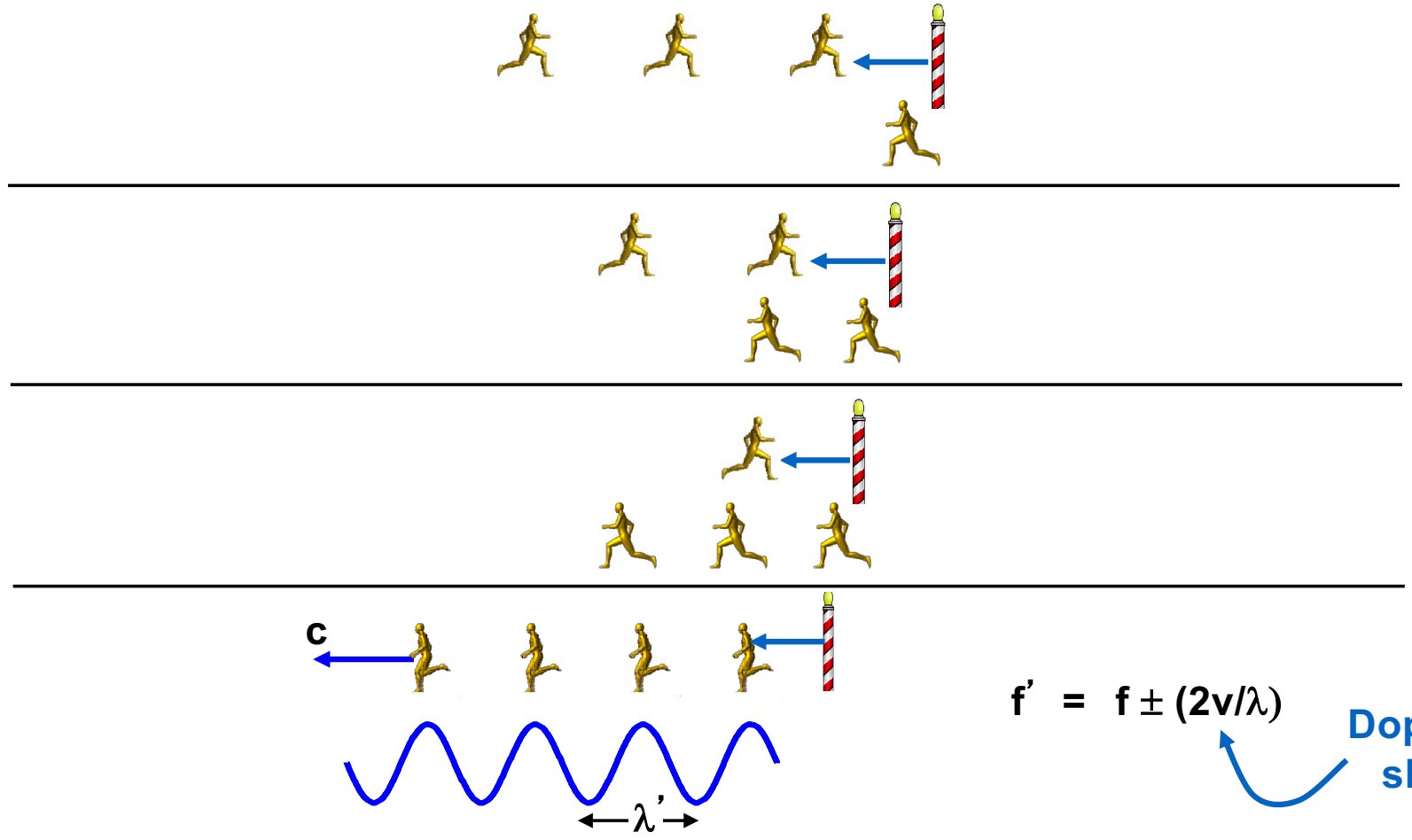


Positive Doppler = target moving **toward** the observer
Negative Doppler = target moving **away** from the observer

Doppler Shift Concept



$$f = \frac{c}{\lambda}$$



$$f' = f \pm (2v/\lambda)$$

Doppler shift

Sign conventions

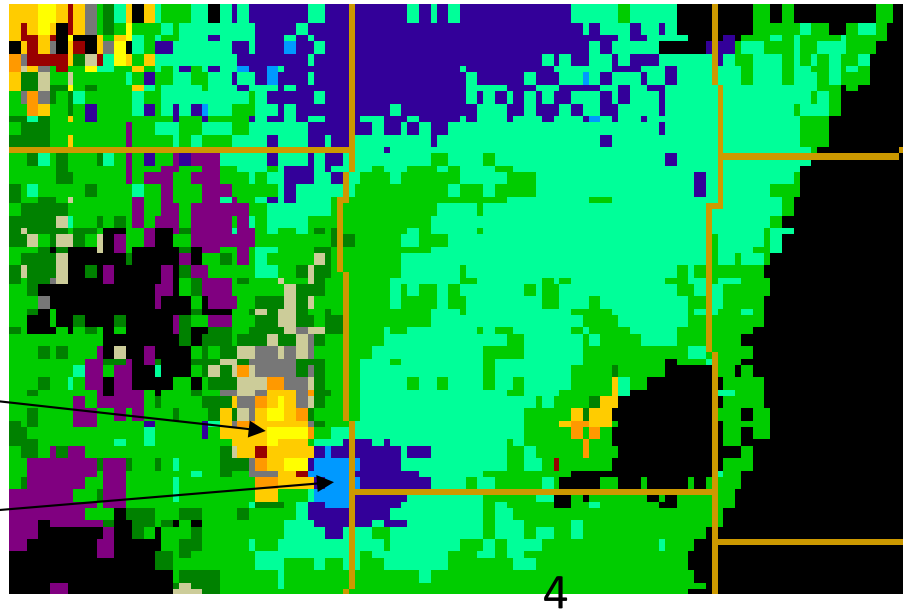
The Doppler frequency is negative (lower frequency, red shift) for objects receding from the radar

The Doppler frequency is positive (higher frequency, blue shift) for objects approaching the radar

These "color" shift conventions are typically also used on radar displays of Doppler velocity

Red: Receding from radar

Blue: Toward radar



Doppler shift frequency

Tx signal: $\cos(2\pi f_o t)$

Return from a moving target: $\cos[2\pi f_o(t + 2R/c)]$

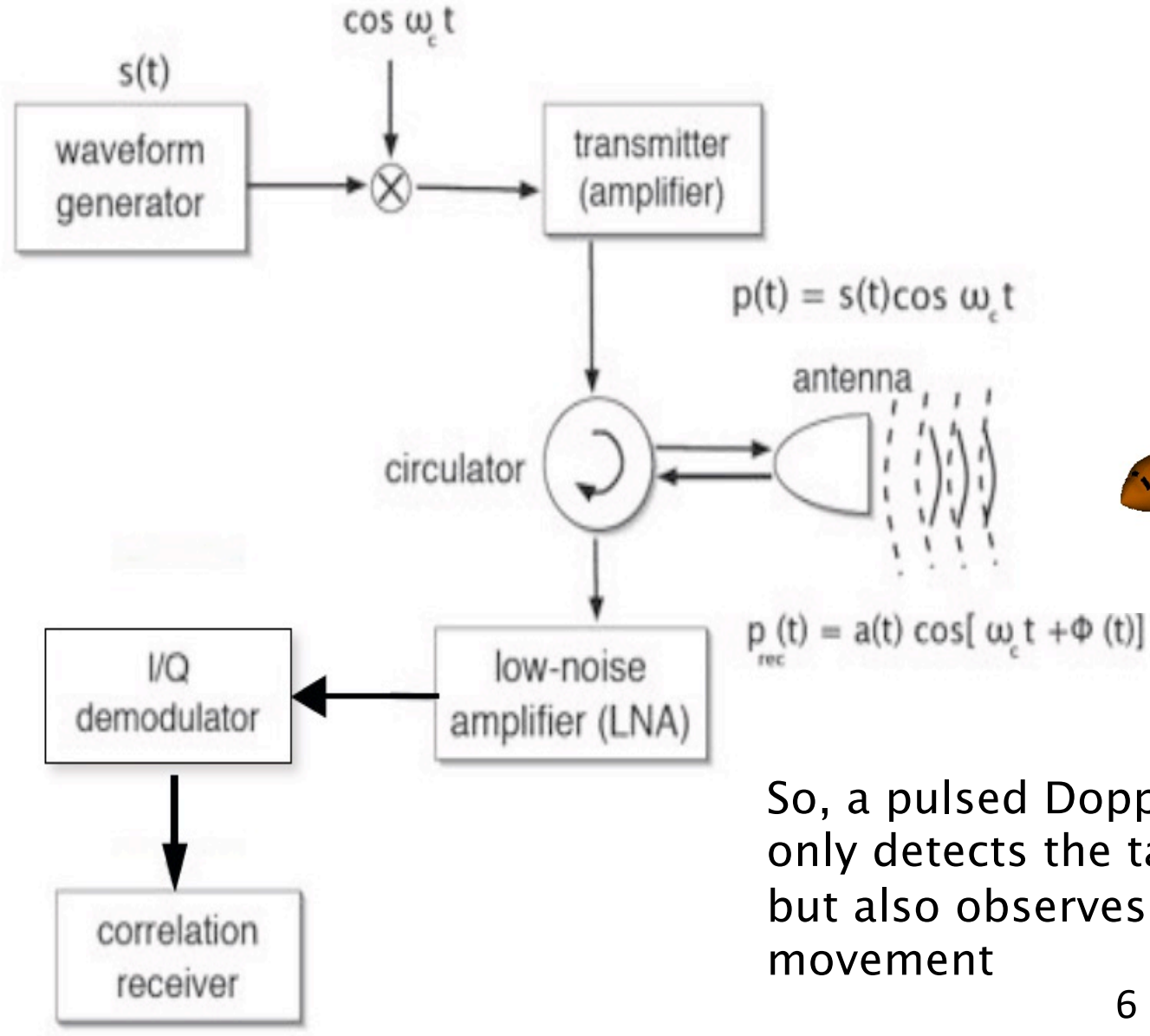
If target is moving with a constant velocity: $R = R_o + v_o t$

then,

Return: $\cos[2\pi(f_o + f_o 2v_o/c)t + 2\pi f_o R_o/c]$

Doppler frequency:
$-2f_o v_o/c = -2v_o/\lambda_o$

Pulsed Doppler Radar system



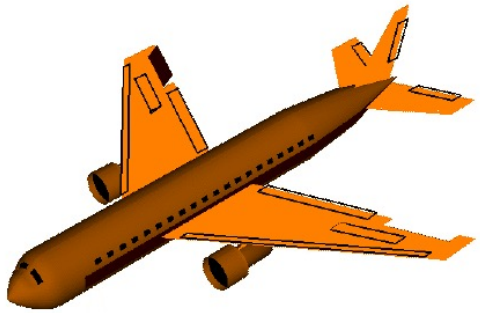


Image courtesy of NASA

So, a pulsed Doppler radar not only detects the target location, but also observes the target movement

Useful Fourier transforms