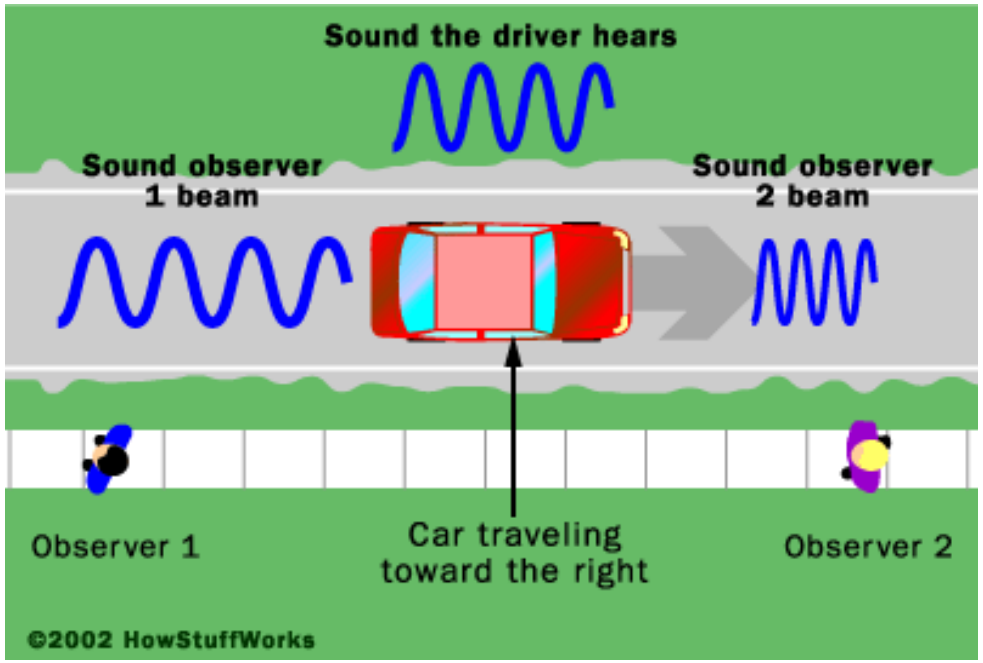
# Radar Physics

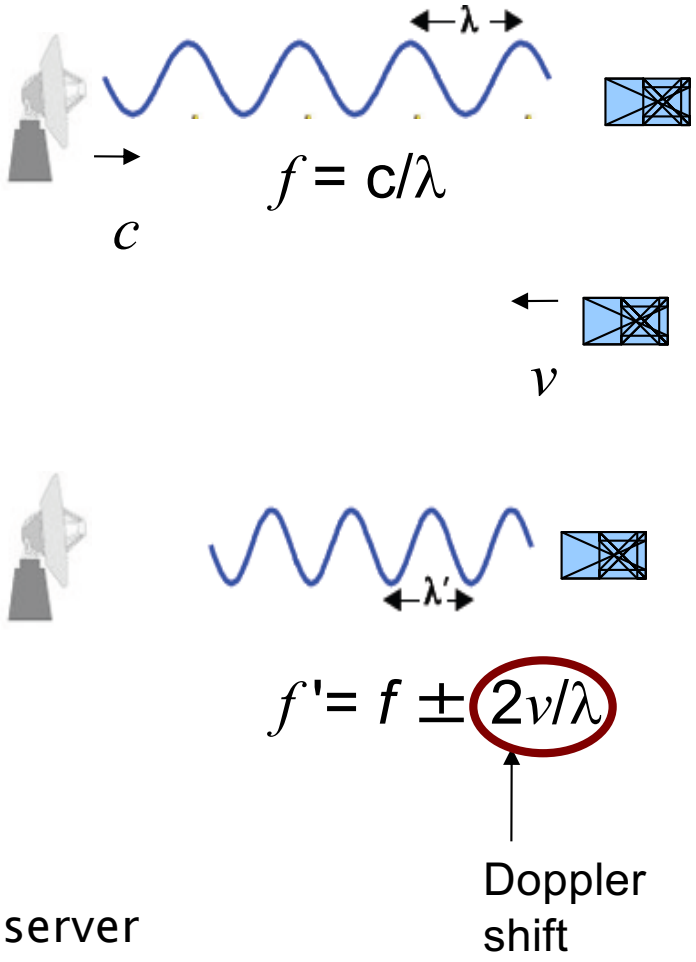
Anthea J. Coster

## Outline

Doppler

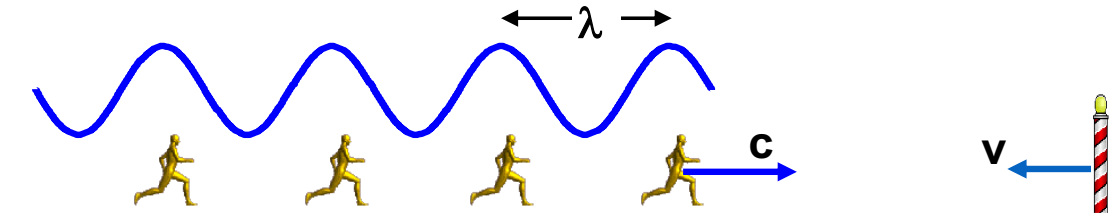
# Moving target: Doppler



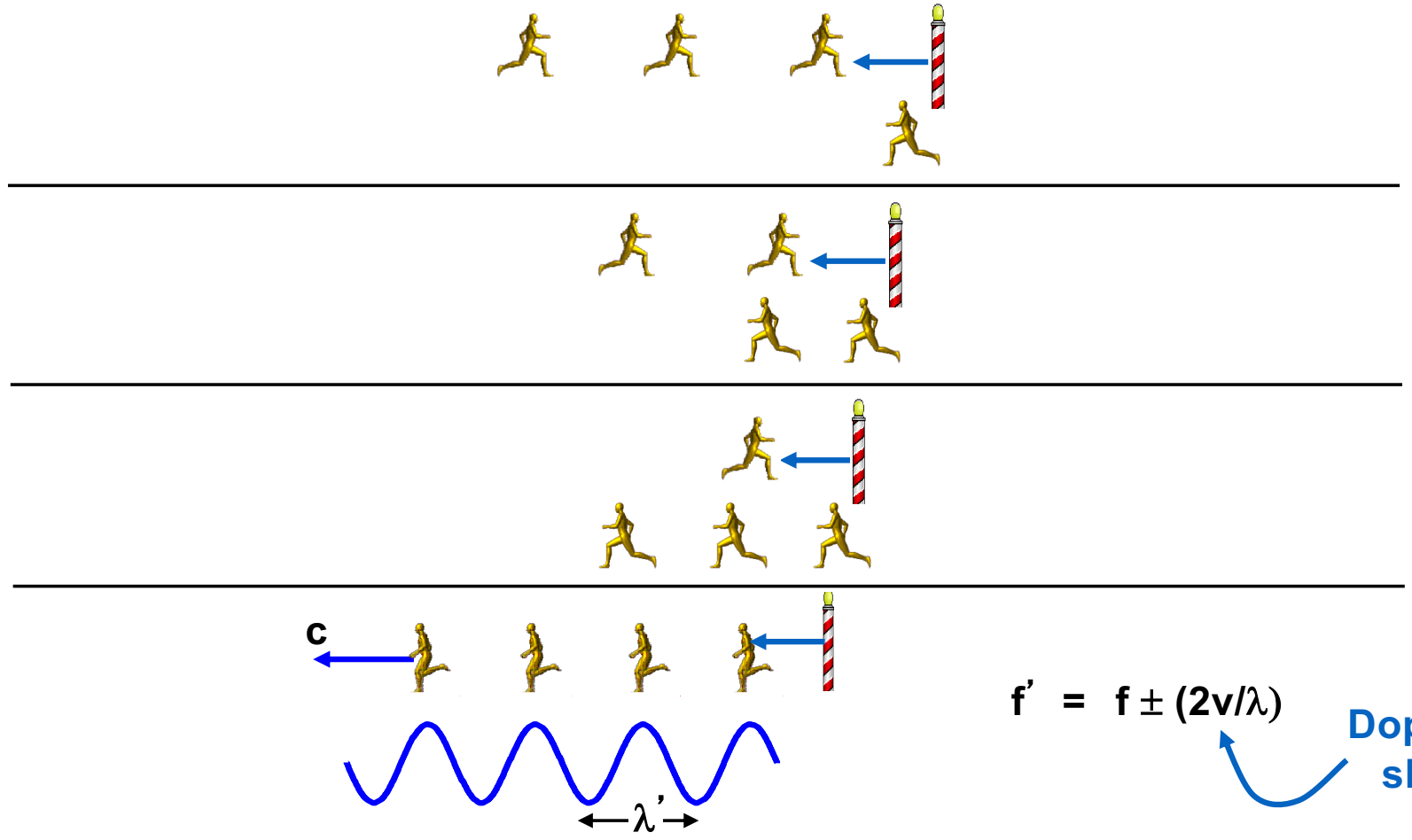




**Positive** Doppler = target moving **toward** the observer
**Negative** Doppler = target moving **away** from the observer

# Doppler Shift Concept




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




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

Doppler shift

# Sign conventions

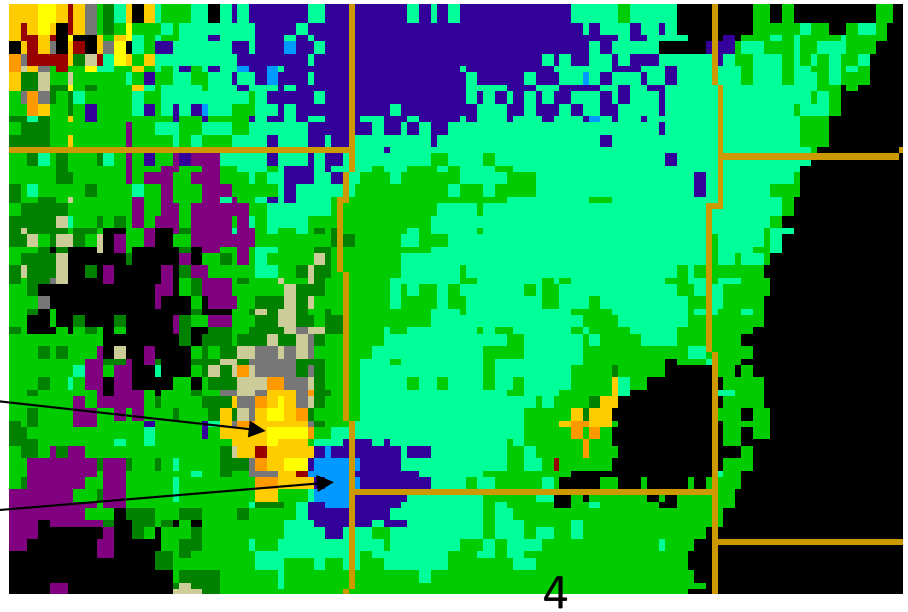
*The Doppler frequency is negative (lower frequency, red shift) for objects receding from the radar*

*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: $\cos[2\pi f_o(t + 2R/c)]$

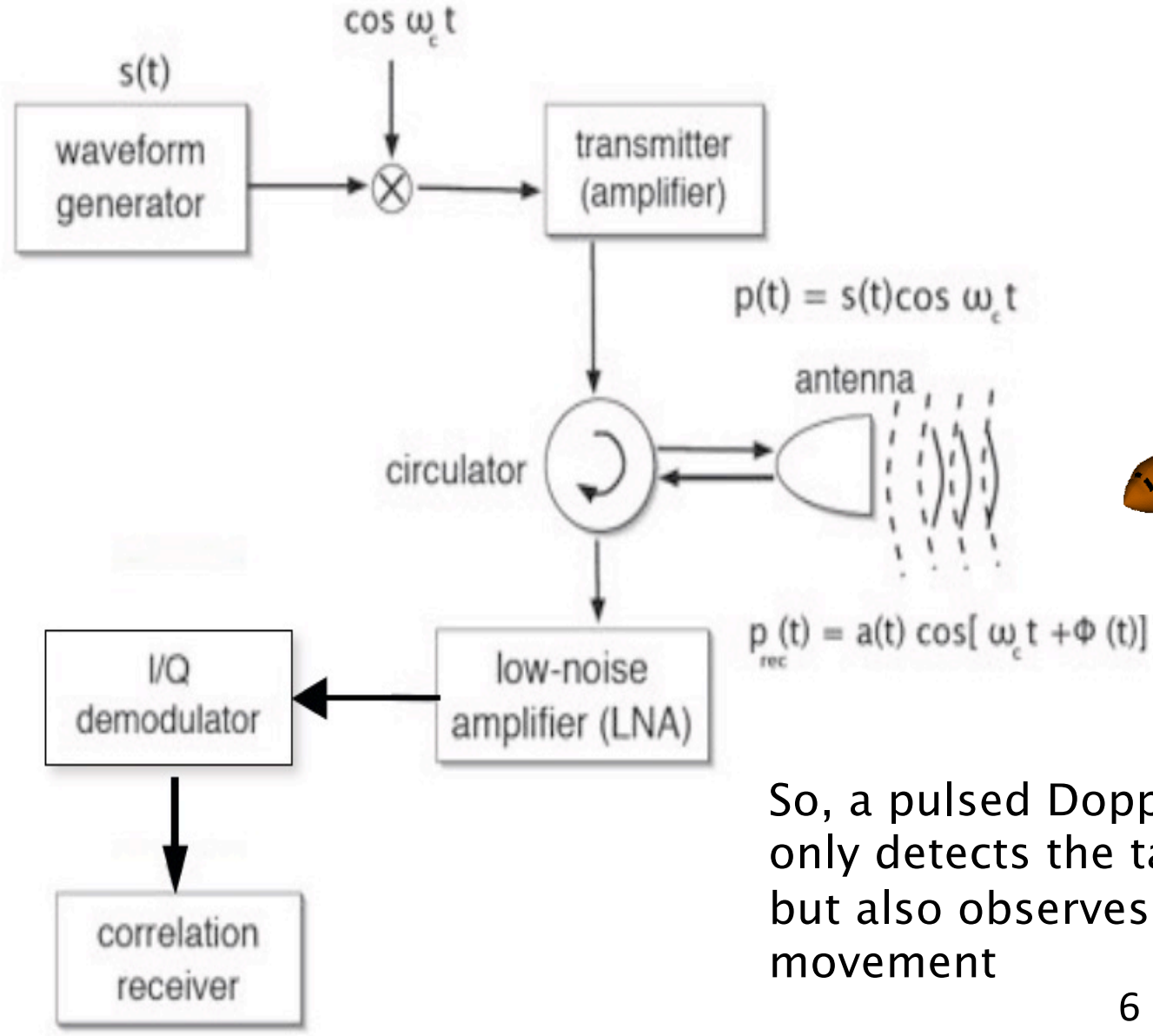
If target is moving with a constant velocity: $R = R_o + v_o t$

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



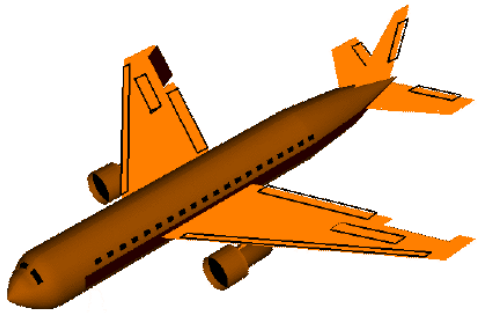



Image courtesy of NASA

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

# Useful Fourier transforms