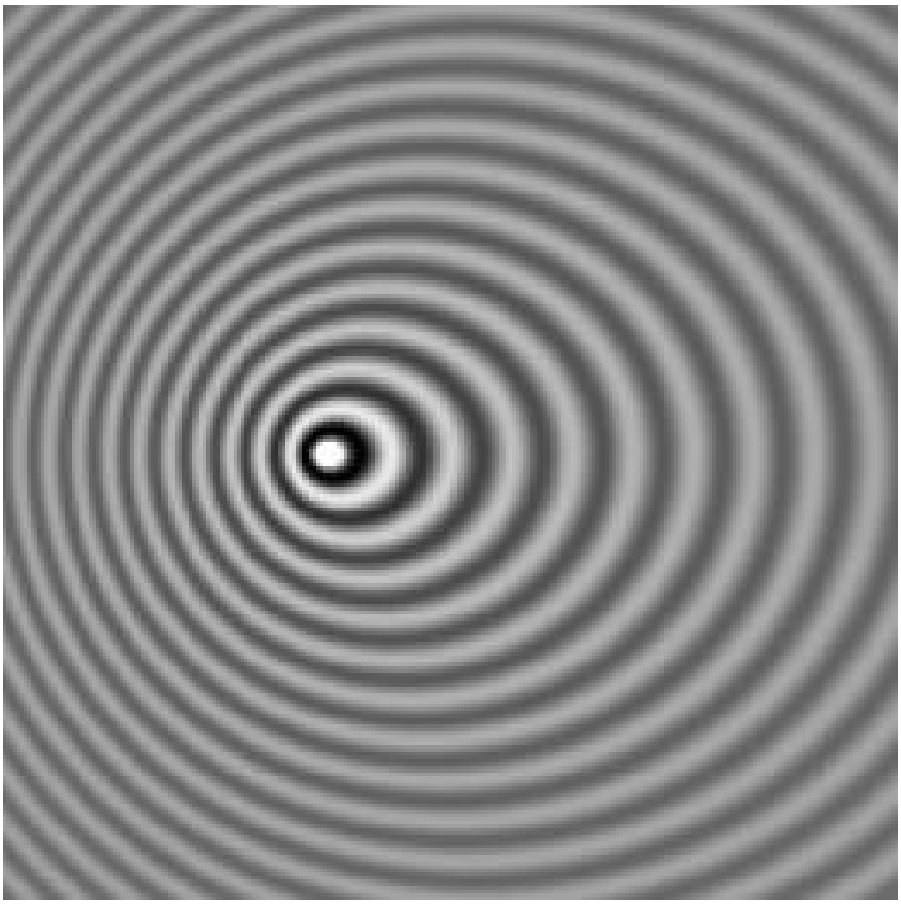
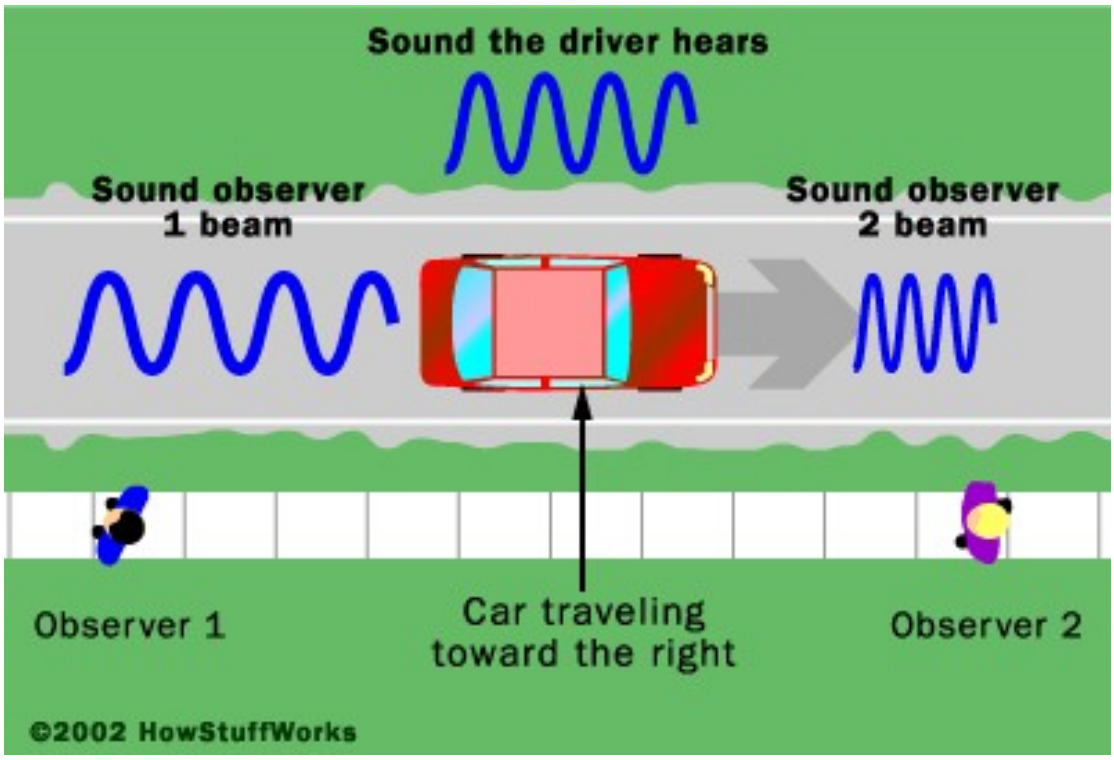
Doppler Shift

- A source generating waves moves relative to an observer, or vice – versa, there is an apparent shift in the source's frequency.
- If the separation between source and observer is increasing, then the frequency apparently decreases.
- If the separation between source and observer is decreasing, then the frequency apparently increases.
- This can be seen by visualizing what happens to sound waves of a moving object.



http://en.wikipedia.org/wiki/Doppler_shift

- The waves compress in the direction of travel and expand in the other direction.
- This is a phenomenon familiar to many people if you've ever stood on a road with traffic going by.



http://static.howstuffworks.com/gif/doppler.gif

- The relationship between the frequency of a moving source and an observer (in one dimension) is represented by the Doppler shift formula as two cases: The observer and source are approaching or receding.

$$f_{obs} = f_{src}\left(\frac{v_{sound} \pm v_{obs}}{v_{sound} \mp v_{src}}\right)$$

Examples

1. What is the observed frequency of a 525 Hz source moving towards a stationary observer at 75 m/s? Take the speed of sound to be 375 m/s.

$f_{obs} = ?$

$f_{src} = 525\,Hz$

$v_{obs} = 0\,m/s$

$v_{src} = 75\,m/s$

$v_{sound} = 375\,m/s$

$$f_{obs} = f_{src}\left(\frac{v_{sound} + v_{obs}}{v_{sound} - v_{src}}\right)$$

$$f_{obs} = (525)\left(\frac{375+0}{375-75}\right)$$

$$f_{obs} = (525)(1.25)$$

$$= 656\ Hz$$

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2. A police siren has a frequency of 1.8×10^4 Hz. A crook in his getaway car drives away from the police at 105 m/s. ~~What frequency is heard~~ by the crook if the police car is driving at 85 m/s? The temperature today is 25 ºC.

$f_{obs} = ?$

$f_{src} = 1.8 \times 10^4$ Hz

$v_{src} = 85$ m/s

$v_{obs} = 105$ m/s

$T_{air} = 25°C$

$v_{sound} = 331 + 0.59\,T_{air}$

$= 331 + 0.59(25)$

$= 346$ m/s

$$f_{obs} = f_{src}\left(\frac{v_{sound} - v_{obs}}{v_{sound} + v_{src}}\right)$$

$$f_{obs} = (18000)\left(\frac{346 - 105}{346 + 85}\right)$$

$$= (18000)\left(\frac{241}{431}\right) = \boxed{10065 \text{ Hz}}$$

Pg 18-19
#39-50, ~~45~~, ~~49~~
Ans Pg 22-23