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Topic: Doppler Effect
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THE DOPPLER EFFECT

If you stand on the street while an ambulance speeds by with its siren on, you will notice the pitch of the siren change. The pitch will be higher as the ambulance approaches and will be lower as it moves away. As you read earlier in this section, the pitch of a sound depends on its frequency. But in this case, the siren is not changing its frequency. How can we account for this change in pitch?

Figure 5
As this ambulance moves to the left, Observer *A* hears the siren at a higher frequency than the driver does, while Observer *B* hears a lower frequency.

Relative motion creates a change in frequency

If a siren sounds in a parked ambulance, an observer standing on the street hears the same frequency that the driver hears, as you would expect. When an ambulance is moving, as shown in **Figure 5,** there is relative motion between the moving ambulance and a stationary observer. This relative motion affects the way the wave fronts of the sound waves produced by the siren are perceived by an observer. (For simplicity's sake, we will assume that the sound waves produced by the siren are spherical.)

Although the frequency of the siren remains constant, the wave fronts reach an observer in front of the ambulance (Observer *A*) more often than they would if the ambulance were stationary. The reason is that the source of the sound waves is moving toward the observer. The speed of sound in the air does not change, because the speed depends only on the temperature of the air. Thus, the product of wavelength and frequency remains constant. Because the wavelength is less, the frequency heard by Observer *A* is *greater* than the source frequency.

For the same reason, the wave fronts reach an observer behind the ambulance (Observer *B*) less often than they would if the ambulance were stationary. As a result, the frequency heard by Observer *B* is *less* than the source frequency. This frequency shift is known as the **Doppler effect.** The Doppler effect is named for the Austrian physicist Christian Doppler (1803–1853), who first described it.

Doppler effect
an observed change in frequency when there is relative motion between the source of waves and an observer