[SQUEAKING]

[RUSTLING]

[CLICKING]

MARKUS KLUTE: Welcome back to 8.20, Special Relativity. In this section, we're going to discuss the classical Doppler effect. The Doppler effect was first noted by Christian Doppler, hence the name, in 1842. And what we're discussing as the Doppler effect is a frequency change when moving from one reference frame into another. So this can happen, for example, if the source of a sound wave is moving like we experience when a car is passing by.

The application of the Doppler effect are numerous. We can use the Doppler effect to measure the velocity of a speeding car. We can use the Doppler effect to measure the distance of distant galaxies. As a reminder, the velocity of a wave, so the velocity in which the wave is propagating is equal to the frequency times the wavelength.

So when we move relative to the source of the wave, we see this apparent change in frequency. But let's introduce this topic not in my words, but in the ones of Sheldon Cooper from *The Big Bang Theory*.

[VIDEO PLAYBACK]

- We go to the party.

- I don't care if anybody gets it,
I'm going as the Doppler effect.

- No, it's not--

- If I have to I can demonstrate.
[IMITATES DOPPER EFFECT]

PROFESSOR: That's the sound wave of a moving car.

- So what time does the costume
parade start?

- The parade?

- Yeah, so the judges can give
out the prizes for best costume.
Most frightening. Most authentic.
Most accurate visualization of a
scientific principle.

- Sheldon, I'm sorry but there aren't going to be any parades or judges or prizes.

- This party is just going to suck.

- No. Come on, it's going to be fun, and you all look great. I mean, look at you, Thor, and oh, Peter Pan, that's so cute.

- Actually, Penny, he's--

- I'm Peter Pan. And I got a handful of pixie dust with your name on it.

- No, you don't. Hey, what's Sheldon supposed to be?

- Oh, he's the Doppler effect.

- Yes. It's the apparent change in the frequency of a wave caused by relative motion between the source of the wave and the observer.

- Oh, sure. I see it now, the Doppler effect. All right.

[END PLAYBACK]

MARKUS KLUTE: The Doppler effect, so now we have it. All right, so let's look at a specific situation here, in which we have a sound wave emitted by a moving car. The car is moving with the velocity u, and it's emitting sound, via the engine or the horn of the car. If you then look at the wavelength as we observe, so we have an observer here.

As we observe the wavelengths, the wavelength is actually modified because the crests of the moving car, the horn, the engine, they are moving themselves with the velocity u times to 0, which is a period, which is equal to u times 1 over the frequency as the frequency emitted by the car addressed. So the wavelength is modified to lambda minus u times 1 over f0.

So then we can use this equation here to calculate the wavelength at the frequency as observed by this person here, which is the velocity of the moving wave divided by the modified or the observe wavelengths. And so that's v over lambda minus u times 1 over f0 or f0 times 1 over 1 minus uv. All right, so we see that the frequency is modified when we observe the moving car.

And you have all experiences in life already, so let's look at a few more examples of this. I'll just share this little video. It's a very short video.

[VIDEO PLAYBACK]

[HONKING INCREASES AND FADES]

[END PLAYBACK]

So you're able to hear the change in frequency in this example. Here's another one.

[VIDEO PLAYBACK]

[SIREN INCREASES AND FADES]

[END PLAYBACK]

So this is interesting now. So you've heard exactly what I was describing before, the sound of a moving vehicle. In the first case, a car honking, in the second case, a European fire truck passing by. And so there is an additional part of the story here. If I would ask you, please do make the sound of a fire truck, I think not many of you would say nina, nina, nina, which is the sound of this fire truck for European.

There's a few more of those examples, which are really weird. If I ask you to make the sound of a rooster, you and I will probably disagree on the sound of a rooster. I would say [NON-ENGLISH] and you would make a sound which is rather unfamiliar to me. So that's just a fun fact on the side, but this was a short introduction to the classical Doppler effect. And in the next video, we will look at the relativistic Doppler effect.