Doppler Effect -
Building Background

Document Overview:

The purpose of this activity is to help students build a background on the Doppler Effect using a youtube video, an applet simulation and a teach demonstration

Minnesota State Academic Science Standards:

Sound waves are generated from mechanical oscillations of objects and travel through a medium.

9P.2.3.1.4 Describe the Doppler Effect changes that occur in an observed sound as a result of the motion of a source of the sound relative to a receiver.

Objective:

- Students will use Doppler Effect to describe why objects moving toward you sound different than objects moving away from you

Type of Activity:
This activity includes the use of a YouTube video and/or a teacher demonstration and an applet simulation

Duration:

Connection to Nobel speakers:

One of the world's most highly cited astronomers, Alexei Filippenko was a member of the Supernova Cosmology Project and the High-z Supernova Search Team that used observations of extragalactic supernovae to prove the accelerating expansion of the universe and thus imply the existence of "dark energy." The discovery was voted the top science breakthrough of 1998 by *Science* magazine and earned the teams' leaders the 2011 Nobel Prize in physics. Filippenko also works on quantifying the physical properties of quasars and active galaxies and searches for black holes in both X-ray binary stars and nearby galactic nuclei.

Cosmologist George Smoot shared the 2006 Nobel Prize in physics for his work with senior NASA astrophysicist John Mather on the Cosmic Background Explorer Satellite (COBE) that led to the measurement "of the black body form and anisotropy of the cosmic microwave radiation" and evidence of the fiery birth of our universe. Smoot's group at Berkeley National Laboratory has mapped the early universe, noting variations in the cosmic background radiation that are the "seeds" of present-day galaxies and clusters of galaxies.

Concepts:

- Doppler Effect

Description of Activity:

Most students are familiar with the concept of Doppler Effect, they have heard trains or fire engines drive past them and heard the pitch change as it goes past. Start out with a discussion of their experiences of hearing trains, fire engines, race cars, etc. without naming the Doppler Effect. If you have the equipment, demonstrate the Doppler Effect for them. Possible ideas if you don't have specific Doppler Effect equipment:

- Tie a tuning fork on a string, strike it with a mallet and swing in a circle
- Buzzer on a string
- Sound tube like these from Teacher Source
- Nerf Vortex Aero Howler football like this

There are also some good YouTube videos of Doppler Effect:

- Here is one that does a good job of describing Doppler effect and relating frequency of a wave to the pitch of the sound we hear.
- Here is one of Paul Hewitt describing Doppler Effect
- Here is one from the Big Bang Theory, just for fun

After an introduction of Doppler Effect, elicit responses from kids putting it into words, then give them the 'textbook' definition.

Next direct them to the following applet simulation: . The first drop down box says setup: single source, change this to Doppler Effect.http://falstad.com/ripple/

1. Students can play around with the simulation speed, resolution, damping, source frequency, brightness and source speed by moving the sliders at the bottom. I find if you move the simulation speed all the way to the left, it is easier to see the effect. Students can also change the color scheme using the drop down box near the top of the page, some are easier to see the crests and troughs than others, some of the contrasts can be hard to look at. Damping, resolution, and brightness don't make much of a difference on the waves created.

Students should be able to see how the waves in front of the object seem to bunch up and get closer together and that the waves behind the source spread out. You may want to discuss with your students that with sound waves, frequency = pitch and that a higher frequency (move waves/second) will mean a higher pitch and that a lower frequency (less waves/second) will mean a lower pitch. The first YouTube link does a good job of explaining Dopper effect and how it relates to pitch.

Activity:

1. Open the applet simulation here.
2. From the first drop down box, select 'setup: Doppler Effect 1'
3. You can see that as the object (also called a source) moves down the screen, the waves in front of it bunch up closer together and the waves behind it spread out.
4. Feel free to play with the sliders in the bottom right corner to change how the source behaves. Resolution, damping, and brightness doesn't change it too much. If you slide 'simulation speed' all the way to the left, it sometimes helps to see what it happening better. You can also check to 'stopped' box to freeze the simulation if you need.
5. What does changing 'source frequency' do to the wave? What is changed? Does anything stay the same? Write a sentence or two summarizing your findings.

6. What does changing 'source speed' do to the wave? What is changed? Does anything stay the same? Write a sentence or two summarizing your findings.

Extension and Follow-up Activity:

http://www.pbs.org/deepspace/classroom/activity2.html

Resources
http://www.esa.int/Our_Activities/Space_Science/What_is_red_shift

Paulie1982 - YouTube video http://www.youtube.com/watch?v=RsiY8VdDlDQ

mellenstei - YouTube video http://www.youtube.com/watch?v=m3MkZjlacaI

John Thomas Miller - YouTube video http://www.youtube.com/watch?v=Tn35SB1_NYI

Paul Falstad's ripple tank applet http://falstad.com/ripple/