Rockin' Little Neutron Star

Lesson Activity by Rocky Alvey
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Rockin' Little Neutron Star

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Listen up children, got a story to tell
There's music out in space, ringing clear as a Bell
I promise that it's true, though it's hard to believe
Get your radio tuned to the frequency....here goes

Her career was finished and her bright days were done
She'd been up on the stage she'd outshined the Sun
All the other stars said it's time to move over
But man they got an eyeful when she went supernova

She's a neutron star, and she spins like a top
She's a little pulsar, man she knows how to rock
If she'd been a little bigger would have been a black hole
We can hear her rhythm on the ra….a….dio…oh…oh….oh

She's been a heavyweight since the moment of birth
A spoonful weighs as much as a mountain on earth
A thousand years ago man she lit up the skies
She's gonna be around till the universe dies

She's a neutron star, she spins like a top
She's a little pulsar, man she knows how to rock
If she'd been a little bigger would have been a black hole
We can hear her rhythm on the ra….a….dio…oh…oh….oh

Dr. Jocelyn Bell Burnell:
"This is the pulsar in the constellation Vela.
It formed when the Vela supernova took place
ten thousand years ago."

She's a neutron star, she spins like a top
She's a little pulsar, man she knows how to rock
If she'd been a little bigger would have been a black hole
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Dr. Jocelyn Bell Burnell:
"Here is the edge of the material expanding out
And it will continue expanding and spinning from the supernova."

The Crab Nebula (containing a pulsar)
Credit: NASA, ESA, J. Hester, A. Loll (ASU)

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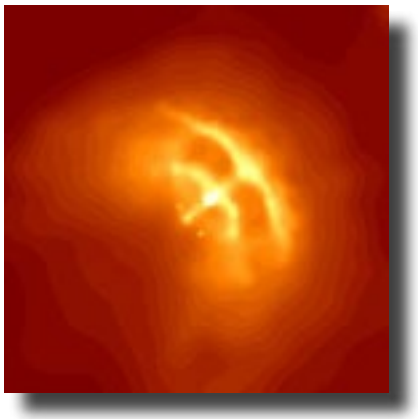
From the lyrics:
She's a neutron star. She spins like a top. She's a little pulsar.....
Play the song "Rockin' Little Neutron Star." After the song has played and the students have actively listened to it, tell them that today they will study neutron stars.

A neutron/pulsar star is so dense that a spoonful of material would weigh as much as a mountain. Neutron stars contain more material than the Sun, but are only about 12 miles (20 kilometers) in diameter. It is often difficult to tell how massive something is by its size.



Chandra X-ray Observatory image of the Vela pulsar
NASA/PSU/G.Pavlov et al.

Activities:
Materials
-one flashlight
-scales that will accurately measure one pound or .45 kilograms
-one pound (.45 kilograms) of metal
-one pound (.45 kilograms)of packing peanuts (contained by a lightweight sack.
-an internet connection with a computer with sound capability.

Weigh the metal and foam materials to establish you have the exact amount required. Compare the volume of foam packing peanuts to the metal. The atoms in the metal are more densely packed together - so it is with star stuff. Given enough mass, atoms are forced together so tightly that they can collapse into a point smaller than the period at the end of this sentence. Astronomers call these exotic objects black holes. They often reside in the center of galaxies. Ask the participants to think about weight versus volume of other materials such as sand, water, cotton, etc.

For the next activity, darken the room lights and give one student a flashlight. Have them turn it on and rotate slowly 360 degrees for several revolutions. The beam of light will project toward and then away from the other students. Allow others in the class to do the same. Ask the students what this reminds them of – the answer is a lighthouse.

Once this concept has been established, tell them that neutron stars spin and as a result, pulse in this same manner. Note that a neutron star is very easily detected in radio light, not visible light." A young graduate student named Jocelyn Bell Burnell first detected and analyzed these signals in 1967.
Play the sound of the Vela Pulsar:
http://www.jb.man.ac.uk/research/pulsar/Education/Sounds/ After hearing the pulsar, ask the students if they have heard this sound before. After all answers are given, replay "Rockin' Little Neutron Star". The students should clearly recognize the sound of the pulsar incorporated into the melody of the song, if not, point it out to them. The Vela Pulsar recording was used as the basic rhythm track for the song. Afterwards, you may want to listen to several different pulsars in order to understand that all pulsars spin at a different rate. The Vela recording captures the pulsar signal which left the star nearly one thousand years ago, as it is 1,000 light years distant.

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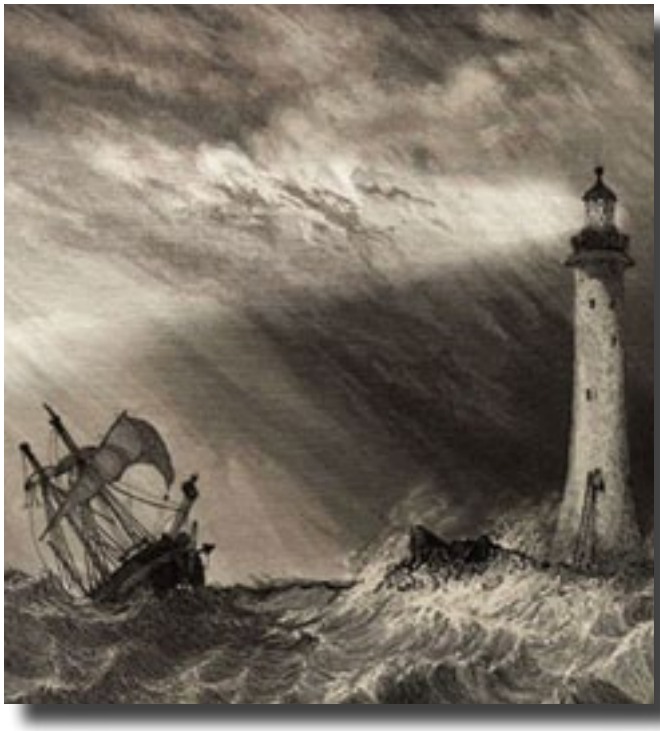
As was mentioned earlier, the first pulsars (rapidly-rotating neutron stars) were discovered by Dr. Jocelyn Bell Burnell, who is speaking at the end of the song.

Ask students if they can hear radio waves? Almost all will say yes, but in-fact, we cannot. What we hear are air pressure waves which have been converted from electromagnetic energy in the radio part of the spectrum. This is an extremely difficult concept to grasp. For a further extension activity, trace the chain of signal transmission and conversion from a local radio station to sound coming from your radio. It is very interesting to understand the various ways information is transferred from one process to another in order to hear a song.

Web Resources

http://imagine.gsfc.nasa.gov/docs/science/know_l1/pulsars.html
http://imagine.gsfc.nasa.gov/docs/resources/resources_h.html#pulsars
http://www.astronomytoday.com/cosmology/evol.html
http://chandra.harvard.edu/edu/formal/stellar_ev/
http://www.jb.man.ac.uk/~pulsar/Education/Sounds/sounds.html



Eddystone Lighthouse, engraved by W.B. Cooke 1836