

Physics Nocturno

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This is the second GIREP seminar that featured an evening demonstration session called Physics Nocturno. This year's show featured three educators from the United States, Brian Jones from Colorado State University, Chris Chiaverina The American Association of Physics Teachers (AAPT) past president, TPT column editor, and retired high school teacher, and Stanley Micklavzina lecture demonstration expert from the University of Oregon. The three of us have been involved in workshops focused on taking physics on the road at the Summer national AAPT meetings.

For Physics Nocturno we combined our efforts and put together some favorite demonstrations used especially for bringing physics to the public.

Demonstrations performed by Stanley Micklavzina

Energy transfer: Transverse waves

An assistant from the audience holds the end of a long spring that has a bell attached to it. When I wiggle the my end of this long spring, waves are created and these waves move along the spring and cause the assistant's arms to wiggle up and down which causes the bell to ring. The energy is transferred by the wave motion. The characteristics of the wave, the material between the ends only moves in the vertical direction and does not move in the horizontal direction. The energy however moves down the spring. You can see waves produced by an object making sound when a tuning fork is placed in a clear rectangular baking dish sitting on an overhead projector. The vibrating tuning fork produces waves and the energy is transferred to other parts of the water tank. My voice gives energy to air molecules which vibrate back and forth (longitudinal wave) producing the wave of varying pressure, and this wave transfers the sound energy to the audience's ear drums, which vibrates, and they detect and therefore hear my voice.

Extra demonstration notes

The long spring works great for transverse waves. (example Arbor Scientific http://www.arborsci.com/Products_Pages/Sound&Waves/SpringyBuy2.htm#Snaky) I have also made a long rope made from Lycra stretchable fabric which works well on a big stage and you can contact me if you would like more details. I have also done waves with people holding hands, similar to waves in a stadium. For extra effect in a room that can make dark, I have a row of people come on stage hold glow sticks and have them hold hands and send a wave along and the person at the far end has a bell they ring when the wave gets to them. Great for more audience participation and it looks great with the lights out. Perhaps a set of illuminated LEDs would also work well.

Wave phenomena

Copper tubing bent into the shape of a sine wave works for discussion of wave characteristics. Two copper waves can show how waves interact to produce interference. Sound interference can be experienced with two speakers connected to a signal generator. Set

the frequency for around 800 hertz and have the audience plug one ear and move their head from side to side, or move one speaker to change one of the path lengths to their ear, and they will hear the sound get louder and softer. You can also use good quality stereo system and speakers to demonstrate sound cancellation with interference. Place the speakers facing each other with no space between them. The sound source is the white noise that comes from an FM tuner when no station is selected. Connect one speaker backwards, so the speakers move out of phase with each other. When the noise is sent to the speakers it will not be very loud. Start moving one speaker away from the other and you will begin to hear high frequencies. Lower frequencies will appear the farther the speakers are apart. Move the speaker back so it is again facing the other speaker and the noise will again decrease. Reverse the wires on one of the speakers and the noise will again be loud. You can set-up a reversing switch connected to one of the speakers. The sound will then be either canceled out or be loud depending on which position the switch is in..

Light and color spectrum

A prism separates white light into its fundamental colors, red ,green, and blue. These are the three colors that our eyes are able to detect. There are also frequencies of light our eyes cannot detect, the infrared and ultraviolet. We can use a special camera that is sensitive to infrared light that we cannot see. Look at the spectrum from the prism with the IR (infrared) camera connected to a monitor and notice that it is wider than what we see with our eyes. Placing an IR filter (blocks visible light but passes infrared) in front of the prism, and the spectrum our eyes see disappears, but the camera can still see a band of light. This is infrared light.

To see the spectrum from a prism requires a line source of light. This is possible using light from a slide projector with a slit slide in it. A slit slide can be made easily by placing aluminum foil inside a slide mount and cutting a very narrow slit in the foil. Put the slit slide into the projector and place the prism in front of the slide projector lens and rotate it until you see the spectrum. Focusing will make the colors sharper. You can also make a line source by putting two pieces of paper close together on an overhead projector and build a small holder out of foam core that will hold the prism on the head of the transparency projector. The IR camera is an inexpensive (\$45.00 U.S) generally available from companies that sell equipment for security monitoring.

Photoelectric effect modern day applications

Light can liberate electrons and thereby produce electrical energy. This is used in many applications in today's technological way of life. The photovoltaic cell is made from modified silicon so electrons are. Liberated by lower energy visible light, even energy as low as infrared light. Connecting a photovoltaic cell to an audio amplifier is a simple way of showing this effect. The cell picks up noise from the fluorescent light because the light turns on and off at a rate of 100 cycles each second. We can also pick up light we cannot see, such as the light from this IR remote control. Point a remote control at a photovoltaic cell connected to an audio amplifier and you get some pretty need sounds.

Video and digital photo cameras also use a charge coupled device where the principle of operation is related to the photoelectric effect. These cameras are also sensitive to visible and invisible parts of the electromagnetic spectrum. Pointing the IR remote at the camera we can actually see the pulses of infrared coming from the remote. You can try and observe this at home with your digital or video cameras. Video cameras have a built in a filter to block the IR from coming in so they work better in the visible region of the light spectrum. Some cameras like the Sony Nightshot have a special switch that takes out the IR blocking filter

and making the camera sensitive to IR radiation. Some of the little black and white security cameras have its own IR light emitting diodes (another physics quantum mechanics application) that can illuminate objects with light we cannot see. The camera sees this light just fine and is able to “see” in dark places, like a pocket, or inside a mouth by using an infrared spotlight to illuminate the areas! To our eyes the areas still look dark because our eyes do not respond to infrared light. There are other interesting things you can do with this camera [1].

References

[1] Stanley J Micklavzina , Phys. Educ. 38 No 6 (November 2003) 492-494)