NJAAPT NEWSLETTER
OCTOBER MMIX

President's Message

We are back into the time of the year when the activities of the section begin to pick up. The workshops, Holiday Treats, the Physics Olympics, Dave's Demo Night, and the Sectional Meeting are all closer than we think. Plan ahead for attending these events because they are fun and allow you the opportunity to meet other section members.

The State rules regarding attending workshops may cause some problems but with careful planning and visiting our website, you can be kept abreast of the dates of the programs and submit your request to attend far in advance. Keep in mind that we are an authorized agent of the State Department of Education to provide hours toward the completion of the 100-hour requirement.

Our presence at the New Jersey Science Convention was very successful with the Demo Dens and workshops presented by our members. The two days provided us with the chance to meet new physics teachers, some more experienced ones, and teachers to be. Talking to individual teachers gives us more understanding of what we can do to assist physics teachers in New Jersey, as well as science teachers at all grade levels.

Our preparations for the Spring Sectional Meeting are just about complete and we are pleased to have the cooperation of Princeton University again as our host for the two-day meeting. The dinner meeting on Friday and the full day session on Saturday are in a relaxed atmosphere allowing for an informal gathering and exchange of ideas to take place between members and our guest speakers.

It is my hope that more of the membership will take advantage of the events and become more fully involved in the life of the section. Time is precious to all of us, but we should be able to make an effort to attend at least one sponsored activity a year.

Ray Polomski

Demonstrations by Jim Ferrara at the NJ Science Convention Demo Den on 10-15-08

Electromagnetic Induction – Faraday's & Lenz Law

Two air-core solenoids (approx 500 windings each) placed vertically about 0.5 m apart each under an individual ring stand. Hanging from each ring stand above each solenoid, is a cow-magnet (any strong magnet will do - even bar magnets work fine), which is magnetically attached to a paper-clip (tape is also optional), which is in turn hung from a large spring (a hookean spring from any catalogue will do). It is important that the two magnet set-ups are not mechanically connected to each other. The two solenoids are then electrically connected by 2 alligator clipped wires, one wire connecting the two top connections and the other two bottom connections on the respective solenoids.

Put ONE of the magnets in motion by pulling it down a bit into the solenoid and releasing it. It will begin to oscillate. The other magnet will very quickly join in the same motion, either in phase or out of phase depending on the orientation of the other magnet (N/S) and/or the order of the connecting wires (top-top or top-bottom).

The principle is the movement of the magnet in a loop of wire will create a current in the loop. The current flows through both solenoids and creates an alternating (N/S) magnetic field in the other solenoid – which in turn repels & attracts the other magnet.

Magnetic Fields around Current Carrying Wires – The Jumping Wire

A loop (3-4 turns) of loose, light wire (~16 gauge) is placed around a strong horseshoe magnet. The both ends of the wire are connected to a power supply (or any other source of large current – several amps). Old car batteries work very well also. Be sure to include a telegraph or other similar switch so that the current can be briefly switched on. When the switch is closed, the wire will "jump" out of the magnet. Sometimes you might have to turn the loop 180° to get the loop to jump out instead of inward.

The principle is the current sets up a magnetic field in the wire that is repelled by the large magnet and the wire "jumps" out of the magnet due to the repelling force.

Forces Between Current Carrying Wires

Two long, straight light wires (~16 gauge – I used magnetic wire, but any wires work fine) are hung physically parallel from an insulated arm connected to a ring stand (or lab rigging). Each wire is connected to a high current DC power source – a car battery works very well! (I used a motorcycle/boat battery) via a telegraph (or similar) switch (very important!!) The wires are connected electrically in parallel by alligator wires and when the switch is briefly closed, the wires will attract. Then reverse the connections on one of the wires to make anti-parallel currents. The wires will then repel when current is passed through. CAUTION: Only close the switch BRIEFLY as this is essentially a short of the power supply and the wires will rapidly heat. The battery can be damaged if the circuit is closed for too long.

The principle is the magnetic fields developed in each wire when there is a current in the wire will cause forces on the moving charges in the adjacent wire. When currents are parallel the forces are attractive, when anti-parallel they mutually repel each other.

Electromagnetic Induction – "Floating" Magnet

A copper pipe (1/2" diameter) is held vertically while a Neodymium alloy magnet is dropped and let fall the length of the copper tube. When compared with an ordinary object (e.g. small regular magnet), the Neodymium magnet falls dramatically more slowly. Green Nickel-based "magnetic tape" can be applied to the side of the tube that then allows students to "see" the magnetic field as the magnet passes down the copper tube.

The principle is the moving magnetic field of the magnet sets up a circular current in the copper tube which in turn creates its own magnetic field with an opposite polarity thus creating an upward force on the magnet which slows its fall. Be sure the tube's diameter is large enough to accommodate the magnet's diameter. The magnets come in many sizes. Any size will work.

Submitted by Jim Ferrara

Black Holes and the Large Hadron Collider [LHC]

I don't know where the media gets their information about mini black holes, but swallowing CERN as well as the rest of the world is not consistent with the current physics understanding about this issue.

First of all, mini black holes of the type that tentatively might be produced in the LHC, if they exist at all, are much more likely to be produced **naturally** by the collision of high energy cosmic rays [made up mostly of protons moving very close to the speed of light and with energies in excess of 10^7 TeV! See with atoms of the Earth's atmosphere. See http://imagine.gsfc.nasa.gov/docs/features/topics/snr_group/cosmic_rays.html. The energies of the most energetic cosmic rays are many orders of magnitude more energetic than the protons being collided in the LHC [maximum energy only 14 TeV]! Experimental work is currently being done in South America [in the Argentine pampas] to detect these naturally formed mini Black Holes. In either case, such Black Holes would, according to current understanding, be **very** short lived due to a phenomenon known as "Hawking Radiation". As a result of Hawking Radiation such mini Black Holes would "evaporate" in a fraction of a microsecond.

Every Black Hole has what is called an "event horizon". The event horizon of a black hole is that distance from the Black Hole where the escape velocity exceeds the speed of light. Since according to current theory no particle that has a non-zero rest mass can reach, much less exceed the speed of light. Any such particle that finds itself within the event horizon of a Black Hole will become trapped within that horizon.

At first glance, this would seem to imply that Black Holes would only grow. But it turns out that the mass-energy contained within a black hole can, in fact, leak out through Hawking Radiation.

According to our current understanding of our universe, particle pairs are continuously and spontaneously being formed all around us from seemingly nothing. Justification for this spontaneous generation of particle pairs is based on the Heisenberg Uncertainty Principle. According to the Heisenberg Uncertainty Principle it is possible to violate the principle of energy conservation as long as the violation occurs for a very short period of time! Specifically, as long as the product of the energy borrowed ΔE and the time interval for which the energy is borrowed Δt is less than or equal to Planck's Constant h divided by $2 \cdot \pi$, such events are permissible. [$\Delta E \cdot \Delta t <= {}^{h}/_{2 \cdot \pi}$] This is NOT mere speculation, but has been demonstrated experimentally! [For more information Google "Casimir Effect".]

Now consider a mini Black Hole formed be the high energy collision between two small particles such as two protons as in the LHC. Imagine that just outside the event horizon of the mini Black Hole a particle pair spontaneously comes into existence. Suppose now that one partner of this particle pair falls into the Black Hole while the other partner shoots off in the opposite direction away from the Black hole! Ordinarily, when a virtual particle pair is formed, they quickly recombine returning the borrowed energy permitted by the Heisenberg Uncertainty Principle. But since one half of the particle pair fell into the Black Hole while the other half remained outside the event horizon they are not capable of recombining and returning the borrowed energy.

What happens now? Well, the partner that fell into the black hole combines with a different particle within the Black Hole and in the process returns the borrowed energy within the required time interval! This means that the mass of the Black Hole has been decreased by the mass of the particle that recombined with the entering partner! The total mass-energy of the Black Hole has DECREASED! The missing mass shows up in the other partner of the particle pair that shot off away from the Black Hole in the first place. That other particle is the Hawking Radiation!

The final piece of the puzzle has to do with the size of the mini Black Hole. If we assume that the Black Hole is in the shape of a sphere, the smaller the size of the sphere, the greater the ratio of the surface area of the Black Hole to the volume, and therefore the mass, of the Black Hole.

The volume of a sphere is given by $V=4/3\cdot\pi\cdot r^3$ while the surface area of a sphere is given by $A=4\cdot\pi\cdot r^2$. If we take the ratio of surface area to volume we get: $A/V=[4\cdot\pi\cdot r^2]/[^4/_3\cdot\pi\cdot r^3]=3/R$. If R is very small [much less than 1, for example! The radius of the event horizon for a mini Black Hole formed by the collision of two protons would be on the order of 10^{-19} m. See http://cerncourier.com/cws/article/cern/29199 for more information.] This ratio gets very large, meaning that the surface area is comparatively much larger than the volume. [This is the same reason why a very thin, small person suffers from the cold much more than a very large, overweight person - the smaller you are, the GREATER your surface area to volume ratio and it is your surface [skin] that radiates away your body heat while is it is your volume [mass] that generates your body heat!] For a mini Black Hole this ratio will be EXTREMELY large and as a result there will be a relatively large surface area emitting Hawking Radiation. What this means is that, for all practical purposes, the smaller the Black Hole, the "hotter" the Black Hole! The rate at which the Black Hole emits radiation is inversely proportional to its radius. So any Black Holes formed by either the LHC or incoming cosmic rays will very quickly "evaporate"! No problem – we get to live another day!

Submitted by: Jim Kovalcin

Physics Olympics

Mark the calendar – Saturday January 10, 2009 – is the date for the next Physics Olympics at Monmouth Regional High School in Tinton Falls. This fun competition has brought many thousands of high school physics students together in a spirit of friendly competition since its inception at Trenton State College (TCNJ) by Dr. Fred Pregger and the late Jud Fink. Why not check out the rules and registration information at our website, www.njaapt.org, and maybe consider a team entry. If this year is not a possibility, then begin thinking about an entry in the 2010 competition.

Fall Workshop – Waves, Sound, and Light

Come and join in the Make and Take workshop at Monmouth Regional HS in Tinton Falls on Saturday, Nov. 22. Jessie Blair, John Valente, & others will present ideas for the teaching of these concepts and take away something that you make. See the registration information at our website. It sounds like a fun time.

Calendar of Events 2009 - 10

Nov. 22 – Waves, Sound, & Light Make and Take Workshop – see website for information

Dec. 6 – Holiday Treats – Rutgers U. Registration: $35 member; $45-65 non-member. Contact Dave Bandel: daranddave@optonlline.net

Jan. 10 – Physics Olympics – Monmouth Regional HS – contact John Valente: John_Valente@mast.mcvsd.org

Feb. 20 – Dave's Demo Night – Rutgers U – FREE – contact Dave Maiullo: maiullo@physics.rutgers.edu

Mar.20 – 21 – Spring Sectional Meeting – Princeton University – contact Ray Polomski for information – Registration TBA