UP undergraduate physics newsletter

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Physics Of Breakdancing

by Harold Rodriguez

Breakdancing, (a.k.a. breaking, b-boying, or busting-your-face) is a dance usually associated with crazy hip-hop kids living in urban cities. While these kids may seem concentrated on the "funk music", with the hippin' and the hoppin' (daww), they are actually hardcore physicists whose muscles are performing high-speed physics calculations. Yes, these kids grew up not only learning the laws mechanics, but also finding ridiculous ways to exploit them.

Before we delve into the analysis of one of the most physics-(and death)-defying dance moves of the genre, let's have a quick rotational inertia review. As you know, angular momentum gives us an indication of "how hard" it is to stop an object: like $p = mv$ (momentum = inertia times velocity), $L = I\,w$ (angular momentum = rotational inertia times angular velocity). Hence, things that spin slowly (but have large rotational inertia) as well as things that spin quickly (but have small rotational inertia) are hard to stop.

To change your angular momentum, you can apply a torque (here, a force acting at a distance from a spin axis). You can either push harder or further away from the spin axis to make an object spin faster. A breakdancer tries to change his angular momentum by both kicking hard and kicking far away! Let's examine the breakdancing move "air flair" or "air track", which is just a bunch of changes in angular momentum.

First, the "breaker" generates a torque between the floor and his foot. This can be achieved by swinging a leg out in front, sideways. The foot of the other leg will experience a torque because the force on your toes goes one way, and the force on your heel goes another. Do not attempt on a slippery floor! After generating a torque, the breaker kicks off of his twisting foot and lands on the floor with both hands. See the figure below.

TO BE CONTINUED IN NEXT ISSUE

who we are

UP is a monthly undergraduate physics newsletter sponsored by the University of Florida's chapter of the Society of Physics Students, for students, by students. We seek to strengthen the undergraduate physics community at the University of Florida by providing a forum for undergraduates to share their views and experiences with each other and act as a source of information for opportunities and events in physics.

Lecture about Feynman
By Dr. Rick Field
Monday, November 19th
6:30pm - NPB 2205

what's UP
in this issue

PROFESSOR SPOTLIGHT

Dr. Heather Ray

by Bryce Bolin

Dr. Heather Ray is a new professor here in the Physics Department who is doing experimental work in the field of neutrino particle physics. She tells us her story in an interview this month, covering specific details about her work, as well as her future plans:

UPNEWS: "Hello, Dr. Ray, I hear you are the new professor here in the Physics Department, how long have you been here and what were you doing just before you came here?"

Dr. Ray: "I have been here for a few months. I just started this semester when before I was working for Los Alamos National Laboratory at Fermilab in Illinois for my post doc."

UPNEWS: "Well, how do you like the environment here? Is it vastly different than where you are coming from?"

Dr. Ray: "Where I was coming from, I was working in a government lab whereas here I am working in a full academic environment. There is to some degree a displacement going from a lab to a complete academic environment, so a comparison can not really be made between the two. Though there was access to the local universities at Fermilab, it is nothing like working in a community devoted to academics. "

UPNEWS: "What are you currently doing as a professor, and what will you being doing next semester?"

Dr. Ray: "Before I was employed here, UF only had Pierre Ramond doing neutrino physics, which was very theoretical. I brought the experimental field for neutrino physics with my experience as a researcher at Fermilab. For right now, I will be leading the discussion for the honors "Intro to physics" sequence. I had fellowship in graduate school and did not have to teach students, so now I am gaining experience in this regard."

UPNEWS: "What does your current research entail?"

Dr. Ray: "I am still collecting data from the Booster Neutrino Experiment, MiniBooNE, which is on a second run. The goal of the experiment is to find neutrino oscillations - basically looking for physics beyond the Standard Model. I am also currently working on a proposal for my own neutrino experiment located at Spallation Neutron Source, Oak Ridge Laboratory where we will be looking for oscillations from muon antineutrinos to electron antineutrinos on the mass scale relevant for astrophysical processes.

UPNEWS: "How did you come to be interested physics? What do you now look forward to the most in physics?"

Dr. Ray: "I had originally planned to study computer animation, but after going through the course sequence for that field, I decided that it did not hold my interest at all. So, while completing the general education requirements for a degree, I took a course in philosophy on the history of science. The topics in physics "clicked" with me and I then decided to switch to doing physics. I had always done well in math, however it was not until I was exposed to the topics of physics, particularly modern physics, that I discovered I had proclivity for it and found it most intuitive. I am looking forward to doing my own experiment which is much unlike any other. Being able to work on something new and exciting, something that is truly mysterious and beautiful is what I have always looked for in physics – not something like just trying to find another significant digit."

UPNEWS: "Is there any advice that you can give to current students interested in physics?"

Dr. Ray: "Make sure you try out doing some research with a few different people as an undergraduate to find out what you are interested in doing. When applying for graduate school be sure to realize that your department determines the topic of your thesis within your field. Students should realize this and spend an afternoon calling professors who do the physics they are interested in with very pointed questions about the work they would be involved in as an incoming graduate student. While a university may have someone specializing in the general area you're interested in (i.e. neutrino physics), that person may only do one type of measurement (i.e. oscillation searches), while you might want to do a different measurement (cross section measurement). You cannot choose a graduate school based on its having someone in the general area you're interested in, because you may end up performing a measurement that holds no interest for you."

COWBOYS ON THE ENERGY FRONTIER ENGAGE IN PARTICLE SHOOTOUT

by Steven Hochman

When it comes to particle physics, the fastest particle accelerator will reveal the future, and the past. That's what Young-Kee Kim from the University of Chicago espoused in one of the UF Physics Colloquia. Accelerators are extremely important to particle physics. Currently many professors at UF are analyzing data from the 2 TeV proton-antiproton accelerator at FermiLab in Chicago. Accelerators have many useful aspects. High powered accelerators are used as microscopes and as "time travel" devices to simulate what it was like micro-seconds after the big bang. Right now physicists around the world are trying to complete the standard model and unite the four forces of nature. One of the looming mysteries physicists also hope to shed light on is the elusive dark matter, and its even more abundant counterpart, dark energy. The future looks bright for particle physics though, as the LHC at CERN goes operational. The massive 14 TeV proton-proton collider is expected to produce the elusive Higgs Boson particle. The observation of the Higgs could provide the missing links in the standard model that have been plaguing physicists for many years. Even with that assumed obtainable, most of the universe (of which dark matter and dark energy constitute 96%) remains uncharted. These physicists are truly the "Cowboys" of the universe.

THE GREAT CONSERVATION LAWS

by Jonathan Young

Very recently, the great Richard Feynman gave a lecture here at the University of Florida, just as he had done a year before. He appeared on 16mm film, his lecture being part of a series of lectures recorded in 1964 by the BBC entitled the "Character of Physical Law." These lectures centered on general physics principles and were intended for the general public.

One aspect that distinguished Feynman was his uncanny talent in conveying difficult ideas clearly and memorably. His recent lecture at UF was no exception to the high quality of his teaching. Called "The Great Conservation Principles," the subject matter was mostly familiar to beginning physics majors. However, Feynman presented the material in such a way that is not commonly taught at the introductory level. A conservation law was related as a calculation of a certain quantity, and as nature evolves with time, re-calculation of the same quantity produces the same number as before. He likened physics to a chess game, in which physicists do not know the rules of the game but are allowed to discover them through observations of the game being played. And one rule they discover is that the bishop generally remains on squares of the same color. Like the calculated quantities in conservation laws, throughout most of the game the bishop never changes color.

Among the conserved physical quantities explained in Feynman's lecture were baryon number, angular momentum, charge, and energy. Feynman stressed the local conservation of charge – suppose two points A and B are separated by some distance. Point A has charge q and point B has no charge. If the charge at point A gradually "disappears," can it simultaneously appear at point B? By introducing the relativity of simultaneity through the classic platform-and-train thought experiment, Feynman shows that the conservation of charge cannot be made relativistically invariant without stipulating that charge is locally conserved.

Feynman also spent considerable time on the conservation of energy. He gave a unique explanation in part by making an analogy with a child playing with 28 indestructible toy blocks. His mother is interested in counting the number of blocks at the beginning and end of each day. Some days she sees 28 blocks; other days she sees less than 28 blocks in the room. Upon further inspection, on the days where she spots less than 28, she finds the remaining blocks tossed outside the window or under a rug. The connection between this analogy and the conservation of energy is that when calculating the energy, it is important to recognize that at times some energy goes away by leaving the system and energy may also come in. To verify the conservation of energy, one must account for any energy that was taken out or put into the system.

The remainder of Feynman's lecture is notable for employing similar analogies to illustrate physics. It was also readily apparent how Feynman's wit and enthusiasm allowed him to craft memorable and engaging lectures.

MEET GRAD SCHOOL APPS

by Larry Camarota

This is the time of year when many undergraduate physics students are looking to apply to grad school.

The first step is to research potential graduate schools. There is a very useful website called gradschoolshopper.com that can help here. It is hosted by the American Institute of Physics, and it allows you so search for schools by state, subject, and degree. You can also ask a professor that specializes in your area of interest for an idea as to what schools are good for your subject.

This brings up the second step: thoroughly researching the schools that you are applying to. It does you no good to have a smoking hot application, if the school you're applying to doesn't offer anything in your field of interest. It also keeps your application from sounding like a form letter. If you say that you are interested in a field that a school offers, it may help you get accepted there.

For the application itself, the three biggest influences are your GRE scores, your GPA, and your letters of recommendation. For your GRE and GPA, the only things you can do are study hard and take the GRE twice. For your letter, however, you are going to want to make sure that whoever you ask to write it knows you. The best letter you can get will come from your research advisor, as they can comment on your research skills, which looks much better to a grad school than a generic 'good student' letter.

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NOBEL FOR IPOD TECHNOLOGY

by Jonathan Young

It is considered to be among the highest honors that can be bestowed upon a physicist. The fame and prestige that immediately accompany its recipients are products of innate talent, years of concentrated effort, and luck. Awarded annually, the Nobel Prize in Physics seeks to honor lasting and outstanding contributions to the field. The prestige is due in part to the long and rigorous process of being nominated for the prize.

The first Nobel Prize in Physics was claimed by Wilhelm Röntgen in 1901. This year, the prize went to two Europeans for their independent and nearly simultaneous discovery of Giant Magnetoresistance (GMR) in 1988. Germany's Peter Grünberg and France's Albert Fert will share the $1.5 million and collect their medals at an annual ceremony in December in Stockholm. Fert is currently a professor at Université Paris-Sud, the same institution at which he obtained his Ph.D. in 1970. Grünberg is affiliated with the Jülich Research Centre. Obtaining his Ph.D. from the Darmstadt University of Technology in 1969, he moved onto a postdoctoral position at Carleton University in Canada before settling in Jülich. Both men were also awarded the Wolf Prize last year.

The phenomenon of Giant Magnetoresistance has far-reaching practical implications – especially in nanotechnology. From portable computers to music players, there is a constant demand for smaller size but increased storage. GMR is the technology that makes this possible. The simplest type of system in which GMR can be observed consists of a layer of non-magnetic metal inserted in between two layers of magnetic metal. The basic idea behind GMR is that when both magnetic layers are magnetized in the same direction, the majority of electrons will have the same spin, and thus resistance to their movement through the layers is low. On the other hand, if the magnetization of one magnetic layer is opposite to that of the other, then the electrons in one of the layers will have anti-parallel spin, and therefore higher resistance. The application to data storage is apparent when the magnetization of one magnetic layer is fixed and the magnetization of the other layer is varied, leading to high or low resistance which corresponds to binary one or zero. GMR is a first step in the development of spintronics (a new type of electronics based on the spin of the electron), and it also leads the way for the development of the next generation of memory, MRAM, which can serve as both working and permanent memory. In other words, MRAM could replace both the traditional hard disk and SDRAM that are widely used today.

The applicability of Giant Magnetoresistance certainly makes this year's Nobel Prize well deserved. As for Fert and Grünberg's plans on the prize money, Fert says that he will share some of the winnings with his colleagues. Grünberg said that his share of the prize would let him conduct research "without having to apply for grants every tiny bit."

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