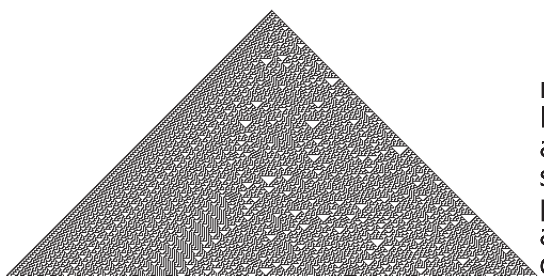
A New Kind of Science

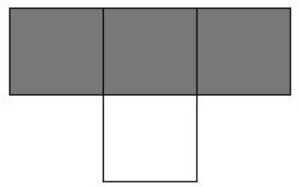
A Book Review from UPNews

by Brady Nash

This beefy 1200 page book is a bit daunting at first but once you get into the material it flows smoothly and isn't quite as big as originally assumed. Written by computer scientist Stephen Wolfram, it collects years of research and presents it in user-friendly format. The book has 400 pages of notes/references and includes hundreds of pictures to elaborate on the content. While the remaining pages of the text may be somewhat dense and dry, it is enjoyable to look at Wolfram's "new kind of science."



Wolfram believes the universal laws scientists use can be represented by simple programs known as cellular automata. After running thousands upon thousands of programs, he witnessed the same unexpected events. Randomness and complexity evolved from very simple instructions given to the programs. The set of rules given to the program, over time, would develop extremely complex patterns. It might seem counter-intuitive to most people that complexity could emerge from such a primitive set of instructions. It might also be reasonable to assume there is a correlation between the complexity of the rules and the complexity of the patterns. However, when Wolfram formulated a much more complex set of instructions, the complexity of the results



remained the same.
For example, the picture above evolved from a basic set of rules given to the program. A single rule may go as follows: there are only two options, black or white, for a cell to choose from. The cell below the particular cell being observed is determined by the color of the top cell and its adjacent cells. If the top cell and the cells to its left and right are also black then the cell directly below the middle cell will be white (see diagram below).
If Mr. Wolfram is correct in saying that very simple sets of rules run the universe and have created what we see here today, then every field of science would be altered: physics, chemistry, biology, etc. Despite criticism from fellow scientists, simple programs have been shown to model thermodynamic behavior, crystal growth, and sociological phenomena with relative ease.

Currently, Stephen Wolfram spends most of his time continuing to develop Mathematica, computation software he created. He also delivers talks on his research, teaching people about his very elusive yet very intriguing new kind of science.

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Ah, another year, another welcome...

To the n00b5

by James Stankowicz

There's a lot to do as a physics major at the University of Florida– aside of course from tons of homework.

Research

With the current job market being as bad as it is, you'll definitely want to start bolstering your resume as soon as possible. One of the highlights on a job or graduate school application is being a published author. Despite the seemingly hefty prerequisites to research, it is possible to start doing research that might lead to your name on a published paper as an undergraduate.

Take a look at the Physics Department research page (http://www.phys.ufl.edu/research/), find a few professors whose work looks like it might be interesting to you, and send them e-mails asking if they need any help. Some professors may let you hang out around the lab and help out, but then there are some who might be able to offer you money, and still others may be willing to allow you to take 'independent research' credit with them (another gold star for a freshman's or sophomore's transcript).

Scholarships

It's always good to win lots and lots of scholarships. Applying to graduate school is a bit pricey, so the money you win will come in handy, but the prestige of some of these awards are real 'career makers,' particularly for people pursuing careers in academia. The Goldwater Scholarship is one such prestigious scholarship based on the applicant's research ability and potential. A physics major or student working with a physics professor at UF has won the award going back at least four years. A well kept secret is that graduate programs, particularly in the liberal arts, pay students to attend their programs. It's possible to win scholarships and grants on top of whatever financial aid a graduate school might offer, and the more scholarships you win starting at a young age, the more practice you get and the more impressive you'll look when you start applying for the truly baller $tatu$ scholarships your senior year and beyond.

Society of Physics Students

The Society of Physics Students (SPS) is a microcosm of the many ongoings in the UF undergraduate physics program. SPS holds Research Opportunity For Undergraduate (ROFU) seminars several times a year, where professors who are looking for undergraduate research assistants will try to recruit students to come work for them. The UF chapter of SPS will begin this year offering its most active members scholarships at the annual end-of-the-year picnic, and past members have even won scholarships on the national level. The approximately bi-monthly SPS meetings are also a great opportunity for physics majors old and young to intermingle, eat free pizza, drink free soda, and learn about what research other undergraduates are doing.

SPS Lounge

On the second floor of the physics building is the SPS Lounge – a

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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 to act as a source of information for opportunities and events in physics.

Visit Department
Coffee Time
Tuesdays & Thursdays
3-4pm In NPB 2205
Professors, staff, and students are all invited!
Coffee, tea, hot cocoa, and cookies only 50 cents

what's UP
in this issue

Spotlight on Science:

Philosophy of Science

by Victor Albert

Throughout the last one-hundred years, science has fragmented into a mess of various disciplines, most of which overlap each other. This section attempts to clear up and organize the various scientific kingdoms and phylums one topic at a time. This is only an attempt as the distinctions among the fields are almost always debatable. This month we deal with the interface between science and philosophy.

In the spectrum of abstraction vs. application, there is a pair of areas, one more applied and the other more abstract, for almost every technical field. For example, chemistry is considered more applied (in my opinion) than physics, and math is more abstract. Thus, physics is "sandwiched" between chemistry and math. Math, in turn, can be said to be sandwiched between physics and logic. Logic, in turn, is between math and philosophy, and philosophy to my knowledge, has no discipline more abstract than it.

There is a branch of science that deals with specifically the metaphysical and ethical issues in and ramifications of the empirical and experimental sciences – scientific philosophy. However, this discipline, no matter how subjective the previous statement made it seem, also deals with more concrete aspects of science, like quantifying theories and determining properties such as locality (whether objects described by a given theory are influenced only by their "local" surroundings) and contextuality (like quantum mechanics, i.e., where measured values depend on the measurement itself). There has been much discourse ever since the Einstein-Podolsky-Rosen paradox about whether quantum mechanics is local or non-local. While entanglement seems to hint that quantum mechanics is non-local, there is (to the author's knowledge) no concrete agreement about this.

Scientific philosophy can be divided into various self-explanatory subfields. While most of the topics discussed above deal with philosophy of physics, there also exists philosophies of biology, mathematics, chemistry, economics, and psychology. Concepts studied in each of these include the foundations, moralities, and fundamental concepts of the particular field.

In addition to the more abstract philosophical and mathematical implications of science, there is another branch of science which situates scientific experience in a social and historical context. Although its name sounds like a fifth grade science course, science studies is responsible for investigating the culture of science as well as the interrelationships between science and society. This may include ethical issues, although some, like bioethics, can be studied by both philosophers and science studies practitioners.

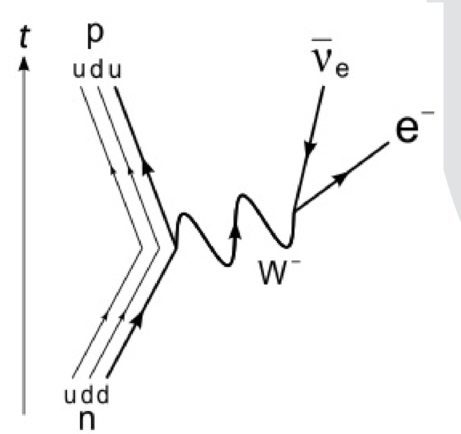
Weak Forces: The Big W

by Steven Hochman

What's the Weak Force?

You may have heard of the four fundamental interactions of nature: Strong, Weak, Electromagnetic, and Gravitation. When you first start physics you start learning about gravitation and not soon after, electromagnetism. What about the weak and strong force? Well this time we aren't going to ignore it. Here's a bit about the weak force.

As you might learn in modern physics, just as EM is mediated by photons, the weak force is mediated by W and Z bosons. The W is named for the weak nuclear force. The Z particle was given its name for its lack of electric charge. The W+ has a charge equal in magnitude to the charge of an electron but positive, while its anti particle has a charge euqal to the magnitude of an electron and negative. Both W particles and



the Z are very heavy at 80.4 and 91.2 GeV/c^2 respectively (compared to ~0.5 MeV/c^2 for an electron or ~1 GeV/c^2 for a proton) and all have a spin of 1. Because these mediating particles are so massive, they posses limited range, meaning the weak force acts only over a limited range.

The W can play a role in certain nuclear decays. A neutron can decay into a proton, electron, and electron antineutrino. On a more fundamental level, the flavor of one of the down quarks in the neutron changes to an up resulting in the creation of a W- boson. By emitting a W- the down quark changes to an up, conserving spin and charge in the system, and the neutron becomes a proton. This interaction is shown in this Feynman Diagram.

To be continued in next month's issue...

History's Great Men of Science:

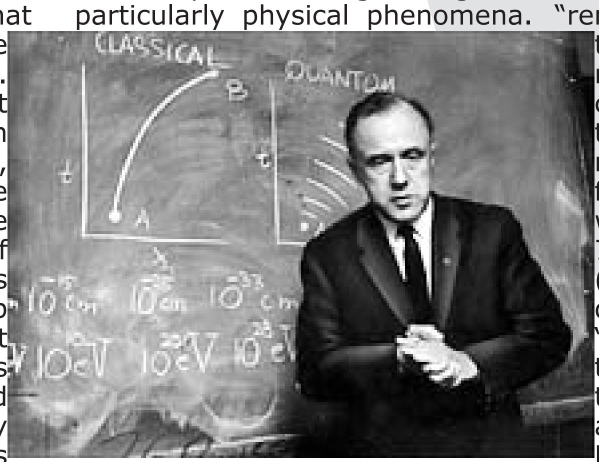
John Archibald Wheeler

by James Stankowicz

Professor John Archibald Wheeler was born on July 9, 1911, and passed away on April 13, 2008. In memory of Prof. Wheeler, the April edition of "Physics Today" presented an issue recounting his life through several biographical articles written by his students, and by including reprints of some of Wheeler's former articles in "Physics Today."

The first biographical article discusses the early career of Wheeler – a period of time that Wheeler himself coined the "everything is particles" phase. During this span Wheeler spent much of his time working on problems in atomic physics, focusing particularly (given the state of global affairs in the 1930's and 40's) on the process of fission. The article also recounts Wheeler's close relationship with Neils Bohr during that time, and even briefly mentions his role as advisor to Richard Feynman, which was partially interrupted by both Feynman's and Wheeler's involvement with weapon development during World War II.

The second phase of his life Wheeler termed the "everything is fields" phase, and the second biographical article recounts that part of Wheeler's life. During this time, Wheeler almost single-handedly turned general relativity from a stagnant area of research into the blooming subject it is today. He coauthored (with his postdoctorates and graduates) papers presented at the First International General Relativity Conference in 1957, which largely mapped into eight papers appearing in the July 1957 issue of "Review of Modern Physics." Several of these papers marked the beginning of what what would develop into groundbreaking work. The fact that Wheeler labeled the eras of his life gives some insight into how he functioned as a physicist. He took pride in accurately and succinctly describing things – particularly physical phenomena.



His work on dying stars led him to "Schwarzschild singularities" which he later termed "black holes" (since the escape velocity of these super dense objects meets or exceeds the speed of light – so that no light can leave the object). His work on the topology of spacetime led him to the concept of "wormholes," a concept which has, if nothing else, certainly enriched the life of the science-fiction community. The final biographical article discusses Wheeler's mentoring throughout his career. "Prolific" does not even begin to describe Wheeler's intellectual heirs. One overwhelming statistic that conveys just how influential Wheeler was also has a tie to UF.

The SPIRES database for particle physics suggests a scale for classifying the fame of a physicist based on how many citations that physicist has in other literature. Applying that scaling to those who worked under Wheeler results in eleven students in the "renowned" category, nine in the "famous" category, and nine in the "very well known" category (where "renowned" is the level of highest fame). So roughly 25% of his students fall into these three categories, whereas, by comparison, only 7% of all particle physicists (for whom the scale was developed) are at or above the "very well known" level. One of the "renowned" physicists, by the way, is Richard Feynman, and another is UF's very own Prof. John R. Klauder.

Of course this article does not delve nearly as deeply into the astounding life of Wheeler as the "Physics Today" articles do, and there is not coverage here, even, of Wheelers articles on the topics of black holes, and fission that also appear in the "Physics Today" publication. If your interest is piqued, pick up the April copy of "Physics Today," and learn about one of the most influential intellects of this century.

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room donated and dedicated to the UF undergraduate physics population. Some of the amenities include: computers, a refrigerator, coffee maker, and, most importantly, other students stuck on the exact same homework problems you're stuck on. Hang out here if you want to find all the other people trying to get a week's worth of homework done before it's due in an hour – a real bonding experience.

Cookie and Coffee Time!

One last exciting event worth mentioning is the bi-weekly cookie and coffee time hosted by SPS. On Tuesdays, there are fresh baked cookies, and freshly brewed coffee and tea available for $0.50 each in the main upstairs conference room, NPB2205 (just follow your nose). On Thursdays, these same things are available for free, but because the cookies are so delicious, they disappear very quickly. The Thursday coffee time immediately precedes the weekly colloquium, where either a visiting professor or a UF professor gives an hour-long talk about his research. The purpose of coffee time is to have undergrads, graduate students, and faculty all interacting in a non-classroom environment, and is another great opportunity to meet your fellow classmates, and get to know faculty and staff on a more personal level.