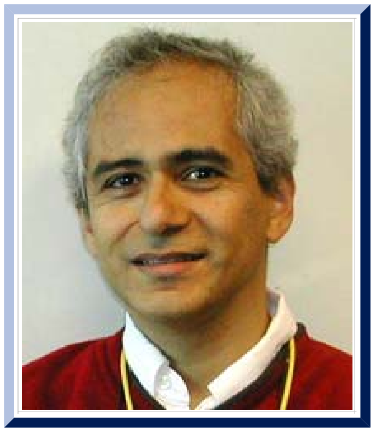
Spotlight

On Alumnus Fernando Pineda (Ph.D., 1977)



By: Karrie Sue Hawbaker, editor

When Fernando Pineda was in the third grade, he entered a competitive private school with a focus on science and technology. Today, with a Ph.D. in physics from the University of Maryland to his name, he is helping to develop groundbreaking biotechnologies for biodefense. Okay, so there's a little more to it than that.

Born in Peru , Pineda spent his formative years in Chicago , where he attended The University of Chicago Laboratory School, a school that Pineda calls “competitive but with a supportive environment.” When he finished high school, he left Chicago for Boston to study physics at the Massachusetts Institute of Technology.

Pineda graduated from MIT in 1977 with graduate school plans left unsettled. He spent a few years as a data analyst at the Harvard Smithsonian Center for Astrophysics. In this position, he was the “computer guy” for a small group working on the SAS-C satellite x-ray observatory. He found the work interesting and rewarding, so he decided to go for graduate school. The University of Maryland offered him a quality program and a teaching assistantship.

Pineda was impressed by the caliber of the students at Maryland . He says collaborating with fellow students was a significant part of his graduate education. Collaboration was good practice for his professional future. Pineda credits collaboration with his fellow students as essential for his survival in his first semester of graduate school, which was, quite possibly, the most rigorous experience of his life.

In his second year, he began working as a graduate assistant in the nuclear theory research group. First, under the direction of Dr. Jim Griffin and later under Dr. Manoj Banerjee. He used computer modeling and simulation to study the forces between interacting Bayons.

It was a Friday when Pineda turned in his final thesis, “Baryon-baryon interaction in a chiral-quark mean-field model.” He took that weekend off and then started work on Monday at The Johns Hopkins University Applied Physics Laboratory (APL). He had accepted a position in a computing group within the space department working on neural networks. It was 1986 and, at that time, neural networks, a subspecialty of statistics used for pattern recognition, was the next big thing in artificial intelligence.

Within his first six months, Pineda produced some significant work. Catching the attention of

Spotlight

A Neutrino Update

By: Professor Rabindra Mohapatra

Neutrinos are tiny particles that are emitted when nuclei undergo a process called beta decay and were postulated by Pauli to explain the apparent lack of energy conservation in these processes. They were discovered by Reines and Cowan in the mid-1950's and their interactions with matter were extensively studied in the ensuing decades. It was soon discovered that unlike other forces in Nature, neutrino interactions are always left handed. There was no evidence for the right handed neutrino. Thus, while all other particles were “full” particles, neutrino remained “half” a particle. Physicists became resigned to live with this unpleasant asymmetry. In the 1960's and 1970's, two more species of neutrinos with very similar properties the beta decay neutrino were discovered. Subsequent studies provided key confirmation of the standard model of particle physics which is now the accepted theory of electroweak and strong interactions. Thus neutrinos have been playing a key role in broadening the horizon of our knowledge of fundamental forces and matter.

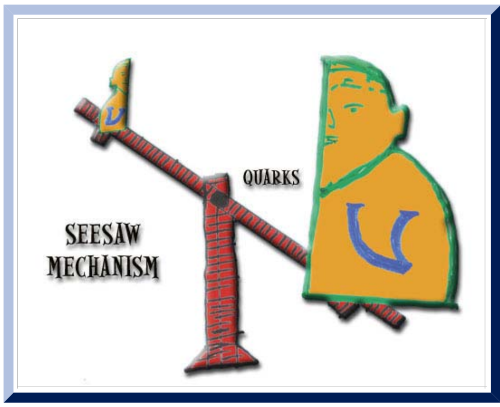
They are also extremely important in our understanding of the Cosmos. Born at the moment of the big bang, they have survived as relics until today and fill the Universe almost as abundantly as cosmic black body radiation. They were responsible for the formation of light nuclei in the early stage of the Universe, which eventually led to the formation of heavier nuclei that we use in every day life. The nuclear fusion at the core of the Sun responsible for sunlight is also possible due to the existence of the neutrino.

Despite a great deal of knowledge about how the neutrinos interact, the very basic properties that characterize every matter in the universe (i.e. how much it weighs) remained a deep mystery for the neutrinos until about seven years ago. In June of 1998, the results of the Super Kamiokande experiment in Japan looking for neutrinos from the Sun and cosmic rays were announced and our ideas about neutrinos changed forever. They announced evidence for neutrino oscillations which can occur only if neutrinos have a mass. Furthermore, observing neutrinos from different directions in the sky, they could give an idea about how much the mass is likely to be. This also confirmed an earlier indication of such oscillations by Ray Davis who was searching for neutrinos from the Sun. During the past seven years a large number of other experiments have provided conclusive evidence that neutrinos have a very tiny weight.

The weight of about ten billion neutrinos equals that of a proton and weight of about ten million neutrinos equals that of an electron. It was also found that they can transmute from one species to another giving rise to the phenomenon of neutrino oscillation and providing an understanding of two puzzling observations. For example, most of the neutrinos produced in the solar core and in the cosmic rays seemed to be missing on the way to the Earth.

These observations have raised several profound puzzles for theorists. The key issue is the tiny mass of the neutrinos compared to the masses of familiar particles such as protons and electrons. This puzzle was solved by the work of Rabi Mohapatra and Goran Senjanovic in 1979 (and independently in four other papers) who suggested the so-called seesaw mechanism. According to this mechanism, the neutrinos, which are known to be left handed, are light because they are accompanied by neutrinos, which are right handed with superlarge mass. Mohapatra and Senjanovic, at that time, were studying a class of models called left-right models which postulated that at very short distances beta decay forces that neutrinos participate in, are parity conserving at a fundamental level.

The fact that all observed weak processes appear parity asymmetric is explained in this theory by the assumption that the right handed neutrinos processes are suppressed due to their superlarge masses, which is precisely what is required to work out the seesaw mechanism. So they concluded that weak interactions are parity asymmetric because neutrinos have such tiny masses. This mechanism has become a standard paradigm in neutrino mass physics.



A prediction of the seesaw mechanism is that the mass of the right handed neutrino is around ten thousand trillion times the mass of the proton. This is of course an extremely high mass and is therefore unlikely to be ever seen directly. However, the effect of such masses had already been considered in a different context in the 1970's when it was realized that as we go up in energy, the strengths of the known forces become similar and at precisely around the seesaw scale, they become unified into one force giving rise to the so called grand unified theories. This raised the possibility that the two ideas, grand unification and small neutrino masses must go together. It turns out that there is a symmetry group called SO(10) group which provides just the right setting for understanding the origin of forces as well as the origin of neutrino masses. Mohapatra has studied the physics implications of SO(10) grand unified theories prior to the discovery of neutrino masses. With the discovery of neutrino masses, has applied this group to understand the neutrino properties. Along with his recent collaborators (research associate Salah Nasri and former students Hock Seng Goh and Siew-Phang Ng, two collaborators in Canada , Bhaskar Dutta and Y. Mimura) he has returned to these theories and proposed them as the theory of all forces and matter beyond the standard model and studying their implications for proton decay and origin of matter in the Universe.

Dr. Rabindra Mohapatra is professor in the particle theory research group here at the University of Maryland. He can be reached at rmohapat@physics.umd.edu.

Tel: 301.405.3401
1117 Physics Bldg.
University of Maryland
College Park, MD 20742

Contact the editor.
Contact the webmaster

some key people in the field, he quickly made a name for himself in the Neural Network community. So, when he was giving a talk at the California Institute of Technology about two years after he began working at APL, he was approached by the leader of the newly formed neural computation and nonlinear science group at the Jet Propulsion Lab (JPL) there. He joined the new group's technical staff and stayed there for about two years.

Pineda says he enjoyed his JPL colleagues, the challenging work and, of course, the Pasadena weather. However, there was the matter of this girlfriend. He had met her when he was still in Maryland , just a few months before leaving for Pasadena . After two years of cross country flights and long distance phone calls, Pineda returned to Baltimore , bought a house and married his fiancée (They now have two children and two cats).

When he returned to the east coast, Pineda also returned to APL, where he spent the next 11 years. During this time, he worked on applying pattern recognition, artificial intelligence and signal processing. He collaborated with Johns Hopkins colleagues in Electrical Engineering and Computer Science on projects involving artificial neural networks and statistical pattern recognition. About six years ago he started applying his techniques to the interpretation of mass spectrometry data. DARPA was funding APL to develop an instrument to quickly detect bio-warfare agents in the atmosphere. Pineda and his team developed analysis techniques for the mass spectrometer, which takes an air sample and determines – within five minutes – if it contains a harmful substance like anthrax. Pineda began to study more biology and how computing, physical sciences and biosciences converge.

Then, the tragedies of September 11, 2001 occurred and this area of science became more important than ever. At the same time, the practice of applying computation and statistics to the field of biology began to emerge. Suddenly, biology began to undergo radical changes, including becoming more of a quantitative science like physics. With these changes and his experiences, Pineda was well-positioned to take a leadership role in this field.

Deciding, it was time to move on, Pineda applied to two places – The Johns Hopkins Bloomberg School of Public Health and the University of Virginia Bioinformatics Institute. He received attractive offers from both places. However, when his wife was offered a faculty position in The Johns Hopkins School of Medicine's Department of Comparative Medicine (sometimes referred to as veterinary science), Hopkins was the clear choice.

Now at the Bloomberg School , Pineda is an associate professor in the Department of Molecular Microbiology and Immunology and director of the departmental Bioinformatics Core Facility there. He works with students and post-docs, using physics, biology and computing to develop novel technologies and valuable answers to public health problems.

Pineda says that he is enjoying the research, especially developing new tools, as well as the teaching. Even when he was at APL, he taught courses for the university's part-time program as well as professional development courses for his colleagues at APL. He says he finds that teaching is a lot of work, but that the interaction with the students is great.

Pineda advises our current students and recent grads that one of the best things to do is to associate with people who know more than you do. You'll never learn anything if you're always the smartest person in the room. Also, when you are applying for positions and you are asked for a personal statement, remember that this is essentially a proposal. So, treat it that way. Be sure to show the search committee what you bring to the table. And, he says, young scientists must remember that the Ph.D. is just the starting point. There are many paths to take and many, many new things to learn.

Pineda is always on the lookout for bright students with a computing background. If you would like to reach him, please contact the editor. She will be happy to pass along the message.

Tel: 301.405.3401
1117 Physics Bldg.
University of Maryland
College Park, MD 20742

Contact the editor.
Contact the webmaster.