FIAP Newsletter
Fall 2013
American Physical Society Forum on Industrial & Applied Physics

Dear FIAP members,

In the hope of making your newsletter easier to read on the handhelds and tablets our work have helped make possible, we are adopting a new newsletter format. As always, please let us know what you think of both the format and content by emailing fiap_newsletter@aps.org .

Best regards,
Your editor

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Announcements & Meetings

Industrial Physics Fellow joins APS 5

The APS is demonstrating the commitment to physicists working in industry by naming the first Industrial Physics Fellow to work in APS headquarters. Steven Lambert joined the College Park staff in September to improve the visibility of industrial physics within the APS and to strategize on ways the APS can better serve this important cohort of physicists. This will include collaborating on industrial physics sessions and job fairs in national and section meetings, engaging with early career programs to highlight industrial options, and advocating for the viewpoint of industrial physicists within headquarters. He will be a key contact for FIAP within the APS.

Steven earned his PhD in superconductivity and magnetism at the University of California, San Diego. He then spent 27 years in the hard disk drive business in San Jose, California where he participated in many aspects of technology ranging from the esoteric to schedule-driven product development. His work included studies of the limits of magnetic recording, developing and validating new concepts for next generation products, and incremental improvements of heads and disks to increase hard drive yields. This broad experience gives him points of contact with the wide range of physics activities in industry, and he is enthusiastic to connect with physicists working in industry. He would welcome input from FIAP members. You can reach Steven at lambert@aps.org.

Following our successful pizza lunch at the 2103 APS meeting in Baltimore on thinking about and preparing for physics careers in industry, FIAP has started working with APS Sections to hold similar events across the country. In mid-October FIAP partnered with the Texas APS Section at their annual meeting held at the University of Texas at Brownsville (UTB).

FIAP Program for the March APS Meeting, March 3-7, 2014 5

Invited Speaker Sessions for FIAP/Industrial Physics Forum at the 2014 March APS Meeting

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5:30 - 7 pm		FIAP Business Meeting		FIAP & AIP Reception	

Updating FIAP's Bylaws 12

The APS Council voted on 23 November to approve a new set of bylaws for FIAP. The new bylaws will soon be put before the FIAP members for approval.

Comments and questions can be sent to fiap_newsletter@aps.org. Opinions expressed represent the views of the individual authors and not the American Physical Society or author's employers.

Helping Students Think about Industrial Physics Careers

by John Rumble

John Rumble, current Chair-elect, and John Rodriguez of Texas Instruments shared with about 50 students from the Texas area about their experiences in career building in industry and how that relates to the new generation getting started in theirs. We would especially like to thank Dr. Rodriguez for sharing his experiences from growing up in San Antonio though his present career, and would like to thank the financial support of Texas Instruments for helping make this event possible. We also extend thanks to Heather Galloway of Texas State University and Karen Martirosyan of UTB for generously working with FIAP towards the success of this event.

The most recent FIAP effort was in mid-November at the APS Southeast Section meeting at Western Kentucky University in Bowling Green Kentucky. There were two separate events. Brad Conrad of Appalachian State University organized an Early Career Physicist with five talks about different aspects of a career in physics. John Rumble facilitated a session featuring talks by leaders at user facilities located in the Southeast, with the aim of introducing industrial physicists to accessible, high-end, research facilities located near-by. A selected number of graduate students held a special poster session targeting the commercial sector on the relevancy of their graduate work to industry.

FIAP is very interested in working with other APS Sections to help them reach out to finishing students about non-academic careers in physics. Please contact John Rumble (jumbleusa@earthlink.net) or Mark Bernius (mtbernius@yahoo.com) if you would like to discuss an industrially-targeted event at your Sectional meeting. Even better, let us know if you wish be a speaker at one of these sessions and share your experiences as an industrial physicist.

Is Industry Really a "Nontraditional" Career?

by Jefferey Hunt, Boeing Corporation

It is perhaps not a coincidence that Physics Today recently published an article discussing what happened (bad) to the physics community in the 1970s and how the professors at the University of California, Santa Barbara responded. The article's point is that the professors, doing what they had to in order to survive, created what is essentially the model for any modern academic to maintain financial viability. The point of my article (originally published in 1998) is that industrial scientists have had to follow a similar path as I outline in my article. Now, 15 years later, I think that I have the empirical evidence to back up my positions. I am still employed at Boeing, having just passed my 25th anniversary. Maybe that does not seem like much, but my colleagues who did not share my philosophies are long gone. If long term employment is of interest, perhaps a graduate student might read this and benefit.

It seems there is still a good deal of discussion and confusion regarding the sort of employment physicists can and should aspire to when seeking jobs in the nontraditional (or "industrial") sector. Are graduate students to be directed towards areas where skilled technicians are needed? Should we be encouraging universities to de-establish exotic technical areas in favor of those where jobs are plentiful? What are the special qualities that a physics background can bring to a company?

I'd like to begin with another question: when, exactly, did industrial laboratories become non-traditional? If you look back to the applied joumals in the 1940s and 1950s (and even the 1960s), most of the exciting new developments were not coming from universities or national laboratories. They were coming from companies. This included not only Bell Labs and IBM, but also Xerox,General Electric,Hughes and Varian, among others. All had R&D development within their companies, and several had separate divisions altogether. Things changed in the 1970s when companies stopped hiring, due to less than optimum economic conditions. At that time many graduating PhDs had to abandon their dreams of working in excitng research areas, and were forced to take low-paying jobs as professors. There, they spent many years toiling away in poorly equipped labs with untrained students, forced to watch the company-sponsored research labs from the sidelines. [Don't laugh, you'd be surprised how many 50-something physics professors have told me this privately] Thus, being a professor was the fallback position in a weak economy. But times change, and nowadays only failed academics are supposed to go into industry, or so some grad students and professors have informed me. Regardless, there are somethings which every grad student should know, but most professors will not tell you. I offer the following "Seven Undeniable Facts". Physicists cannot do:

- **electrical engineering as well as electrical engineers.**
- **chemical engineering as well as chemical engineers.**
- **software engineering as well as software engineers.**
- **mechanical engineering as well as mechanical engineers.**
- **optical engineering as well as optical enigineers.**
- **aeronautical engineering as well as aeronautical engineers.**
- **mathematics as well as mathematicians.**

Given these facts, why would anyone want to hire a physicist? The answer: Physicists can do 80% as well as the experts on all these tasks, whereas each of the experts' abilities goes quickly to zero once outside their disciplines. Even in my company there are engineers of many types on many tasks, but the guys at the top are disproportionately physics PhDs [Okay, there are a couple of engineers

and maybe even a chemist]. Why? Because they are the ones who can comprehend the big plcture and make sure that all the subdisciplines are exchanging the right informaton with each other.

So, am I in favor of directing the workforce away from, for example opto-electroncs and microelectromcs and toward rf and microwaves? Of course I'm not. I'm against physicists being directed to any one area of specialization. From the time you leave high school to the time you receive your doctorate will be at least a decade. Todays practical growing industry is tomorrows out-of-date technical assembly line.

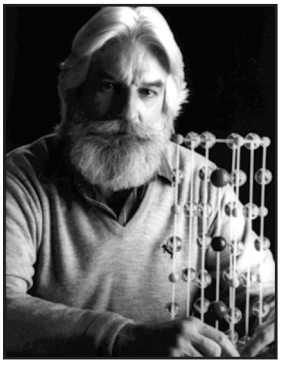
What I do favor is making graduate school what it is supposed to be: an apprenticeship at working independently. Too many students these days do experiments with equipment that is all commercially manufactured. They never learn electrical control and design; they never learn machining. These are indispensable skills in an industrial environment. If you're being paid the big bucks that industrial physicists make, you're not getting them because you only know how to work with things that already exist commercially. You're being paid to come up with new ideas and adaptations on a daily basis. This is the sort of thing you leam to do if you have a "homemade" project as a PhD dissertation. Even though your experiment may look primitive by industrial standards, the skills you learn are the same. Only the complexity changes. Put another way, the sophistication and expense of the things that don't work, increases. While in school I performed a measurement in which I (1) designed the optical system, (2) machined most of the set-up, (3) designed and built the electronics, (4) integrated the system, and (5) programmed the (simple) computer controls. And oh yeah, I conducted a neat experiment, too. The truth is, in most cases,no one will care about your thesis six months after you leave school. But the abilities you learn stay with you. Who cares if you have no rf or micro-wave experience after leaving school? A "good" PhD should be able to hit the library, read up and be able to start making contributions within a few weeks, if he knows what he is doing. Since your schooling should be concerned with making you a generalist, you should be able to come into a scenario that you don't understand at all, get the background under your belt and be able to start to contribute quickly. That is what a PhD in physics is about. It is not about whether you're an expert within some given area of specialization. This is the message that we really should be sending to faculty who are training students. The students have to do things on their own. Even if things are available commercially, they should still go out and do as much as they can from scratch. It's the thing that makes you useful and, dare I say, employable down the line.

Pake Prize Winner

The Pake Prize was endowed in 1983 by the Xerox Corporation in recognition of the outstanding achievements of George E. Pake, as a research physicist and a director of industrial research. It recognizes and encourages outstanding work by physicists combining original research accomplishments with leadership in the management of research or development in industry.

We are pleased to announce that Dale Compton of Purdue University is the 2014 winner of the Pake Prize. His citation reads: "´For exemplary leadership of corporate automotive R&D at a critical time for the industry and for important individual achievements in experimental solid state physics."

Distinguished Lectureship on the Applications of Physics



The American Physical Society's Committee on Careers and Professional Development (CCPD) and the Forum on Industrial and Applied Physics (FIAP) seek to recognize and honor physicists in industrial and other non-academic careers for their significant contributions to the advancement of physics of a technical, industrial, or entrepreneurial nature and for their demonstrated ability to give interesting and engaging lectures to both experts and non-experts.

Paul Grant has been chosen as the 2014 Distinguished Lecturer. Dr. Grant has published over 120 peer-reviewed articles during his 40 years at IBM, 11 years at the Electric Power Research Institute, and 9 years as a private consultant.

Enterprise: Physics Today's newest online department

by Charles Day

The transistors, lasers and fiber optic cables that drive modern economies were invented by physicists decades ago. What are the next revolutionary technologies to come from research labs? What companies will bring them to market?

Answers to those and other questions about the role of physics and physicists in the private sector already appear in the pages of *Physics Today*, but irregularly and spread among several editorial departments. Now *Physics Today* has a new online department, Enterprise, which greatly expands the magazine's industrial coverage.

Why have a department devoted to private-sector physics? *Physics Today's* prime directive has always been to unite the diverse community of physicists and their close professional relatives by providing news stories, feature articles and other editorial content that interest all members of the community. New departments, in print and online, must heed that directive. Given its breadth and importance, physics-related activities in the private sector more than qualify for additional, dedicated coverage.

What's more, we already know that such coverage is popular with readers. The Industrial Physicist, which AIP published from 1995 to 2004, was not financially viable, but it was an editorial success. The so-called hidden physicists who subscribed to the magazine are still among us, as are their younger counterparts who never had the chance to subscribe. Both groups can be reached online.

Although Enterprise runs the occasional opinion piece, the editorial heart of the department consists of original, freelance-written news stories that appear 2-3 times a month. The stories' scope is broad. Expect to see a report about technologies based on zinc oxide nanowires, an interview with the CEO of a major physics-based company, a profile of a new start-up, or a description of new tax R&D incentives in China.

Coverage goes beyond factory-scale industrial physics to encompass software, services and other commercial sectors. The so-called physics engines that make realistic animation possible fall within Enterprise's editorial territory, as do businesses that conduct physics-based consulting. A story about a two-person startup's first product could run alongside a story about a multinational conglomerate's latest acquisition.

You can read Enterprise articles at http://www.physicstoday.org/daily_edition/enterprise

Charles Day is *Physics Today's* online editor. He welcomes ideas for Enterprise stories from FIAP members. He can be reached at cday@aip.org .

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FIAP Program for the March APS Meeting, March 3-7, 2014

by David Seiler, NIST

The objective of this year's FIAP program is to showcase several frontiers of physics areas of interest to the industrial and applied attendees of the Society. This year FIAP is again partnering with the Corporate Associates of the American Institute of Physics (AIP) to co-organize the Industrial Physics Forum (IPF). For over 30 years, the IPF sponsored by the American Institute of Physics (AIP) has brought together research managers and decision makers from industry, academia, and government, who seek to keep abreast of the latest research affecting the industrial and applied physics community.

All FIAP invited speaker sessions form the IPF program which will

take place on Tuesday through Thursday, March 4-6, 2014 in Denver, Colorado. The FIAP/IPF program features invited-speaker sessions that are of interest to industrial and applied physics attendees and which also complement other APS sessions. Experts from many disciplines of physics discuss new advances and applications of physics that form the basis of industrial innovation.

The theme of the 2014 AIP/APS Industrial Physics Forum is Frontiers of Industrial and Applied Physics. Seven invited speaker sessions are being held (described in more detail later) on the following subjects: Half Centennial of the SQUID; Frontiers of Physics; Physics and Industrial Applications of Optoelectronics; Advances in Measurement Technology; Frontiers of Nanomaterials and Interfaces; Device Physics at the Nanoscale; and a unique interactive panel on Industrial Innovation and the Intersection Between Industry, Academia, and Government.

Invited Speaker Sessions for FIAP/Industrial Physics Forum at the 2014 March APS Meeting

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Session 1. Half Centennial of the SQUID 8 – 11 am Tuesday, March 4

Session Chairs: John Clarke, Department of Physics, University of California, Berkeley CA, Dale Van Harlingen, Department of Physics, University of Illinois at Urbana-Champaign

Session Description: What is the most widely used small scale superconducting device used today? The SQUID—with its exquisite sensitivity to magnetic field, voltage, and other physical quantities with a broad range of applications involving ultrasensitive measurements that would otherwise not be possible. The goals of this session are, first, to present a historical perspective of the origins of the SQUID, starting with two talks describing the primitive devices of the early days and tracing the development of today's modern SQUIDs and, second, to provide a broad overview of three applications of SQUIDs that have had a huge impact in advancing science.

Speakers will discuss events that led to the invention of the SQUID, describe early thin-film devices that ultimately led to today's practical SQUIDs, discuss the combination of the transition edge sensor with SQUID amplifiers to yield the world's most sensitive detector of far infrared electromagnetic radiation, present the use of high transition temperature SQUIDs in geophysical prospecting by measuring the magnetic response of the Earth's surface to a large injected current, and give an overview of the application of SQUID-based gradiometers to magnetoencephalography (MEG), the detection of tiny magnetic signals emanating from the human brain. Such sensors are installed on many telescopes around the world, with typically 1000 on a given telescope. Numerous important cosmological discoveries have been enabled by this technology. The same technology finds applications in national security.

Speakers:

Arnold Silver, Ford motor company (retired)—"Origins of the SQUIDs"

Abstract: John Lambe's accidental observation during microwave electron-nuclear double resonance experiments led to the first ob-

servation of macroscopic quantum interference in superconductors by John Lambe, Robert Jaklevic, James Mercereau, and Arnold Silver at the Ford Scientific Laboratory. This device incorporated two Josephson tunnel junctions in a thin-film superconducting ring, the "dc SQUID," acronym for Superconducting Quantum Interference Device. Further investigations by Arnold Silver and James Zimmerman produced a phenomenological model of the SQUID based on the switching of single magnetic flux quanta (h/2e) by Josephson junctions and a single junction device, the "rf SQUID."

John Clarke, UC Berkeley—"SQUIDs: Then and Now"

Abstract: Following the observation of macroscopic quantum interference in the SQUID—a superconducting ring containing two Josephson junctions—the SLUG, consisting of a blob of solder frozen around a piece of niobium wire, was used as a voltmeter with a resolution of 10 femtovolts. The extraordinary sensitivity of today's SQUIDs to magnetic flux makes possible an amazingly diverse range of applications. A quantum limited amplifier enables a search for the axion—a candidate particle for cold dark matter. An ultra sensitive magnetometer is used in magnetic resonance imaging at frequencies four orders of magnitude lower than in clinical systems.

Kent Irwin, Stanford University—"SQUID-amplified photon detection: from cosmology to material science"

Abstract: Superconducting photon detectors amplified by SQUIDs are playing an increasing role in science ranging from cosmology to materials characterization. In cosmology, they are used to measure the cosmic microwave background, resulting in new constraints on cosmological parameters, including the absolute masses of neutrino species and the possibility of additional sterile neutrinos. Very similar SQUID-amplified detectors show great promise at synchrotrons and free electron laser x-ray sources, where their combination of high x-ray spectral resolution and high efficiency enables new science.

Cathy Foley, CSIRO, Materials Science and Engineering, Sydney, Australia—"SQUIDs for mineral exploration: finding billions of dollars"

Abstract: This talk tells the story of SQUIDs in geophysics, beginning with the work of SQUID pioneers including Jim Zimmerman and John Clarke in the early 1980s. It was the discovery of high temperature superconductors, however, that drove the application of SQUIDs to mineral exploration. The subsequent development of magnetometers and gradiometers from the early 1990s—and continuing today—led to successful commercialisation by start-up companies and significant impact on the global resources industry. Some critical technical challenges that had to be overcome are described. To date, SQUID-based systems have discovered mineral deposits estimated to be worth US$6 billion.

Risto Ilmoniemi, Aalto University, Helsinki—"Magnetoencephalography: From first steps to clinical applications"

Abstract: Magnetoencephalography or MEG, the measurement of femtotesla-level magnetic fields produced by electrical signaling in the brain, became possible by the introduction of the SQUID magnetometer in the late 1960's. Today, the complete magnetic field distribution over the head can be measured with arrays consisting of hundreds of SQUIDs. Advantages of MEG include its non-invasiveness, perfect time resolution, accuracy in locating brain activity, and ease of use. Clinical applications include the characterization of epileptic activity prior to neurosurgery. Future trends point to further improvements in sensitivity and the use of the SQUIDs also for ultra-low-field MRI in hybrid measurement systems.

Session 2. Frontiers of Physics 2:30pm – 5:30pm Tuesday, March 4

Session Chair: James Hollenhorst, Agilent Technologies
mailto:Jim_hollenhorst@agilent.com
Session Description: Speakers will describe some of the latest exciting scientific challenges occurring in physics. These topics are well outside the usual focus of physics in industry, so join us for information beyond the bleeding edge of product technology. You might come away with an inspiration for your next project!

Speakers

Suzanne Staggs, Princeton University—"Probing the Last 13.8 Billion Years in the Universe with the Atacama Cosmology Telescope"

Abstract: The Atacama Cosmology Telescope (ACT) is a 6 m special purpose telescope designed to measure the cosmic microwave background (CMB) at millimeter wavelengths. ACT has an angular resolution of better than 1.4', which means it measures not only the primordial fluctuations in the CMB, but is also sensitive to the intervening universe in several ways. ACT observes from a site at 5300 m elevation in the Atacama Desert in Chile. This midlatitude site allows ACT to map regions of the sky in which there exist substantial data from surveys at other wavelengths. Cross-correlating the ACT lensing deflection field with other optical surveys in the same region is a particularly fruitful way of deriving cosmological information on the expansion history of the universe.

H. Eugene Stanley, Boston University—"The Physics of a Networked World"

Abstract: Massive power outages, global financial crashes and sudden cardiac death seem to be unrelated phenomena. However, they all could be viewed as shocks to interconnected systems, whose interdependencies create dangerous vulnerabilities. We have uncovered laws that show why everyday fluctuations in one network can trigger abrupt failures across coupled networks. Market moves that economists call "rare events" turn out to have the same statistical properties as everyday fluctuations in physical systems. Recently,

we have applied these principles to analyzing Google query data and to finding early warning signs of market changes.

Pamela G. Conrad, NASA Goddard Space Flight Center —"Exploring the Habitability Potential of Mars with Mars Science Laboratory"

Abstract: Curiosity has been roving Gale Crater since landing on Mars on August 5, 2013. The investigations that comprise the Mars Science Laboratory payload have interrogated the environment in as comprehensive an approach as has ever been attempted on the surface of another planet, using a variety of approaches to characterize both the surface materials and the atmosphere. This talk will summarize Curiosity's progress at Gale Crater.

Rupak Mahapatra, Texas A&M University—"Cryogenic Semiconductor Detectors in Search of Dark Matter"

Abstract: Dark Matter dominates the matter content in the Universe and is believed to be made up of Weakly Interacting Massive Particles (WIMP) that rarely interact with ordinary matter. Cryogenic Dark Matter Search (CDMS) has been a leader among more than 30 experiments worldwide, which are attempting to detect tiny vibrations from the recoil of WIMPs in terrestrial detectors. It uses sophisticated photo-lithographically patterned cryogenically cooled large mass Germanium and Silicon. Help from the semiconductor industry has been crucial in reducing the cost 20 fold from half-million/kg, while simultaneously improving the quality and throughput of fabrication, essential for large ton-scale experiments capable of making such a discovery possible.

Ellen Zweibel, University of Wisconsin—"The Physics of Cosmic Rays"

Abstract: Cosmic rays, mostly relativistic protons, comprise only about one billionth of interstellar particles by number, but have as much energy as the rest of the interstellar gas combined. They are probably accelerated in supernova remnants, and are confined to the Galaxy by the interstellar magnetic field. Through interacting with the field, they exchange energy and momentum with the interstellar gas, driving turbulence, outflows, and generating significant heat. An even smaller minority of cosmic rays, those with the highest energies, probably originate outside the Galaxy and challenge all existing theories of how they are accelerated.

Session 3. Physics and Industrial Applications of Optoelectronics 8am – 11am Wednesday, March 5

Session Chairs: Robert Hickernell, NIST
Steven S Rosenblum, Corning, Inc.

Session description: How important is optoelectronics? What are some of today's frontiers? Do you know that optoelectronics is pervasive in industry and society, covering a broad spectrum of applications including materials processing, optical communications, imaging, sensing, display, material science, astronomy, solar energy, security, and others? Lasers alone play a pivotal role in enabling over $6 trillion of revenue in the transportation, bio-tech/healthcare, telecom, e-commerce, and information technology sectors of the U.S. economy.

Rapid advances in optoelectronics research and development are occurring at the intersection of physics and other disciplines. The goal of this session is to highlight the range of application space with overviews and specific examples of cutting-edge optoelectronics research in industry and university laboratories. The anticipated audience of applied physicists, from students through senior scientists, should come away with an excitement for the future of the field and its potential for new discoveries that will ultimately translate into products and services which greatly improve the quality of life.

Speakers:

Alan Willner, USC—"The National Academies' Report on Optics and Photonics: The Road to a National Photonics Initiative"

Abstract: This presentation will highlight aspects of the recent report from the U.S. National Academies on Optics and Photonics. Enabling science and technology issues were discussed, as well as the past and future impact on the economy. A key recommendation of the study is the formation of a National Photonics Initiative, which has started taking shape with the crucial backing of the major professional societies.

Marin Soljacic, Massachusetts Institute of Technology—"Nanophotonic phenomena in systems of macroscopic sizes"

Abstract: Nanophotonic techniques provide unprecedented opportunities for controlling behavior of light. However, to make these techniques useful for many applications of interest (e.g., energy applications) one has to have the ability to implement nanophotonic techniques in systems of large sizes. I will present some promising novel nanophotonic phenomena, as well as some fabrication techniques to implement them on large scales.

Carmen S. Menoni, Colorado State University—"Exploring the nano-world with soft x-ray lasers"

Abstract: Bright soft x-ray laser (SXRL) beams with wavelengths in the range of 10-50 nm are enabling the implementation of imaging and patterning tools that can probe the nano-world on a table top. In this talk I will describe novel microscopies that have reached sub-50 nm spatial resolution and can: i) image dynamics at the nanoscale using single-shot flash illumination, ii) image surfaces and iii) map chemical composition in three dimensions. I will also present a SXR coherent defect-free lithography method for printing nanoscale patterns suited for sensing and plasmonics applications.

John E. Bowers and Chong Zhang, University of California, Santa Barbara—"Hybrid III-V Silicon Lasers"

Abstract: A number of important breakthroughs in the past decade have focused attention on Si as a photonic platform. We review here recent progress in this field, focusing on efforts to make lasers, amplifiers, modulators and photodetectors on or in silicon.