

## Chair's Statement

Our faculty has enjoyed another successful year with a number of awards including the *Senior Humboldt Research Award* for Professor **Hubert Saleur** and the *General Education Teaching Award* for Professor **Stephan Haas** (please see page 3 for more details). I am also happy to share with you the latest honor that I received from the *Chinese American Faculty Association* of Southern California as the recipient of its *Distinguished Service Award* this year. In addition, our congratulation goes to Professor **Krzysztof Pilch** for his promotion to Full Professor (see the story on page 5). We are also very close to the conclusion of a high profile senior faculty hiring in a research area which depends intimately on the most advanced high performance parallel computing technology.

Thanks to **Ty Buxman**, Director of the Undergraduate Affairs Office, our technical staff, and a few dedicated faculty, we have successfully concluded our effort, started four years ago, to upgrade our undergraduate laboratory facilities. The Instructional Demonstration Laboratory has also enjoyed its unprecedented success of achieving our goal to integrate the state-of-the-art technology into a multi-media instructional environment, thanks to the hard work of **David Mehrania**. Our congratulation also goes to **Lisa Swanson** for her promotion as the coordinator of the departmental administrative staff.

In this newsletter, you will find the second part of the narrative on the history of the department put together by **Margo Burrows**. Last, but not the least, I wish to thank those of you have contributed generously to the department. Please stay in touch by writing me at [tnchang@usc.edu](mailto:tnchang@usc.edu) or call me at (213) 740-1133. ♦

### **Faculty News...**

Professor **Tu-nan Chang**, Chair of the Department, has been invited to serve as a member of the *Scientific Advisory Committee* for the Theoretical Physics Division at the Center for Theoretical Sciences in Hsinchu, Taiwan. He is also a member of the *Advisory Committee* for the University of Science and Technology of China at Hefei in China. ♦

## DEPARTMENT THANKS DONORS

*The Department of Physics and Astronomy  
would like to thank the following  
individuals for their generous support:*

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## THEN AND NOW...

### 1920 - 1940

We've decided to chronicle our department's history since the inception of the University of Southern California to the present day and share it with our alumni and friends in our bi-annual newsletters. No narrative has existed prior to this and we feel it's important to recognize those who have come before us in order for us to fully appreciate and understand where we are today and hope to go in the future.

In our Fall 2001 Physics and Astronomy Newsletter, we examined the first forty years (1879 - 1920) of our department's history. This second installment looks at the years from 1920 through 1940. I've used many sources, among them the notes from Professor Arthur W. Nye, course catalogues, and the book "Southern California and its University" by Servin and Wilson.

*Any errors or misinterpretations contained within are mine alone. - Margo Burrows*

The 1920's was a truly exciting period in physics. Albert Einstein won the Nobel Prize in Physics in 1921 for his services to Theoretical Physics, and especially for his discovery of the photoelectric effect. In 1925, a 23 year old German physicist, Werner Heisenberg, developed what has been called the greatest achievement in the history of physics; the development of quantum mechanics. Dr. Heisenberg was awarded the Nobel Prize for his work in 1932.

In 1921, the University of Southern California Physics Department (having separated from the Electrical Engineering Department in 1919) was under the leadership of **Arthur W. Nye**. Tuition ran \$75 plus a four dollar physics lab fee. The Department offered the following courses:

#### LOWER DIVISION COURSES

- 1ab. General Elementary Physics.** A course intended for those who have not studied high school physics. Lectures, recitations, demonstrations and laboratory exercises dealing with the principles and applications of physics.
- 1abL.** General laboratory courses to accompany 1ab.
- 2. Mechanics.** Lectures and recitations.
- 3L. Mechanics.** Laboratory course.
- 4. Heat.** Lectures and recitations.
- 5L. Heat.** Laboratory course.
- 6. Electricity.** Lectures and recitations.
- 7L. Electricity.** Laboratory course.
- 8. Light.** Lectures and recitations.

**9L. Light.** Laboratory course.

**Note - Courses 2 to 9, inclusive, require a knowledge of high school physics and trigonometry. They are recommended for students pursuing scientific or technical studies. In the laboratory courses, instruction sheets prepared by the department are the basis for the work. The experimental work performed by the students is similar to that described in Millikan's "Mechanics, Molecular Physics and Heat" and Miller's "Laboratory Physics". Courses 3 and 5 may be taken coincidentally, half of the time being spent on each, and half credit received. The same is true of Courses 7 and 9.**

**16. Applied Electricity.** A course in the principles and applications of electricity.

**17L. Physical Measurements.** Laboratory course to accompany 16.

**50ab. Pre-Medical Physics.** A course similar to General Elementary Physics but adapted especially for those preparing for the study of medicine.

**50abL.** A laboratory course to accompany 50ab.

#### UPPER DIVISION COURSES

**102. Analytical Mechanics.**

**107L. Electrical Measurements.** A laboratory course in which the theory and methods of exact electrical determination are taken up, including the determination of resistance by various methods, galvanometer constants, the measurements of current and electromotive force, insulation tests, hysteresis and permeability tests, the calibration of instruments, etc.

**108. Physical Optics.** Study of theories of refraction and reflection, diffraction, interference, polarization, relativity, electron theory, etc.

**109L. Advanced Light Laboratory.** To accompany course 108.

**110. Sound.** General principles, theory of vowel sounds, construction of musical instruments, architectural acoustics.

**111L. Physical Measurements.** To accompany course 110.

**112. Photometry and Illumination.** A study is made of the physiological and physical phenomena of artificial illumination, methods of measurement, types of photometers, types of illuminants and their characteristics, reflectors, and the principles of interior and street illumination.

**113L. Photometry.** A laboratory course to accompany course 112.

**114. Geometrical Optics.** Study of lenses, mirrors and prisms. Optical systems. Aberrations. Design of optical instruments, especially military instruments used in gun-fire control.

**116. Physics of the Air.** A course of lectures, recitations and demonstrations dealing with atmospheric temperature phenomena, composition, and circulation; hygrometry; storms; electrical phenomena; elementary atmospheric optics; and factors of climatic control.

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## Professor Hubert Saleur Receives Humboldt Award

Professor **Hubert Saleur** is the recipient of the *Senior Humboldt Research Award*. This award is given to outstanding and internationally recognized scholars and honors their academic lifetime achievements. Award winners are invited to carry out research projects of their own choice in Germany in cooperation with German colleagues.

The *Alexander von Humboldt Foundation* (<http://www.avh.de>) was established after the death of Alexander von Humboldt in Berlin in 1860. At that time, its aim was to sponsor research travel abroad by German scholars. After loss of the Foundation's capital in 1923, it was re-established in 1925, with its focus shifting to assisting non-German scholars in undertaking postgraduate studies in Germany. After the collapse of the Third Reich in 1945, the Foundation ceased its activities.

At the urging of former Humboldt researchers, the Foundation was re-established by the Federal Republic of Germany in 1953 with its headquarters in Bonn-Bad Godesberg. It is a non-profit organization whose goal is to promote international research cooperation through an active world-wide network of scholars. Over 20,000 individuals from 125 countries have been sponsored by the Foundation. Past Humboldt Research Award recipients from the USC Department of Physics and Astronomy include **Kazumi Maki** and **Robert Hellwarth**.

Dr. Saleur works at the interface between High Energy Physics and Condensed Matter Physics, and is mostly interested in non-perturbative properties. His recent work concerns strongly correlated electronic systems, in particular transport in the presence of charge fractionalization and spin charge separation. He intends to visit Germany during the academic year 2002-2003 and work with colleagues in Freiburg, Stuttgart, Düsseldorf and Hannover on several topics ranging from quantum dots to field theories for disordered electronic systems.

The Department congratulates Dr. Saleur on receiving this honor and wishes him continued success. ♦

## Professor Stephan Haas Receives Award

The General Education Teaching Award was presented to Professor **Stephan Haas** at a holiday reception on December 4th, at the Davidson Conference Center. The award is presented annually by the *College of Letters, Arts and Sciences* to recognize faculty contributions to the General Education Program during the preceding Fall through Spring academic year. Award winners are selected based on the student comments on evaluation forms, course syllabi and evidence of rigorous grading. Prior General Education Award recipients from the Department of Physics and Astronomy include **Gene Bickers**, **Werner Däppen**, **Nick Warner** and **Ed Rhodes**.

Professor Haas taught *Physics 100*, an introductory course designed specifically for non-science majors who have little or no background in science or mathematics. One of the primary goals of the course is to introduce the students to the most important and useful concepts of physics. Another is to expose the class to new ways of thinking about things that arouse curiosity.

"Teaching a large group of students who all have such varied science backgrounds is quite challenging," Dr. Haas said. "Some students begin with negative feelings toward physics, while others may consider pursuing it. My goal is to find a balance that will keep the group as a whole involved - and interested."

Comments on student evaluation forms demonstrate the high regard students have for Professor Haas. They include; "He was extremely entertaining and made the class fun. He always took the time to explain hard concepts and came up with interesting demonstrations to apply physics concepts." "He is probably the best GE professor I have ever had." "I think that Stephan Haas is the best teacher I've had at this school." "He made this potentially dreadful subject quite fun." "He was incredibly enthusiastic and engaging about the subject. He is able to make students who don't like science be interested in it." "If all professors were as smart and interesting as Prof. Haas, USC students would be a lot better off."

The Department joins with the College in congratulating Professor Haas. His exceptional instructional skills, indefatigable enthusiasm and ability to inspire students unite to make him an outstanding professor. ♦

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## GRADUATE COURSES

- 206. Teachers' Course.** Lectures and discussions of methods of presenting and teaching various parts of Physics; and the equipment and management of the laboratory.
- 216. Advanced Electrical Theory.** A course dealing with modern theories of electricity and the structure of matter.
- 218. Ions, Electrons, and Radiations.** A course dealing with vacuum tube phenomena, ionization and allied topics.
- 219L.** Laboratory course to accompany course 218.

For a major, thirty units in physics, of which six could be in engineering were required. Minor work necessitated twelve units, including at least two units of upper division. To acquire a high school teacher's certificate, the candidate must have completed the equivalent of a major and, in addition, eight units of advanced work, including course 206. He must also have demonstrated his ability to pursue methods of thinking and experimenting, which were in accord with modern scientific investigation.

In 1921, **George F. Bovard**, the fourth President of the University of Southern California, suffered a severe health crisis and was unable to continue his presidency. He asked that the board look for his successor. The board appointed their second choice, **Rufus von KleinSmid**, then President of the University of Arizona. He was offered a house, moving expenses, and the unheard of sum of \$8,500 in salary.

Although USC was southern California's largest institution, and the state's second largest, the University was plagued by seemingly insurmountable problems. The most obvious was the lack of physical space. President von KleinSmid embarked on a building program. He erected nine buildings between 1921 and 1931, including the new Science Building. In 1928, the Physics Department moved to the Science Building from the Old College, which had been home since 1907. Despite the Great Depression, the President and the board grandiosely celebrated the semicentennial of the founding of the University, dedicating four buildings and the Trojan shrine (Tommy Trojan).

President von KleinSmid also devoted much of his time to the integration and reorganization of the University. By 1923 he had incorporated Music, Pharmacy, Oratory and Law as integral parts of the institution. On the recommendation of the dean, **Rockwell D. Hunt**, the Graduate School was reorganized in 1923. All graduate work in the University, regardless of department or school, was supervised by the renamed *Graduate School of the University*. The following year, recognizing that a great need for doctoral work existed in the Southland, the University was the first institution in southern California to implement the granting of the Ph.D. degree in qualified areas.



*Science Unit*

Dr. **Arthur W. Nye** was the Chairman of the Department throughout the 1920's - 1930's. In 1928, when space in the new Science Building was occupied, a program in optometry was initiated in a sub-department called *Physics-Optics*. Doctors Hutchinson, Jones and Scown were engaged in the work in optometry. However, the financial depression and the opposition of the American Medical Association caused this work in optometry to be abandoned in 1933. In 1928 - 1929, the Physics Department taught a course in Sound for the *Academy of Motion Picture Arts and Sciences*. Approximately 800 employees of various technical laboratories of the motion picture industry attended.

By 1930, there were two Assistant Professors working with Dr. Nye; Loren T. Clark and Fay Wilson. Finley Neal was an instructor. Tuition for the *College of Letters, Arts and Sciences* was now \$290. The Department had added the following course work:

- 101ab. Physiologic Optics.** The eye as an optical mechanism. Image formation; light, form, and color perception; direct and indirect vision; monocular and binocular perception of depth; relationship of accommodation and convergence; visual acuity; emmetropia, hypermetropia, myopia, and astigmatia; orthophoria, heterophoria, heterotropia or strabismus.
- 102. Selected Topics in Optics.** The application of certain optical theories and phenomena to the design and operation of optical devices. Characteristics and operation of optical instruments; optical glass; lens forms; selective absorption and transmission; sources and phenomena of radiation; polarization; diffraction.
- 126. Radio-Electricity.** An advanced course in the principles and theorems of electricity, with particular attention to their application to radio communication. *Two units; second semester. Neal*

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## PILCH PROMOTED TO FULL PROFESSOR

Dr. **Krzysztof Pilch** has been promoted to Full Professor in the Department of Physics and Astronomy. He has contributed much to both the Department and the University. He currently serves on the Departmental Graduate Committee as Chair and on the Qualifying and Screening Exams Committee. He has also worked on the Faculty Committee on Tenure and Privileges Appeals, and the LAS Faculty Council.

Dr. Pilch was born in Wroclaw, Poland. He attended liceum ogólnokształcące in Wroclaw, a high school with an extended curriculum in mathematics and science. He doesn't remember a time when physics didn't interest him - he's always been fascinated by the application of mathematics to physics.

From the liceum he went on to the *University of Wroclaw* where he received his M.S. Theoretical Physics in 1979 and then joined the graduate program there. In 1980, he also started teaching, first as an asystent (lecturer) and then adiunkt (senior lecturer).

Dr. Pilch made his first trip to the United States on his birthday in 1981, shortly before the declaration of marshall law in Poland. For one year he visited the Institute for Theoretical Physics at *Stony Brook* on an exchange program between SUNY and the University of Wroclaw. "This was a crucial year for my scientific and personal development," he believes.

At the end of his stay, in the summer of 1982, he spent a month in Berkeley and then for two weeks traveled back to the East Coast on a Greyhound bus. He remembers his first encounter with Los Angeles during this trip; "One very hot evening, after spending most of the day on a beach in Santa Barbara I took a bus to Los Angeles. It brought me to the downtown Greyhound Bus depot. I thought of spending a night somewhere nearby, however, after getting there and walking around the block, I immediately boarded the first available bus due East."

While at Stony Brook, he was invited with a group of Polish scholars for dinner at the residence of Dr. **John Marburger**, who was then-president of SUNY and a former chair of the Department of Physics at USC. "That was probably the first time that I heard about USC," he said.

After one year back in Wroclaw, where he received his Ph.D. in 1983, Dr. Pilch returned to Stony Brook for three years as a post-doctoral fellow and then continued his postdoctoral work at *MIT* in Cambridge, Massachusetts, where he also worked as an instructor in Applied Mathematics.

Dr. Pilch joined the faculty at USC as an Assistant Professor in 1989. He was not only attracted to USC, but also by the southern

California area, which by then he knew quite well from short visits to Caltech. "However," he said, "the main reason for deciding to come to USC was the dynamic and burgeoning **High Energy Physics** group comprised of Drs. **Bars**, **Nemeschansky** and **Romans**. They were working on various topics in string theory, which were very close to my own interests. I was also very impressed by the strong support for their area of research from the Department and the College administration. This was something quite unique at that time, which made USC very special."

Dr. Pilch has taught various levels of courses since his arrival at USC. This semester, he is teaching an advanced graduate level course on selected topics in string theory and field theory related to the so-called AdS/CFT correspondence. He finds he is most effective teaching in a small class setting and admires those who can capture attention of an audience two hundred strong.

Krzysztof's research interests are in string theory and related mathematics. Recently, he has been working on the AdS/CFT correspondence, which provides new deep insights into the relation between string theory and quantum field theory. In this work, he has been collaborating with Dr. **Warner**, another string theorist who joined the Department in 1990.

According to Dr. Pilch, the past few years have been a very exciting period for string theory as a whole field, and for the USC string theory group in particular. In 1995 the group organized Strings '95, the main annual meeting in string theory with close to 300 participants. This meeting, entitled "*Future Perspectives in String Theory*," was a turning point for the field and started what is now called a "second string theory revolution."

In the Fall 1999, string theory groups at Caltech and USC have joined forces and, with a generous support of administrations of both institutions, created the Caltech-USC *Center for Theoretical Physics*. "This brought research activities in string theory in the Los Angeles area to a new level and made us one of the premier string theory centers in the world."

Krzysztof is married to Marianna Chodorowska-Pilch who is also Polish. She received her Ph.D. from USC in 1998 and is now a visiting lecturer in the Department of Spanish and Portuguese. They have a 3 year old daughter, Elena. Marianna and Krzysztof enjoy travelling, entertaining friends and, obviously, spending as much time as possible with Elena. They regularly visit Poland and spend time with their families there.

We congratulate Dr. Pilch on his promotion to Full Professor. His presence enhances the prestige of USC on a worldwide scale and we are honored to have him as part of our superior faculty. ♦

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- 128. History of Physics and Physical Sciences.** Considers contributions of the most important physicists from the social, political, and philosophical points of view. *Two units; second semester. Neal*
- 133. Thermodynamics.** Fundamental laws of thermodynamics and their application to heat engineering; gases, saturated and superheated vapors. *Two units; second semester. Nye*
- 150. Selected Topics in Modern and Advanced Physics.** Consideration of molecular and electron theories, theories of atomic structure, photoelectricity, spectroscopy, positive rays, X-rays, radio-activity, physical therapy, and kindred topics. *Two units; first semester. Neal*
- 160. Elementary Photography.** (Developing, Enlarging and Reducing.) This course considers camera construction, use and performance; exposure; developing; copying; enlarging and reducing; fixation; reversal; intensification; and kindred topics. *Two units; first semester.*
- 161L. Advanced Photography.** (Printing, Still Photography, Retouching, and Splicing.) This course considers sensitometry; printing and toning; use of color screens; color photography; use of cameras for special purposes; motion picture technique; projection; and allied topics. *Two units; second semester.*

GRADUATE COURSES

- 214. Kinetic Theory.** An introduction to the method of statistical mechanics as used in the derivation of relations between various gas and liquid constants. *Two units; second semester. Neal*
- 216. Seminar.** Advanced study in various fields of investigation in Physics. The topics considered will vary from year to year. Papers, reviews of current literature, discussions of recent problems. *Two units; first semester, repeated second.*
- 220. Research.** Open to students who wish to work out an experimental or theoretical investigation or who wish to learn laboratory technique as a preparation for thesis work. If the investigation leads to results which are acceptable as a thesis, credit will be shifted to the latter and the corresponding course credits cancelled. *One to four units; first semester, repeated second.*
- 230. Spectroscopy and Atomic Structure.** Lecture and demonstration course dealing with theory of radiation and propagation of light; spectroscopic apparatus and experimental methods; production and analysis of spectra; spectral series and atomic structure. *Two units; first semester. Nye*
- 261ab. Thesis Work.** Required of applicants for the master's degree, in conformity with general requirements. *Four units. Credit on satisfactory completion of thesis.*

In 1923, three men received the first Master Degrees in Physics from USC. By 1929, ten others had graduated with Masters Degrees, including our department's first woman M.S. recipient. During the 1930's, twenty-eight Masters were earned.

In 1935, our first Ph.D. was awarded. **George Llewellyn Shue** had his final exam on Tuesday, September 10, 1935 at 1:30 p.m. in the Presidents Room in the *Doheny Memorial Library*. The committee in charge were Professors Vollrath, Chairman, Arthur Nye, L.D. Roberts, Steed and Gurney. Dr. Shue's dissertation was entitled *Earth Resistivity Measurement and Its Application to Layer Problems*. There were no others Ph.D.'s awarded during the 1920's or 1930's.



*President Franklin Delano Roosevelt was awarded an honorary Doctor of Laws degree on the steps of Bovard Hall in October of 1935, by then-president Rufus B. von KleinSmid (left) in academic robes. Three thousand Trojans gathered on the lawns in front of the Administration building for the ceremony.*

By the end of the 1920's, President von KleinSmid had changed USC from a denominational institution governed by Methodists to a large secular university. USC had attained full national accreditation by this time, as well as established a graduate school to unify graduate work throughout the university. However, even with these changes the high moral tradition that the University was founded on continued.

The *Handbook of the University of Southern California for 1930-1931*, describe the traditions that must be observed at the University.

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# NANOCLUSTERS

by Professor Vitaly Kresin

Atomic nanoclusters occupy the range intermediate between small molecules and bulk matter. A cluster is an aggregate of identical atoms  $A_n$ , or a set of atoms (e.g.,  $A_nB_m$ ). The number of atoms  $n$  ranges, roughly speaking, from a few to tens of thousands, spanning particle dimensions from a few angstroms up to several tens of nanometers.

Until the early 1980's, most cluster research focused on ensembles of particles produced by evaporating a small amount of the desired material and condensing the vapor on a substrate or capturing it in a matrix. Such samples did manifest a variety of interesting effects related to the particles' smallness, but they suffered from unavoidable wide distribution of particle sizes and from strong but poorly understood particle-substrate interactions. In order to follow cluster evolution in detail, it was imperative to be able to focus on the intrinsic properties of a particle of well-defined size.

This goal was realized with the advent of molecular beam techniques for the study of clusters. Bulk material is vaporized (in a hot oven, by laser ablation or sputtering by a fast ion beam, etc.) and expands through a very small nozzle into vacuum, condensing and forming a beam of clusters. Cluster beam formation is often facilitated by entrapping the expanding vapor in a flow of inert "carrier" gas. In this way, free clusters of almost any chemical element or compound can be produced. The idea is relatively straightforward, but practical cluster beam sources require careful construction, precise control over temperature, alignment, timing, pressure, vacuum, etc., and a fair amount of "black magic" (alternatively known as "operational experience"). For example, depending on the application, beam nozzles vary in diameter from several

microns ( $0.001'' = 25 \mu\text{m}$ ) to a millimeter or so, and in temperature from less than 10 to over 2000 Kelvin.

Particle size is determined by passing the beam through a mass spectrometer. By tuning the spectrometer to progressively higher masses, it becomes possible to study continuous sequences of clusters literally atom by atom. The upper limit of the sequence is set by the range - and cost - of the mass spectrometer; free clusters with as many as 20,000 atoms have been produced and mass-selected. The types of mass spectrometers employed include quadrupole-field, time-of-flight, and magnetic-sector designs.

Thus, in cluster science the size  $n$  of the particle becomes a new physical variable. By following the step-by-step evolution of cluster properties one can map out the transition from molecular to solid-state behavior. In addition, nanoclusters display interesting and useful size-dependent properties of their own. The ability to follow the evolution of a little chunk of matter as it grows atom by atom is both novel and attractive.

This research field is fundamentally interdisciplinary. It is of interest to condensed-matter physicists and to physical chemists, to researchers in surface science, in microelectronics, and in materials science. It has attracted a lot of attention from nuclear physicists, who have a lot of experience in dealing with finite systems, and from atomic physicists (clusters and nanostructures are sometimes nicknamed "artificial atoms"); furthermore, there are similarities between electrons trapped in a cluster and atoms confined to an atomic trap). It is interesting as well as challenging to hold discussions with people of diverse

scientific backgrounds. A great deal of progress has come out of this, as well as many heated disagreements fueled by scientific "cultural differences."

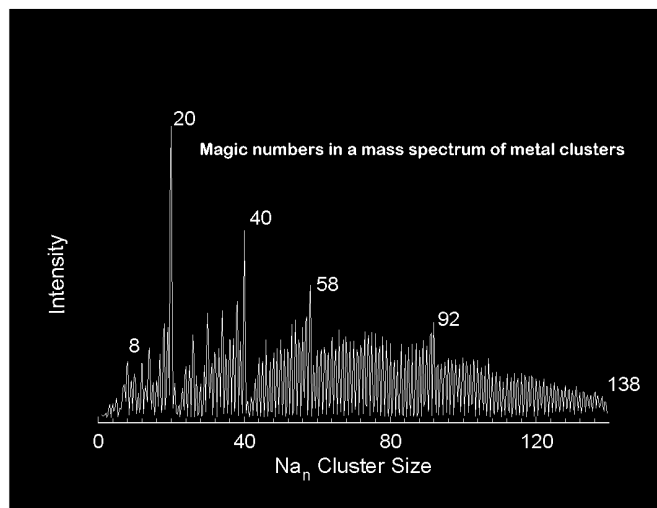
It should be noted that many common points are becoming apparent between the studies of finite clusters and those of semiconductor nanostructures and quantum dots, single-electron tunneling contacts, and other confined systems operating in the so-called "quantum size regime." Advances in microfabrication and lithography techniques have resulted in nanostructure research beginning to approach from above the size range that cluster science has been reaching from below. It has been predicted that within the next one or two decades commercial electronics will be forced to go down to manufacturing scales where atomic-size precision will matter. Another area of enormous economic importance is that of catalytic and chemical activity of clusters, which has been found to be very high as well as strongly size-dependent.

While, as described above, it is now possible to produce clusters of a variety of sizes and materials, the same cannot yet be said about our ability to interpret their behavior. The situation is different from that in solid-state physics where metals, insulators, and semiconductors can be understood from a unified point of view. Thus, for describing the behavior of, say, noble gas clusters one appeals to models quite different from those for metal clusters. There are both theoretical and practical reasons for this predicament. From the experimental point of view, our control over, and knowledge of, the internal state and structure of clusters are still limited. On the theoretical side, the situation reflects both the diversity of chemical bonding and our still incom-

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plete understanding of it. Nevertheless, within some specific cluster families it has become possible to formulate “unified viewpoints” which are very successful at explaining a wide body of experimental data. This represents a dramatic shift from the earlier days when clusters were regarded as either individual overgrown molecules or small chunks of bulk materials.



In particular, the family of “simple metal clusters” is a category which has developed a solid conceptual foundation and given rise to a variety of fundamental questions. This family includes such materials as the alkalis, aluminum, copper, etc. In the bulk, these form so-called nearly-free electron metals. It is found that the outer-shell valence electrons leave their parent atoms and form a delocalized sea of conduction electrons. Their interaction with the lattice of the remaining ion cores is relatively weak and often can be taken into account as a residual perturbation.

It turns out that when just “a handful” of atoms of these elements form a cluster, the same phenomenon occurs: the atoms lose their weakly bound valence electrons which then form a delocalized cloud. There is thus a strong analogy with the physics of atoms and nuclei, in that we are dealing with a finite-sized system of identical Fermi particles. As in those cases, the energy levels of valence electrons in metal clusters organize into shells. In clusters this shell structure is not washed out by temperature or surface effects and leads to observable consequences. This phenomenon is referred to as the quantum size effect.

Clusters with closed energy shells of delocalized electrons (e.g., those with 8, 20, 40... valence electrons) possess spherical symmetry and are especially stable; clusters with open shells find it energetically favorable to acquire distorted shapes. A clear manifestation of this was discovered in the mass spectra of cluster beams. Closed-shell metal clusters, known as “magic number”

clusters, are dramatically more abundant than their neighbors. This effect has by now been seen in mass spectra extending to hundreds and even thousands of atoms. Cluster properties as diverse as abundances, cohesive energies, ionization potentials, photoelectron spectra, fission patterns and optical properties and polarizabilities can be understood and analyzed on the basis of the picture of a delocalized valence electron cloud exhibiting shell structure.

Much of the current research in our group at USC is dedicated to achieving a deeper understanding of the behavior of electrons in metal nanoclusters. For example, when a cluster is placed in an external field, the electron cloud will be displaced, resulting in the cluster becoming “polarized.” G. Tikhonov’s recent thesis was dedicated to an accurate determination of the polarizability of sodium clusters. This was done by passing a highly collimated beam between a closely-spaced pair of electrodes with a 40-kV voltage applied to them and measuring the resulting tiny displacement of the beam. Currently, this experiment is being extended by M. Medvetzkiy. Clusters will also become polarized if they are approached by an external charge, such as an electron. It turns out that if this electron is sufficiently slow, it can become trapped by the cluster. In a way, the electron becomes captured by its own image charge. The dissertation work of V. Kasperovich proved that such a phenomenon does occur and studied it in detail. Currently, R. Rabinovich is setting up a new project whose aim will be to investigate the ultimate fate of these captured electrons. We are also looking at the photoelectric effect in clusters: K. Wong is writing his thesis on the ionization yield of alkali nanoclusters as a function of photon energy and cluster temperature. We hope to extend this work to different cluster sizes and to the phenomenon of surface collisional ionization.

In the past several years another fascinating nanoparticle system has begun to attract a great deal of interest: jets of very cold superfluid helium droplets. We have a new collaborative research project in this field, but this is a subject for another story. ♦

## FORMER DEAN CONFIRMED

**John Marburger III**, past dean of the *College of Letters, Arts and Sciences* and currently head of Brookhaven National Laboratory, has been confirmed by the U.S. Senate for the position of *White House Science Advisor*. In the 1970’s, Marburger was a professor of Physics and Electrical Engineering at USC and served as Chairman of the Physics Department before becoming Dean of LAS. In 1980, Marburger became President of State University of New York, Stony Brook. For detailed information, please see *The Chronicle Of Higher Education*, pages A22 - A24, February 8, 2002 issue. ♦

## SENIOR LABORATORIES UPDATED

Our Senior Laboratories have undergone many changes and upgrades throughout the years. Professor **Melvin Daybell** (Emeritus) was the Director of the Senior Laboratory from 1987 through 1998. In 1998, Professor **Gerd Bergmann** took over and since 1999, has shared the duty with Professor **Chris Gould**.

In speaking of his predecessor, Dr. Bergmann had only the highest praise. "After taking over the laboratory, I developed an even higher admiration for Melvin Daybell. Lacking monies or any additional resources, he was running a top-notch lab by scrounging for equipment and visiting a lot of flea markets! What he had established was an excellent starting point." Dr. Bergmann went on to explain that in order to create many of the experiments, Dr. Daybell found it necessary to acquire many pieces of otherwise useless equipment to build a workable experiment. Additionally, over the years many scientists donated old equipment to the senior lab, where it was picked over for parts and then warehoused.

In 1999, when Dr. Bergmann and Mr. Ty Buxman, Director of Undergraduate Affairs, decided that improvements were imperative, they began the Herculean task of clearing out the laboratory by discarding unusable, outdated and defective equipment. Their efforts took several years and many steps to reduce the inventory. Dr. Bergmann said, "I still feel guilty about throwing away so much of the old stuff. It was extremely difficult to make the choices that needed to be made."

Many of the experiments that Professor Daybell designed are still in use. *Magnetic Breaking* - which illustrates the effects of magnetic induction; *Debye Specific Heat* - the specific heat of metals in the temperature range of 77 to 290 Kelvin. (Dr. Bergmann has made slight modifications since Dr. Daybell's time); and *Electron Diffraction*. Dr. Bergmann has added the *Cavendish Experiment* - the measurement of the gravitational constant which determines the motion of heavenly masses; *Velocity of Light* - which measures the speed of light with a five percent accuracy; *Mechanical Linear Chain* - resonance modes of a Linear Chain of coupled masses can be determined using the driving frequency and a Fourier transform of the displacement of a single mass. Two

new chaos experiments have been developed as computer simulations. The *Rigid Rotor* which is accompanied by a small experimental set-up to demonstrate the inverted pendulum and the *Histogram*. Dr. Gould has erected the *Millikan Oil Drop Experiment* - a classic experiment measuring the charge of the electron. He is also developing a Digital Signal Processing module. For more detailed information on individual experiments, please visit our web site at <http://physics.usc.edu/Classes/492/Lab/>.

As part of the equipment upgrade process, the Department utilized its regular laboratory budget plus special funding from the College to increase and upgrade the computers in the laboratory as well as acquire new optical equipment, which was necessary for the *Velocity of Light* and the *Cavendish Experiment*. Also added were power supplies, mechanical oscillators, and Digital Signal Processing hardware.

For the *Velocity of Light* experiment, in particular, the laboratory's physical space needed to be modified as that experiment requires a dark room with approximately 24 meters for light to travel. After creating the dark room, a small hole was cut in an adjoining wall to accommodate the light path distance. The dark room and optics equipment will also be useful for other experiments in the laboratory which are enhanced in low light.

Undergraduate Physics majors are required to take two semesters of Senior Labs to fulfill graduation requirements. Astronomy majors must take at least one. Beginning Fall 2001, our graduate program also added a requirement that all graduate students must set-up, perform and complete one experiment in the senior laboratory during their first year of study. This gives the student a brief introduction in learning to deal with experimental equipment along with giving them a feeling for the real physical world.

Laboratory work is an essential skill for many physicists. It adds a breadth and depth to the understanding of the principles that is not available through theoretical work alone. The Department is proud of our laboratory course offerings and is constantly striving to improve them. ♦

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**TRADITIONS:**

The real Trojan Spirit is shown by every student on the campus of the University of Southern California - both by Freshmen and upperclassmen - in their observance, respect, reverence of the mighty traditions that have been handed down from year to year as the most sacred things of Troy.

**ALL-UNIVERSITY TRADITIONS** (*A partial list*)

All students rise when Dr. von KleinSmid or Dr. George Finley Bovard are introduced.

Seniors challenge the faculty to a baseball game just before the final "exams."

Seniors only wear sombreros; Juniors and Seniors may wear "cords."

All students are expected to know the University songs. The "hello and smile spirit" is observed throughout the year.

All students observe a spirit of honor.

There is no "queening" at football contests.

The Vice-President of the Student Body is hostess at all Homecoming affairs.

Chapel services are held every day in the week at twelve o'clock.

**FRESHMAN TRADITIONS** (*A partial list*)

The Freshmen wear a certain type of hat...

The Freshmen women wear a green armband above the elbow on the left arm...

The Freshmen attend Chapel every day and sit in the balconies only.

The Freshmen always carry their Freshmen Bible while on campus.

By 1939, the Physics Department had expanded its course offerings. Dr. Nye was still the head (and would remain so until 1940 - retiring in 1948), Dr. R. E. Vollrath, who had joined the faculty in 1931 was an Associate Professor, L.T. Clark an Assistant Professor, and J. M. Aitchison an instructor. Tuition was \$302 and the total enrollment for the *College of Letters, Arts, and Sciences* was 1,562 (862 men and 700 women). University-wide enrollment was 16,924. The course catalogue from 1939 describes some of the new Physics offerings:

- 100. **Introduction to Modern Physics.** Consideration of molecular and electronic phenomena; phenomena of atomic structure, photoelectricity, spectroscopy, positive rays, X-rays, radioactivity, physical therapy, and kindred topics.
- 104. **Scientific Measuring Instruments.** Various types of measuring instruments and devices, used in many fields of science and technology. Instruments to measure time intervals,

viscosity, surface tension, and other properties of matter; temperature, flow, insulation, radiation, noise, electrical quantities; optical instruments.

- 140. **Introduction to Television.** Historical introduction. The study of direct and alternating currents of television work. Electric oscillations. The thermionic vacuum tube and its applications. The methods and problems of television. Mechanical and electrical devices used in television. The optical problems of television. Color vision.
- 141L. **Television, Telephotography, and Picture Broadcasting.** Historical introduction; current developments; future problems. Theory of electric oscillations. Superposition of waves. Filter circuits. Scanning and synchronization. The photoelectric cell. The gas ionization tubes and cathode ray tube. Sending and receiving picture impulses. The cathode ray sender and receiver. Generation of sawtooth oscillations and of oscillations of any desired shape. Broadcasting of events and motions pictures.
- 152. **Physics of Vacuum Tubes.** Passage of electricity through gases at various vacua; causes and effects of ionization; thermionic emission; characteristics of vacuum tubes; study of light production and atomic structure as revealed in vacuum tube phenomena.
- 232. **Atomic and Molecular Physics.** Advanced study of atomic, molecular, and subatomic phenomena. Attention is given to molecular structure, polar molecules, mechanism of chemical reactions, nuclear structure, radioactivity, photoelectric phenomena, thermionics, crystal analysis, photochemistry.

During this twenty year period, the University of Southern California matured into a true non-denominational, nationally recognized and respected university. The Physics Department also expanded to meet the challenge of providing quality instruction for its students as well as continuing its development into an excellent research facility.

In 2001, we had 17 students graduate from the Department of Physics and Astronomy. Five graduated with their Bachelor Degrees in Physics and one B.S. in Biophysics. Two Master Degrees in Physics and one M.S. Physics for Business were earned. Our Ph.D. program continues to grow and attract high caliber students. There were eight graduates who were awarded their Ph.D. in Physics from the Department last year.

Currently, the Department faculty areas of interest fall within six primary areas. The **Elementary Particle Physics** group work chiefly out of the *Center for Theoretical Physics* which was formed jointly with the California Institute of Technology (complete article in the *Spring 2000 Department Newsletter*). The members of this dynamic group include Professors Itzhak Bars, Chiara Nappi, Den-

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## CLASSNOTES

## 1960's

**GEORGE STROBEL**

**Ph.D. Physics '65**, devotes time to finding genes of pneumocystis, a yeast, that the yeast cell can't live without the gene functioning. These are called essential genes. They are identified by base pair sequence comparisons (BLAST searches via computer) with two other yeasts, *sacchromyces* and *S. pombe*, for which the cell function of their genes is known. Assuming the same gene has the same function in two different yeast cells, one can identify the gene function of a gene in pneumocystis from comparison and matches to these other yeast genes. Statistics show this is valid in about 98% of the matches, where a gene's function in a cell is known in both yeasts. The goal is to find genes in pneumocystis that are essential to the cell, but which have no similarity to any human gene. Such genes are candidates for drug treatment to kill pneumocystis in situ (the human lung). About two dozen of such genes have currently been found. Pneumocystis causes pneumonia, the most common cause of death in AIDS patients.

## 1970's

**JACKIE ALAN GIULIANO**

**B.A. Astronomy '77**, will have his book, *Healing Our World: A Journey from the Darkness into the Light*, published this spring by XLIBRIS. The book is based on his weekly environmental commentary series for the Environment News Service (<http://www.ens-news.com>). For more information, check out Jackie's website at <http://www.healingourworld.com>. Jackie and his wife Bonnie, have a son, Justin who will be one year old this May. Jackie is caring for Justin full-time and teaching part time at North Seattle Community College and for the University of Phoenix. His wife, Bonnie, is a psychologist.

**TERRENCE LOMHEIM**

**M.A. Physics '76, Ph.D. Physics '78**, The International Society for Optical Engineering will honor 25 new Fellows of the Society at its 47th Annual Meeting this summer. Fellows are members of distinction who have made significant scientific and technical contributions in the fields of optics, photonics, and imaging.

"The annual recognition of Fellows provides an opportunity for us to acknowledge outstanding members for their service to the general optics community," said James Harrington, SPIE President. The Fellows Committee selected Terrence Lomheim to be honored.

Terrence Lomheim, Distinguished Engineer at The Aerospace Corporation, was selected for his achievements in the areas of electro-optical sensors and visible and infrared imaging system analysis. Lomheim has been a leader in the transition from discrete to focal plane array based systems and has developed imaging spectrometers and data analysis techniques unique to satellite applications in the visible and infrared multi-spectral imagers for the military sector. The Aerospace Corp. awarded Lomheim the President's Award in Engineering in 1985, and in 1994 he won the NASA Public Service Group Achievement Award for work on the Hubble Space Telescope Independent Test Review Panel. He has been a session chair for many SPIE conferences including "Infrared Imaging Systems: Design Analysis, Modeling, and Testing" for eight straight years and has taught numerous short courses for SPIE, UCLA and UCSB extension. Lomheim was a recent member of the SPIE Education Committee. He has authored and co-authored 33 papers in the areas of focal plane technology, imaging sensor performance, and applied optics. Lomheim received a B.A. in Physics from California State University, Fullerton in 1973, and an M.A. and Ph.D. in Physics from the University of Southern California. He is also a part-time instructor for the Physics Department at the California State University, Dominguez Hills.

## 1980's

**SHIN-TSON WU**

**Ph.D. Physics '81**, for the latest news on what he's up to, please visit his website at <http://lcd.creol.ucf.edu>. Also, the *University of Central Florida Report* wrote a recent article featuring Dr. Wu and his work. You may see it at <http://www.news.ucf.edu/FY2001-02/020319b.html>.

## 1990's

**BING AI**

**Ph.D. Physics '95**, is at the San Diego office of the intellectual property law firm of Fish & Richardson P.C. He's been working full-time while going through a JD evening program at the University of San Diego. He will graduate with a Juris Doctor Degree in May.

Bing's older son, Stephen, is in kindergarten and is anxiously looking forward to becoming a big boy when he turns six in May. His little brother, Michael, who is two years younger, has officially become the family expert on reptiles and prehistoric animals.

**ERIC WILSON**

**B.S. Astronomy '96**, received his Ph.D. in Atmospheric and Space Sciences at the University of Michigan last October, 2001, focusing on the photochemical modeling of Titan's atmosphere and ionosphere. He is currently finishing up the submitting of papers associated with his dissertation to peer-reviewed journals and will be working at JPL beginning in June as a National Research Council research associate.

## 2000's

**STEFAN WESSEL**

**Ph.D. Physics '01**, is a post doctoral fellow at the Swiss Federal Institute of Technology in Zurich, Switzerland. He is conducting research in the field of strongly correlated electronic systems and unconventional superconductivity in the group of Professor M. Sigrist and Professor T. M. Rice. He enjoys visiting Los Angeles occasionally for continued collaborations with Professor Stephan Haas at USC.

nis Nemeschansky, Krzysztof Pilch, Hubert Saluer and Nicholas Warner. Their main emphasis is on superstring theory, black holes and related topics.

Professors Werner Däppen and Edward Rhodes make up the **Astronomy** group. They work primarily in helioseismology. This work includes both developing foundational theory for understanding experiments as well as data acquisition and reduction principally at the 60-foot solar tower on Mt. Wilson (see *Fall 2001 Department Newsletter* for more information).

Work in the **Space Science Center** is focused in both laboratory and space based investigations of photoabsorption and emission processes in atomic and molecular gasses in the spectral region from the extreme ultraviolet through the infrared. Members of the group include Professors Melvin Daybell (Emeritus), Darrell Judge, Research Professor Robert Wu and Research Scientists Pradip Gangopadhyay, Howard Ogawa and Geraldine Peters.

The **Laser Physics** group has attained national and international prominence during the past decade for its work involving applications of lasers and basic laser studies. Professors Jack Feinberg, Martin Gundersen and Robert Hellwarth are members.

Professors Tu-nan Chang, Maxim Olshanii, Robin Shakeshaft and Howard Taylor are members of the **Atomic and Molecular Physics** group. They are concerned primarily with various aspects of the interaction of the electromagnetic radiation with matter as well as atomic and molecular collisions.

The **Condensed Matter Physics** group is currently investigating a range of topics, including the superfluidity of  $^3\text{He}$ , electron transport at low temperatures, two-dimensional inversion layers in semiconductors, semiconductor physics and semiconductor device properties at low temperatures, magnetism at ultralow temperatures, electromagnetic properties of superconductors, and physics of nanoclusters. Members include Professors Gerd Bergmann, Gene Bickers, Hans Bozler, Christopher Gould, Stephan Haas, Vitaly Kresin, Anupam Madhukar, Kazumi Maki and Richard Thompson.

Since 1921, the Department has experienced many changes, however, much in the core curriculum from those early beginnings have remained fairly constant. **Arthur W. Nye** was the driving force of the Department from 1920 through 1940. His dedication and quest for excellence set the bar for all who have followed. Thank you for your part in making *USC Department of Physics and Astronomy* a strong and significant force in the world of physics. ♦