PHYSICS CWRU

Department of Physics Case Western Reserve University **June 2007**

Greetings to alums and friends of the CWRU physics department. Many significant developments have taken place at the University since our last newsletter which was mailed in the summer of 2005. That issue was called PHYSICS CASE. This issue's title reverts to the earlier form: PHYSICS CWRU. The change is, in a way, symbolic of a time of transition characterized by the appointment of a new president, a new dean, and a new chairman.

As he announced in that last edition, Lawrence Krauss stepped down as our chairman after successfully serving in that position for twelve years. Cyrus Taylor took over as chair in mid-2005.

In a fast-moving upper-level rearrangement, four deans decided to step down soon after the departure of President Edward Hundert in the spring of 2006. Among these was Arts and Sciences Dean Mark Turner who chose to return to teaching and research. To ensure continuity in the academic programs and in ongoing alumni relations, Cyrus Taylor was quickly appointed "interim dean" of the College. Phil Taylor then stepped up to serve as associate chair of the physics department.

It soon became clear that Cyrus is the right person for the position of dean, and in December 2006 Cyrus formally took over the leadership of the College. At about the same time, the Board of Trustees announced the appointment of a new president: Barbara Snyder. With a new president and a new dean in place, the physics department quickly turned to the task of selecting a new chair.

*We are pleased to report that **Dan Akerib** has agreed to serve as our new leader. Dan, who completed his PhD at Princeton in 1991, has led the CWRU cold dark matter search team since joining the department in 1996. Here is his first message to our alums and friends:*

The mission of our undergrad physics program has several facets: to teach all our students how science is done; to provide engineering and pre-med students with an understanding of the role that physics plays in their disciplines; and to offer our physics majors the best preparation possible for advanced studies and careers. Vital to the success of our physics major program is the availability of state of the art laboratory equipment. Our physics major teaching labs have, for many years, benefited from the generosity of our alums. Your gifts have made it possible for us to provide exciting learning experiences for our majors. We hope that you will take advantage of the enclosed donation envelope to help keep our teaching programs exciting and timely.

Thanks on behalf of the department, and especially, of our students.

Message from Dan Akerib, our New Chair

Dear friends and alumni,

I'd like to extend my warmest greetings as the chair of the physics department. I was deeply honored to be recommended by my faculty colleagues to take this new post, which I do with a deep sense of the history and strengths of the department. As I'm sure you know, the department has enjoyed a thrilling resurgence in the last decade, which included a renovation of the Rockefeller building, the hiring of some ten new faculty, an overhaul in the undergraduate and graduate programs, and many other steps forward. These accomplishments have been recognized in several ways, including many prestigious awards and research grants to our faculty, the success of our students, and most recently by the 2005 "Faculty Scholarly Productivity Index" (see page 4, "In the Top Ten Percent") that ranked our department **16th of 172 nationwide!** With

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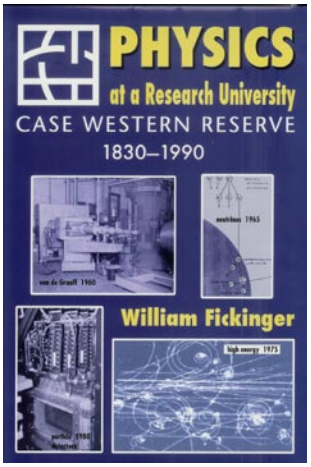
Our World Year of Physics

As we described in the last issue, the year 2005 was designated the **"World Year of Physics"**, marking the centennial of Einstein's *annus mirabilis*. The CWRU contribution to this world-wide celebration included a remarkable event which packed Severance Hall. Chaired by Ira Flatow of NPR, the program featured four talks and a round-table discussion on the impact of Einstein's genius on many aspects of today's world. Joining Lawrence Krauss were Walter Isaacson, former CEO of CNN; Harold Varmus, former director of NIH; and Nobel laureate Frank Wilczek of MIT.

Our Own History

In the spring of 2006, a copy of **Bill Fickinger's** newly published history of the department was sent to each physics alum for whom we have a domestic address. This was made possible through a generous gift from alumnus



Sherwood Fawcett, Case PhD 1950. The book traces the physics research done at Reserve, Case and CWRU from the 1830's to the 1990's, topped off with a final chapter which describes ongoing work. The narrative takes the reader through the major accomplishments in theory and experiment of over a hundred faculty members. Appendices include lists of students and titles of graduate theses. Explanations of how and why the research was done are written for the general reader with an interest in the history of science. Emails from alums, former faculty and their families, have been most enthusiastic. The book, *Physics at a Research University: Case Western Reserve 1830-1990*, is available at amazon.com.

Overheard in the Miller Room (possibly)

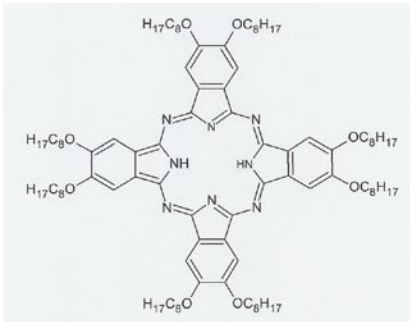
After the condensed matter seminar was over, **Jie Shan** turned to her colleague, **Ken Singer**, and asked, "Ken, could I borrow some of that 2, 3, 9, 10, 16, 17, 23, 24-octakis(octyloxy)-29H, 31H-phthalocyanine? I'd like to check out its terahertz conductivity."

Ken smiled and said. "Sure, Jie. My group has been looking at how those disk-shaped molecules stack up into nano fibers. They are fascinating. It's almost like the way that biological molecules spontaneously self-assemble into long chains. So far, we have been able to stack these 2 nm-wide flat molecules into microns-long nano-fibers".

"Yes", Jie answered, "That's the type of sample I want to study. I think there is a strong possibility that with their quasi-one-dimensional molecular arrangement, they might have interesting transport properties. It may be possible to create nano-structures with all kinds of special photo-physical properties."

"What type of measurements do you plan to make, Jie?"

"I want to measure their transient conductivity. I plan to shake loose some electrons with a 50 femtosecond optical pulse, and then measure how the electrons migrate along the fiber as we probe the structure with terahertz radiation. We need that sort of information to know how these quantum materials can respond to external stimuli."



2, 3, 9… cyanine

"Good idea. We'll prepare some samples for you. I'll give you a call when they are ready."

"Thanks, Ken. More tea?"

MESSAGE FROM DAN AKERIB

Continued from page 1

the support of the new administration, and the members of our larger community, we hope to build further on these achievements. The generous support of our alumni has always been extremely important to the success of our teaching program. I look forward to hearing from you, and welcome your news, your visits, and your continued involvement in the department.

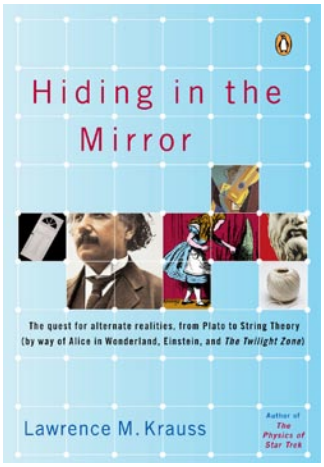
Sincerely,
Dan Akerib

Lawrence

In the 18 months since turning over the physics chair to Cyrus Taylor, **Lawrence Krauss** has even increased his efforts to bring physics related issues to the public through books, lectures, and, probably most important, through op-ed pieces and letters to major publications. High among his agenda is the battle to ensure that publicly supported science courses convey scientific information, unsullied by the introduction of faith-based elements.

The most recent in Krauss's series of books, designed to explain the latest advances in physics and cosmology theory, carries the title *Hiding in the Mirror: The Mysterious Allure of Extra Dimensions from Plato to String Theory and Beyond.* In it, Lawrence explores the possible existence of extra dimensions in space and their impact on the observable universe. In addition, he presents arguments on both sides of the current controversy whether familiar building blocks like quarks and electrons are indeed manifestations of even more fundamental entities known as strings.

Lawrence's special talents in taking physics to the people have led to his election as chair of the Forum on Physics and Society. This ever more important branch of the American Physical Society addresses physics-related social issues such as global warming, arms control, and energy policy. In parallel with his contributions in the political arena, Lawrence will be active in promoting physics education as the newly elected chair of the physics section of the American Association for the Advancement of Science.

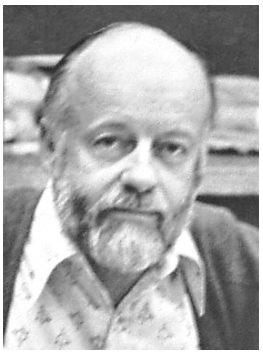


Krauss's latest

Lawrence continues at CWRU as the director of the Center for Education and Research in Cosmology and Astrophysics. Highlight of CERCA's program this past year was an extraordinary meeting which took place in the spring of 2006 in the Virgin Islands. Krauss, Starkman, Ruhl, and Vachaspati joined other experts in a weeklong exchange of ideas titled "Confronting Gravity: A workshop to explore fundamental questions in physics and cosmology." Among the 21 world-renowned participants were luminaries Stephen Hawking, Gerardus 'tHooft, David Gross, Frank Wilczek, and Alan Guth.

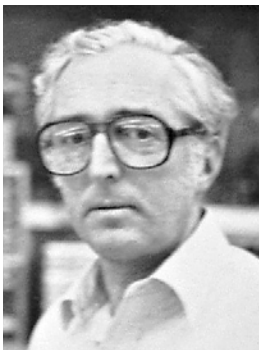
Although officially on sabbatical at Vanderbilt University, Lawrence returned briefly to Cleveland on a *cultural* mission, one on which he was able to smuggle an astronomy lesson into Severance Hall. In a program with the Cleveland Orchestra, he acted as narrator for Gustaf Holst's suite, *The Planets*. Accompanied by projected NASA movies and animations of planetary fly-bys, Lawrence introduced the music lovers to fascinating descriptions of each of the planets and many of their moons, providing the audience with a visual scientific backdrop to Holst's magnificent music.

Glenn Frye and Tom Jenkins: two old friends


Glenn Frye

An important era in the history of our department sadly came to a close this year with the deaths of our colleagues **Glenn Frye** and **Tom Jenkins**. Both of these experimentalists joined the Case Tech department in 1960. Glenn created a program in cosmic ray physics, while Tom worked with Case chair Fred Reines in the study of rare nuclear and neutrino interactions.

Glenn Frye was an expert in the design and construction of detectors of high energy cosmic electrons, neutrons and gamma rays. The special challenge was to create apparatus which was robust and independent enough to hang from a balloon which would travel hundreds of miles through the atmosphere at heights of 30 miles or more. Glenn and his team launched their detectors from Texas, Australia, and Panama, chasing the balloons to their landings to recover the precious data recorders. Their most exciting results were the first observations of high energy gamma rays coming from two known pulsars.


Tom Jenkins

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In the Top Ten Percent

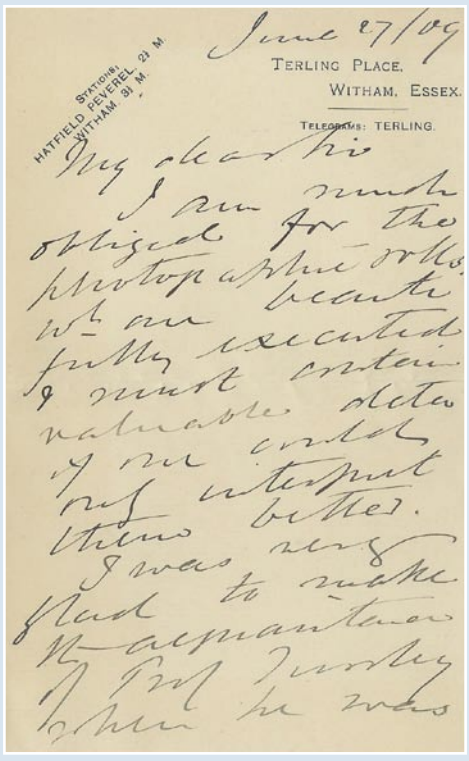
In a new and creative type of survey, devised by an organization called Academic Analytics, the CWRU Physics Department ranks 16th among the 172 PhD granting institutions in the United States. A new metric, called the "Faculty Scholarly Productivity" index, measures the annual productivity of individual faculty based on several factors, including publications (books and journal articles), citations, federal research funding, and awards and honors. A departmental score is then computed on a per faculty basis. From the Academic Analytics website: *The FSP analysis creates, at the discipline level, a scale based on the cumulative scoring of a program's faculty using these measures compared against national standards. By compiling the individual faculty activity into departmental indexes, one can truly assess the research strength of a university.*" The FSP-based standard for measuring doctoral programs, along with its reception by academe, was described in a recent edition of *The Chronicle of Higher Education*.

CWRU Physics in the World of Imaging

A new career track for our Ph.D. students began in 1991, when Mike Martens finished his thesis in industrial MRI physics with **Bob Brown** and **Mark Haacke** as his co-advisers. Mike was followed by 17 more CWRU graduate students and postgraduate fellows who have worked with Bob on imaging research. By now, these former team members make up a major leadership wing in applied physics, with nine senior staff industrial scientists, three physics and radiology professors, three CEO's, and two fresh postdoctoral fellows. The recent opportunities for these trainees have included Harvard, Yale, and NIH fellowship offers, ownership shares in new companies, and spirited competition for their services amongst the leading OEM's in imaging. The remarkable success of this program ensures that it will continue to provide attractive opportunities for our students. And as for Mike Martens? As one of the few physics students in the country educated in applied magnetics, after multiple offers from the top accelerator laboratories, Mike presently has a leadership role in the design of the next generation of particle colliders.

Old Stuff

You might enjoy looking at a couple of websites which feature old letters and apparatus found around Rockefeller. One site, created by 2006 grad, Brian Tinker, includes photos, videos, and explanations of 16 pieces of equipment, most of which were used between 1890 and 1920 by Dayton Miller in his musical acoustics research. The second site presents four dozen old letters which were miraculously preserved, first by Miller, then by Shankland, then Benade and Gordon. The PDF files are scans of the handwritten letters, along with more easily read transcriptions. How about an 1881 letter recommending that Case should move quickly to hire Michelson? Check out the notes to Miller from no less than Lords Kelvin and Rayleigh. Look at this 1909 example of Lord R's handwriting to see if you can decipher it! Links to both of these sites can be found at www.phys.case.edu/history.



Rayleigh to Miller

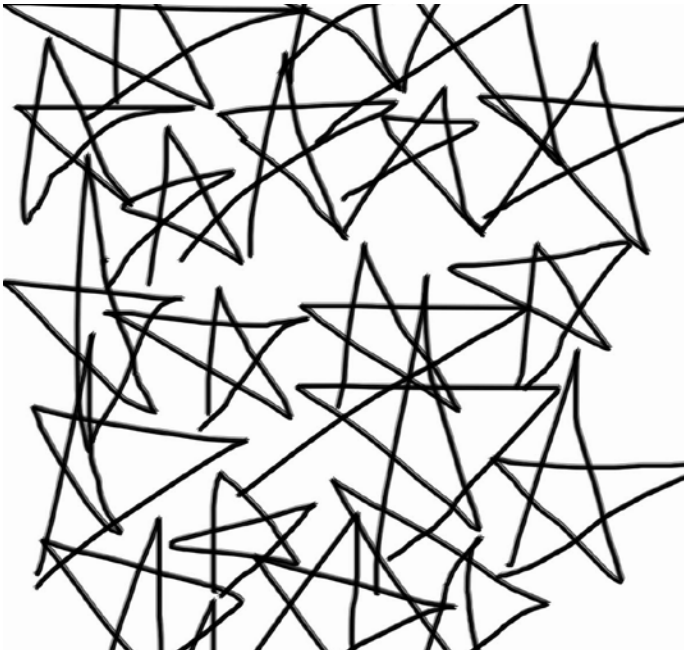
Fabulous Fractals

It's probably been a long time since the work of a graduate student was reported in the New York Times, USA Today and the Plain Dealer, and it's not happened in living memory that one of our graduate students was the speaker at the Thursday physics colloquium. But last semester doctoral student **Katherine Jones-Smith** managed both. She and **Prof. Harsh Mathur** had just published in *Nature* a critique of a claim that the hand-poured drip paintings by Jackson Pollock consist of patterns which satisfy the criteria for fractals.

What criteria?, you might ask. Cover the painting with a grid of square boxes with side L. Count the number of boxes, N, which contain some paint. Decrease the size of the boxes, and count again. For a fractal pattern, a plot of ln N vs. ln L will be a straight line; that is N is proportional to L^D, with the "fractal dimension" D, a non-integer. A less techy description is an image in which the same pattern appears at ever smaller scales, as seen in snow flakes and mountain ranges.

Over the past ten years, a physics prof at the University of Oregon has made quite a name for himself in the art world by declaring that he has found fractal behavior in the paintings of Jackson Pollock.

Why does it matter if Pollock poured fractals? Well, if you found in your closet a few paintings which might be worth millions of dollars (one recently sold for $140M), and if they could be authenticated by determining their *fractal-ness*, you might run to the fractal expert for authentication. At least that's what was done when a fellow in New York found in the attic a few dozen paintings which might very well be JP's.



50¢ or 50M?

Well, the expert said, 'sorry, not JP's'. Rather disappointing. Along comes Jones-Smith, who just wanted to learn something about detecting fractal behavior. She discovers that the Oregonian's criteria were much too loose, and that his authentication method probably needs some authentication. In fact, Jones-Smith whipped up a little drawing of some stars, and applied the prescribed tests, and found that her drawing did as well as any JP. Anyway, she and Harsh Mathur told the world about it in an article in Nature and got the art world buzzing. Maybe if the new-found paintings turn out to be authentic, the lucky finder could donate one to CWRU for a new physics building, or two? Keep tuned.

Norman Tien, physicist, engineer, dean

In July 2006, **Norman Tien** was named Ohio Eminent Scholar in Physics at CWRU. This program was established by the Ohio Board of Regents in order to attract outstanding academic researchers to the state, particularly educators who will contribute to the growth of technology and industry. For the past year, Tien has held a professorship in the physics department while also chairing the department of electrical engineering and computer science. In January of 2007, he was appointed Dean of the Case School of Engineering. As dean, he will continue to promote research and teaching collaborations between the science and engineering departments. His personal research interests center on micro- and nanotechnology, which have strong connections with the research done by physicists Ken Singer, Kathy Kash, and Jie Shan.

The Missing Nine Tenths

If you believe Newton's Theory of Gravity, then you'll have to believe in WIMPS, or at least in some sort of massive stuff which anchors all those spinning galaxies out there. Yes, the observed rotation rates indicate that some 90% of the mass is invisible. The proposed missing matter is particles with masses like nuclei and interactions like neutrinos, that is, Weakly Interacting Massive Particles. We are all flying through this sea of stuff and if we are clever enough, we might catch sight of a few collisions, just as our former chairman, Fred Reines, was able to record neutrino collisions in the 1950's.

This time around, Dan Akerib and his group, as part of an eleven institution collaborative effort (the Cryogenic Dark Matter Search – CDMS II), have developed detectors sensitive enough to catch a WIMP. Trivial, you might say, all you have to do is watch for a little ionization and a little heating in a piece of material. You have to measure both if you want to separate the WIMP signals from the pesky electron background. To reduce the background, you'd best take your detector to a deep mine (as Reines did), and to see the expected temperature rise of a few microKelvin, you have to cool your detector to 50 milliKelvins. This is where the CWRU group's high-tech low-temp know-how comes in.

Detectors consisting of 0.25 g of germanium and 100 g of silicon, have been set up 2200 feet below ground in the Soudan Underground Laboratory in Minnesota. A 2006 Phys. Rev. Letter reports the results of 6 months of running: "No WIMP signal exceeding expected backgrounds was observed. When combined with our previous results from Soudan, the 90% C.L. upper limit on the spin-independent WIMP-nucleon cross section is 1.6×10^{-43} cm^2 from Ge and 3×10^{-42} cm^2 from Si, for a WIMP mass of 60 GeV/c^2". That is, the WIMPs have thus far avoided detection. But here is the important part of the abstract: "The combined limit from Ge and Si … constrains predictions of supersymmetric models."; i.e. current theoretical extensions of the Standard Model predict WIMP cross-sections comparable with the measured lower limits, and if new data to be collected in 2007 put even lower limits on the interaction rate, then CDMS II will send the theorists back to their blackboards.

Undergrad news from Gary Chottiner

So many physics major tracks

A quick count of the 2007 and 2008 classes shows that we have students in a variety of major tracks:17 students are working on a physics BS, 16 on an engineering physics BS, 6 on a math & physics BS, 4 BA, and one each on biophysics, astronomy-physics, and BA in teaching.

More research opportunities

An outstanding feature of our undergraduate physics program has long been the opportunity for our majors to participate in academic research, not merely as observers, but as team members. To do this, students have often become paid lab employees. But the number of such career-forming positions has generally not met the demand, being limited by available research funding. At the request of our current majors, we've now implemented a new mechanism that will allow more students to participate in physics research in a meaningful way. The department has created an elective course, *PHYS 390 Undergraduate Research in Physics,* for which students can receive academic credit. The new course is distinct from the required senior project courses and from paid positions in the research labs. A student can sign up for PHYS 390 alone, or combine it with either or both of the other research opportunities. The department's Senior Project Committee will oversee PHYS 390. It is charged with insuring that students who enroll in this course have a well-defined and significant learning experience that is worthy of the academic credit they will receive.

SAGES Continues to Evolve

for freshmen: For years, **Phil Taylor** taught a popular multidisciplinary course called "Energy and Society". Certainly this course was far ahead of its time. Starting in 2005, Taylor modified the course so it could be offered to freshman as a First Seminar in the SAGES (Seminar Approach to General Education) program. This past fall, two other physics faculty members (**Gary Chottiner** and **John Ruhl**) started teaching their own sections of this seminar course using their own syllabi. All three sections were filled to capacity – or over.

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Newsclips

Diana Driscoll, a recent CWRU PhD who has stayed on in the department to become a favorite teacher of our undergrad courses, has received one of seven "Top Prof Awards" from the Mortar Board National College Senior Honor Society Case chapter.

John Ruhl and **Glenn Starkman** have both been elected Fellow of the American Physical Society: John "for his fundamental experimental contributions to the study of the cosmic microwave background radiation." and Glenn "for his wide-ranging and creative contributions to particle astrophysics, including explorations of the possibility of non-trivial topology in the universe, and uncovering unexpected features in the cosmic microwave background fluctuations at large angular scales."

Alex Bolozhdnaya, senior research associate who has worked with both Tom Shutt's and Dan Akerib's groups on particle detector design, is co-author of a new book titled "Noble Gas Detectors", published by Wiley.

Physics for Jocks

"Drain three pointers, slam dunk easily, and sink that buzzer beater from half court with the help of simple science. Your coach, physicist **John J. Fontanella**, shows how you can improve your game if you take advice from Isaac Newton." That's how the Johns Hopkins University Press website hawks its new book, "The Physics of Basketball", written by a former PhD student of **Don Schuele**. Fontanella, who played basketball in college and studied elastic and dielectric properties of materials at CWRU, has taught and done materials research since 1971 as a member of the faculty of the Naval Academy in Annapolis. Check out his book and then take your kids out to the backyard and show them how important physics is.

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UNDERGRAD NEWS

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and for upperclassmen: The department has created two new courses as part of the SAGES program. All students, starting with the class of 2009, must take a SAGES Departmental Seminar during their junior or senior year. These seminars are meant to give students an introduction to communication, writing, speaking, etc. within the discipline. As with many other University initiatives, the Physics Department was ahead of the curve. For several years, we've split off an hour per week of "Junior Lab" and "Senior Project" and had the students gather to discuss professional concerns. These have ranged from error and data analysis to ethics, writing papers, giving oral and poster presentations, preparing proposals, graduate school, jobs, professional organizations, peer review, physics and society, and everything else that one might expect to encounter during a career as a physicist. We've now formalized these meetings as "Advanced Laboratory Physics Seminar", and "Senior Physics Project Seminar".
You can check out the great variety of senior project topics currently being pursued by our majors by going to www.phys.cwru.edu/undergrad and follow the link to undergrad research and then down to "senior projects 2006".

FRYE AND JENKINS

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Tom Jenkins also was a master designer of particle detectors, beginning with his neutrino work with Reines. When the Case and WRU departments were joined in 1967, Tom put together a group to perform accelerator-based particle physics experiments, starting with the construction of a large detector array to study pi meson production at Argonne National Lab in Illinois.

In the 1980's, the Frye and Jenkins groups joined forces to create a large, high-resolution multi-wire gamma-ray telescope for balloon flights launched from Australia.

The research pioneered by our two colleagues marked the beginning of a long history of cosmic ray research at CWRU. Forty years later, teams lead by Corbin Covault and John Ruhl would continue in the footsteps of Glenn and Tom, keeping the department among the world leaders in observational astrophysics.

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Lucy + Angie – Four score and then some

Any one who studied and worked in Rockefeller during the past forty years or so will remember fondly our two new *secretaries emeritae*, Lucy Rosenberg and Angie Amato. Both of these faithful and indispensable dispensers of forms and purchase orders and postage stamps and ditto machine copies and departmental news and friendly advice have decided to retire to less demanding surroundings. Four decades worth of CWRU physics students, staff and faculty join in wishing Lucy and Angie thanks, health, and a happy retirement.

Don Schuele Retires

Fifty years after arriving at Case Tech to begin his doctoral studies, **Don Schuele** has announced his retirement from the department. Don was a student of Chuck Smith, doing his research on the thermal properties of rubidium iodide. He continued the study of the mechanical, thermal and electrical properties of materials after joining the faculty in 1963. Don directed the work of ten PhD students whose research contributed to the understanding of crystals, semiconductors, alloys, dielectrics and polymers. In the early 1990's, Schuele joined Bill Gordon in a study of the dielectric properties of polymer liquid crystals. Throughout his long career at CIT/CWRU, including three years as department chair and subsequently as dean of science and engineering, Don has been a strong and innovative supporter of the Case Alumni Association, an interest which he plans to maintain in the coming years. In fact, Don has arranged to maintain his lab and to continue an active research program.

Chandra Drops By

This spring we were delighted to welcome back **B. S. Chandrasekhar** (Chandra for us old-timers), who presented a colloquium: "Low Temperature Physics and Physicists Six Decades Ago". Chandra was one of the pioneers in the department's low temperature research, having joined the Western Reserve department in 1963. He predicted, and then was the first to observe, oscillatory magnetostriction. It is hard to believe that it is 20 years since Chandra moved to Germany where he has continued research and writing. His talk described "what the field looked like more than half a century ago: what was known, who knew it and looked for more, how they did it."

PHYSICS CWRU

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