THE CALIFORNIA TECH

The Ultimate Tech

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Dr. John Schwarz, a professor of theoretical physics pioneered the application of superstrings to unified field theory. —photo by Kent Noble

Superstrings and a Unified Field Theory

The following is an abridged version of an article that appeared in the November 1985 issue of Science '85 *under the title "Completing Einstein."*

by John Schwarz

In the second decade of this century, Albert Einstein put forward a new theory of gravity that was revolutionary in its approach. His general theory of relativity described the physics of gravity in terms of geometry: it said that the Earth is attracted to the sun because the mass of the sun distorts, or curves, the local geometry of space.

Now our understanding of gravity is again in need of revision. This time the struggle is to integrate gravity with quantum mechanics, the basic theory governing how matter— particularly subatomic matter— behaves. Indeed, the attempt to revise the theory of gravity is part of an effort to unify all of the known fundamental forces of nature into a single unified field theory. The newest approach, which seems to many physicists to hold hope for success, is one that, like Einstein's general theory of relativity, is inherently geometrical.

A basic tenet of the new theory, known as superstring theory, states that the universe has not just three spatial dimensions, but nine. This may have a science-fiction ring to it, but it is nonetheless a perfectly sensible possibility in the context of a quantum superstring theory. In fact, superstring theory frees physicists from some of the absurdities that conventional approaches imposed on them. Essentially, the new theory allows them to make fewer arbitrary assumptions when seeking the answers to some basic question. For that reason, and because of avenues it opens up, the new theory has captured the attention of some of the best minds in physics.

Extensive experimental studies

continued on page 3

Sunney Chan Wins Travel Award

[CNB]— Sunney I. Chan, professor of chemical physics and biophysical chemistry at Caltech, has received the 1986 John Navas Foreign Travel Award, which annually honors a Caltech faculty member for outstanding dedication to the welfare and education of students. The presentation was made on Monday, February 3, by Dr. Rochus Vogt, Caltech vice president and provost. The award consists of $4,000 in unrestricted travel funds, which Dr. Chan will use to visit Scandinavia this summer with his family.

The Navas Award was established in 1982 through a gift from John Navas, founder and president of Fittings That Fit, Inc., in Alhambra. He has created a similar award at his alma mater, MIT, and at Culver Military Academy in Culver, Indiana.

This year's Navas Award recognizes Dr. Chan for his commitment to enhancing the quality of personal and academic life for Caltech students. Dr. Chan served as master of student houses at the Institute from 1980 to 1983 and is currently chairman of an ad hoc faculty committee to review academic requirements for undergraduates.

A South Pasadena resident, Dr. Chan was appointed professor of chemical physics in 1968, five years after he joined the Caltech faculty, and was executive officer for chemistry from 1978 to 1980. His research focuses on the structure and function of proteins in the cell that convert the chemical energy in food into biological energy that the body can utilize.

The Future of Art History

by Doug Gray

Rumor has it that art history at Caltech is about to become a thing of the past because Professor Marty Ward and BaxArt Director Jay Belloli are leaving at the end of this year. According to Humanities Executive Officer Robert Rosenstone, the rumors have some basis in fact, but art history courses will continue to be offered after this year.

Dr. Ward was hired in 1981, when the HSS division was planning to build an art history group of three or four professors. Then, when Robbie Vogt became provost in 1983, he announced an institute-wide hiring freeze (i.e. a freeze on the creation of new positions in any division, not on the hiring of new faculty). Dr. Ward was the only professor of art history, and the administration announced in early 1984 that tenure in art history would no longer be offered. Ward's contract was extended by an extra year, and it expires in June.

Also in 1984, President Goldberger decided to close Baxter Art Gallery, thereby eliminating Belloli's position as director. His contract was also extended, by a year and a half, and it expires in December.

Ward and Belloli are survived by Robert Wark, part-time lecturer and curator of the Huntington Art Gallery. He has taught courses on British art since 1961.

The elimination of Ward's and Belloli's positions came to the dismay of most of the HSS division and many others on campus, but all is not lost for the students. The division is recommending a new art history program taught by part-

continued on page 6

IBM Lavishes $1,000,000 on Tech

[CNB]— Promising new faculty research ventures and science education for college and high school students will be among the efforts funded by a $1 million grant to the California Institute of Technology from IBM.

"This grant helps meet some of the most vital needs of Caltech," said Caltech President Marvin L. Goldberger in announcing the funding. "For example, a portion of the grant will be used to establish the IBM Research Fund to support research initiatives by both new and established faculty. These funds are absolutely necessary if we are to attempt untried research approaches that would not normally be supported by traditional sources." According to Dr. Goldberger, the IBM Research Fund will also be used to bring outstanding young scholars to the Institute as visitors.

In addition, the IBM grant will help support two innovative efforts by Caltech to educate young scientists and engineers. One is the Summer Undergraduate Research Fellowship (SURF) program, in which Caltech students devise research projects and, sponsored by faculty advisers, carry them out during the summer. This program, established in 1979, has helped hundreds of Caltech students to get a taste of professional-level scientific research while still undergraduates. IBM has helped support the SURF program since 1982.

The other program aided by the IBM grant will be the Institute's Secondary Schools Science Project. Under this program, about 300 junior and senior high school students a year take special free classes in science and mathematics at Caltech each summer. The latest IBM funding continues IBM support of the project, which began in 1981.

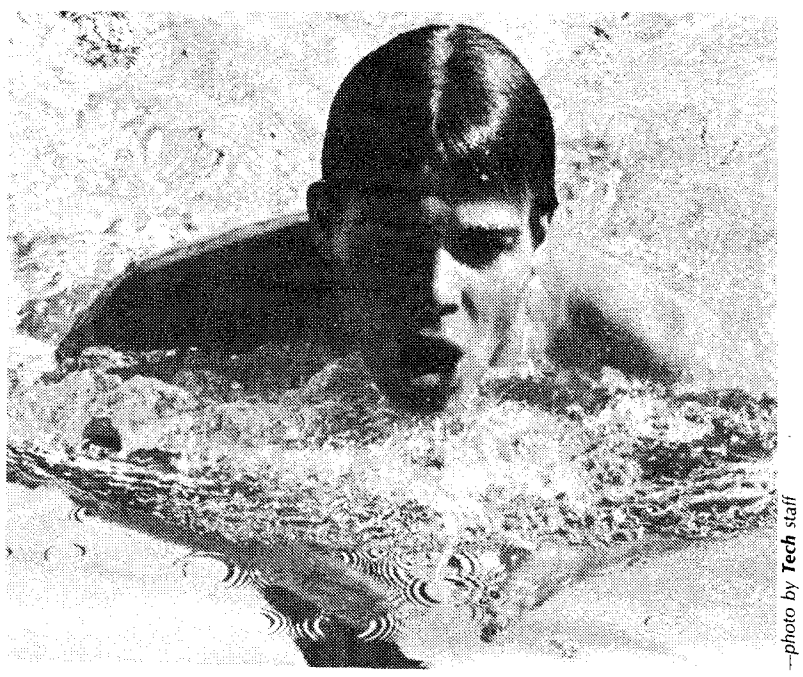
ASCIT ELECTION RESULTS

ASCIT Vice President ..... Pam Feldman
Tech Editor ..... Peter Alfke
Director Social Activities ..... Rob Soderberry
Athletic Manager ..... Chris Schofield
Director Academic Affairs ..... Tylis Chang
BOC Secretary ..... Doug Roberts
Activities Chairman ..... Kledzik/Rosema/Searcy/Vogt

Run-offs

IHC Chairman ..... John Beck
Randy Brown
Steve Gómez
ASCIT Secretary ..... Kathleen Hayashibara
Junko Munakata
Upperclass Director-at-Large ..... Rob Fätland
Susan Gerhart
Eric Scharin
Frosh Director-at-Large ..... Rachel Clark
Bibi Jentoft-Nielsen

Run-off elections will be today for as-yet unsettled offices and to put the proposed ASCIT Bylaws Amendments to a vote. Ballots will be picked up at midnight.



—photo by *Tech* staff

Hans Hermans knifes through the water with the easy grace that has earned him the nickname "Duck." Caltech's swimming team will compete against Pasadena City College tomorrow at 10:00 a.m. in their last home meet of the season. See sports on page 11.

OPINION

Letters to the Editor

Bruce Kahl

To the Editors:

I was pleased to be interviewed by Mr. Blume last week and had looked forward to his article on the Caltech Counseling Service, especially as it might inform more students of our purpose and function. I was very much disappointed, then, by the headline which glared over the story. What I tried to make clear during the interview—and what the "Screw Loose" title negated—is that because an individual seeks counseling does not mean she or he is crazy, as much as that unfortunate stereotype still exists. I also tried to make clear that the Counseling Service is a place for Caltech students to explore, understand, and resolve their problems in the context of a special, confidential, secure relationship with the counselor. My hope is that students at Caltech may view the Counseling Service as an important resource for them in their educations here, a place for self-enrichment through greater self-awareness. My fear is that the headline may have daunted students who were considering counseling for themselves. I hope that the editors will show more sensitivity to their material and their readership in the future.

Sincerely,

—L. Bruce Kahl, M.D.
Director, Counseling Service

To the Editors:

"Screw Loose? See Dr. Bruce" certainly has a certain ring to it. It sounds kind of funny. But is it appropriate for the front page of the *Tech*? Is it an appropriate title for an article about the Caltech counseling service? Is ridiculing the people you interview a good idea?

"It makes people read the article." Sounds like *National Enquirer* strategy to me. After all your fussing about cusswords, I'm surprised that you support this method of getting the readers' attention.

I wrote the article. I gave it a different title. I did not caption the picture.

—Matthias Blume

[It was never the intention of the editors to perpetuate the "counselors are for crazy people" myth. It was precisely because we recognized that the ***entire*** *campus would benefit by greater exposure to the counseling services that we gave the Bruce Kahl interview such prominence. Our selections of headline and photo caption were made with the objective of dispelling any anxiety or stigma through a little levity. If in doing so, we have offended anyone, we apologize. —Eds.]*

Uranus Photos

To the Editors:

Congratulations on your centerfold spread in the January 31 edition of The California *Tech*. Gavin Claypool and Nick Smith did the best job I have yet seen in illustrating some of the spectacular images obtained by Voyager 2 of the Uranus system and, at the same time, putting them in an understandable context.

—F. H. Felberg
Associate Director, JPL

Humanities

To the Editors:

Caltech is fortunate enough to be blessed with one of the finest Humanities departments in the city of Pasadena. A quick perusal of the course catalog reveals such excellent courses as An 101, Selected Topics in Anthropology; H 159, American Radicalism; Lit 10, Sexual Identity in Literature, and Lit 140, Twain and James. Surely any student would leap at the chance to take one of these courses. He would run into one problem, however. They weren't taught this year. Nor were they taught last year. Or the year before that. Or the year before *that*.

In fact, these courses have been listed in the catalog for *6 years* without ever being taught. The typical undergraduate has free run of the Humanities course offerings for only 3 years (since frosh humanities are inflicted upon him his first year), yet there are currently 21 courses listed in Anthro, History and Lit which have not been offered for the past 3 years. Why include them if no one has the opportunity to take them? And why is this deception peculiar to the Humanities Department? No other department comes close to this number of "empty" course listings.

If a course will not be offered for a third straight year, then how about dropping it from the catalog? If it's ever taught again, then surely it can be returned. In the meantime, the department will have dispelled the impression that it is fluffing up its image in the catalog with a bunch of non-existent courses.

—Robert Lang
Applied Physics

SDI Funding

To the Editors:

Universities looking for research funds are finding the Pentagon offers "the only game in town". According to a recent report by the Council on Economic Priorities, funds ear marked for SDI "innovative" research, awarded primarily to universities, will quadruple in FY 1986 to $100 million. Pentagon funding for defense projects at universities has increased 89% in the last five years. Today, incredibly, this constitutes sixteen percent of all federally funded university research—*the same share received by universities during the height of the Vietnam War.*

MIT and its off-campus Lincoln Laboratories, for example, in FY 1985 received a whopping 59% of all its research funds from DoD, at least one fifth of which went to SDI. Across the nation, some 43 other schools have also received Star Wars contracts. Such a rapid increase shows that universities have become the next targeted constituency, after military industries, for the SDI research porkbarrel.

What has happened to basic research? It is expected to grow only 1% this year, while military research and development is expected to increase 21%. Though classified research has been restricted on most major campuses since the '60's, much of the final stage SDI research will fall into this classified category.

What this means is that universities, traditionally a major source of unbiased scientific research, are becoming more and more dependent on the Department of Defense. The Pentagon is supplying more than one half of all federal funds for mathematics and computer sciences, effectively putting it in charge of those disciplines which are key in the development of high technology. Given the Pentagon's spotty record on quality and cost control, this will ultimately hurt U.S. technological growth and competitiveness.

More than 2600 faculty members have already signed a petition calling the Star Wars project "deeply misguided and dangerous," including Hans Bethe of Cornell and Philip Morrison of MIT. Opposition to the "invasion of academia" by the Pentagon is growing nationwide. Students, faculty and the public everywhere should join in making their views heard on this important issue.

Sincerely,

—Rosy Nimroody
Project Director
Council on Economic Priorities
[Readers wishing to respond directly to the CEP or who wish to receive further information from them may contact them at 30 Irving Place, New York, NY 10003. Enclose a business-sized, stamped, self-addressed envelope if you want a copy of their newsletter. —Eds.]

The Caltech Y Fly-by

Friday...February 14

Enjoy the sounds of the big band era with the Blue Tones. Noon concert on the Quad. Bring a lunch and a sweet heart.

There will be a representative of Student Travel International at the concert to provide information on student trips to Europe.

Saturday...February 15

Sailing Trip! All day—meet outside Winnett at 7:30 AM. If you won the the lottery, don't forget to go.

"UFO Verdict: Examining the Evidence," a slide and lecture presentation by Philip Klass. In Baxter Lecture Hall at 2 PM. Co-sponsored by the Y and the Southern California Skeptics.

Sunday...February 16

Sports Day! All day! At the gym and athletic field!

Tuesday...February 18

"Humanizing Technology." Lecture by author Elinor Lenz, in Winnett Lounge at 8 PM. Refreshments will be served. Co-sponsored by the Y and the OWC.

Wednesday...February 19

Noon Update. "Buoyancy-Driven Fluid Motions," discussion with John List, Professor of Environmental Engineering Science. Winnett Clubroom #1. Bring a lunch.

Thursday...February 20

L.A. Philharmonic—Music by Fauré, Debussy, and Strauss. At the Music Center, 8 PM. Tickets are $3 each. Sign up in the Y by Monday afternoon.

Friday...February 21

Noon Concert with Mark Levy. Lunchtime on the Quad.

Movies! Movies! Movies!

The Y has discount passes for the Mann and Pacific Theatres. $3 each. Good anytime.

Any questions, comments, or ideas?
Come see us in the Y office or call x6163

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EDITORS
Paul Gillespie • Peter Ashcroft

ENTERTAINMENT EDITOR
John Fourkas

PHOTO EDITOR
Kent Noble

SPORTS EDITOR
Michael Keating

REPORTERS
John Beck • Jim Bell
Nancy Drehwing • Castor Fu
Doug Gray • David Hull
Ed Zanelli • Marty Zimmerman

PHOTOGRAPHERS
Matthias Blume • Teresa Griffie
Chris Meisl • Rod Van Meter
Min Su Yun • Sing Ung Wong

THE INSIDE WORLD
Blacker: Jim Bell
Dabney: Mike Roberts
Fleming: Steve McAdams
Lloyd: Nicole Vogt
Page: Cynthia LePage
Ricketts: Saxy Workman
Ruddock: Sam Wang

BUSINESS MANAGERS
David Goldreich • Jed Lengyel

CIRCULATION MANAGERS
Sunbo Choi • Paul Gillespie

PRODUCTION
Robert Horn • Nick Smith

PROOFREADER
Theron Stanford

THE CALIFORNIA TECH
107–51 Winnett Student Center
California Institute of Technology
Pasadena, California 91125

Phone: [818] 356-6154

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Strings

from page 1

have revealed a large number of particles that seem to be elementary, meaning that they are not made up of anything else. According to quantum mechanics, the main role of one group of these particles, the gauge particles, is to transmit forces between other particles. Thus particles and forces are deeply interconnected, and an understanding of one is tantamount to an understanding of the other.

Gravity and electromagnetism are the most evident forces in everyday experience. But there are more – the weak nuclear force and the strong nuclear force, and possibly others– that are less familiar because they occur only at nuclear or subnuclear levels. Each of these various forces is carried by specific gauge particles. When the sun lights the Earth, the energy is transmitted from the one celestial body to the other by photons, the gauge particle of electromagnetism. And when the Earth attracts the moon, the two exchange gravitons, the gauge particle for gravity.

Thus, in the context of quantum mechanics, Einstein's theory can be viewed as the theory of a specific elementary particle, the graviton. But although his general theory of relativity is very beautiful and successful, it falls apart when one tries to interpret it quantum mechanically. Quantum calculations based on Einstein's gravity theory give "infinities," answers that are as absurd as the results you get if you try to divide a number by zero. In the language of the mathematician, the calculations diverge, or more descriptively, blow up. This apparent clash between gravity and quantum mechanics is the most severe obstacle that has arisen in attempts to construct a unified field theory. We have found unifying principles that apply to all the other forces. Only gravity, the force described by Newton and Einstein, is still a holdout. A likely reason for this may be found in the most basic premise of quantum field theory. In the theory, gravitons, and all other elementary particles, are described as mathematical points, having no dimension whatsoever. This could be the source of the problem.

In 1974, the late French physicist Joel Scherk and I proposed that elementary particles are not points but rather are one-dimensional curves called strings. These strings have zero thickness. Their lengths vary depending on the circumstances, but their typical value is the Planck length, 10^{-33} centimeters. That's exceedingly small: the Planck length is as much smaller than the atom as an atom is smaller than the solar system.

Superstring theories are currently enjoying a surge of popularity as it becomes increasingly clear that they can be used to describe all of the fundamental phenomena of nature. It is apparently impossible to construct a mathematically consistent quantum theory of gravity without using strings. Conversely, it seems impossible to construct a mathematically consistent theory of strings *without* including gravity. Superstring calculations, even though they involve gravity, do not produce infinities.

Achieving this unity with superstring theory requires a fundamental alteration in the way we view the geometry of the world. For known string theories to be consistent, six extra dimensions must be added to the usual three, making nine dimensions in all. The basic idea is that six dimensions are unobserved because they are too small. They are curled up into a sort of six-dimensional ball that occurs at all points in the space-time continuum. It is conceivable that all of the nine spatial dimensions may once have been equal, but in the moments following the birth of the universe, three of them expanded, leaving the remaining ones shriveled in a little ball.

Two kinds of strings may occur. The open string is a curve with free ends and the closed string is a continuous curve, or loop, with no free ends. The simplest and most promising theories involve only closed strings. Strings engage in some interesting behavior. First of all, they move, with an oscillating or vibrating motion. Which of the various elementary particles a string represents depends on the manner in which it vibrates. By oscillating in a particular way, for instance, a string would be an electron. Also, strings can join or divide– two coming together to form one or one dividing into two. This interaction is the origin of the fundamental force, the single force from which gravity, electromagnetism, and the various nuclear forces are derived. This basic coupling of strings replaces an infinite number of possible interactions that could produce forces in previous quantum theories of gravity.

Thus we may have found a unique mathematically consistent explanation of all fundamental phenomena. Not only does the concept of strings propose a single particle that can be varied to represent all the myriad particles of the subnuclear world, but it also proposes a single source for all of the forces.

An important element of superstring theory is a concept called supersymmetry. Supersymmetry first arose in 1971 in the context of string theory in works by Pierre Ramond, Andre Neveu, and myself.

The notions of symmetry is one of the physicist's most useful tools. Mathematical symmetries are similar to the everyday similarities we notice between common objects but on a much more complex and abstract scale. When elements of a set of equations can be interchanged or altered, and still the whole collection displays the same properties, it is said to have symmetry. An elementary example of this is radial symmetry: the properties of a sphere's surface are not disrupted by the sphere's rotation. The concept of symmetry is useful in the development of theory because it can be used to point out important similarities between widely different things.

Widely differing things may have surprising hidden similarities because observable nature often disregards or "breaks" the symmetries in natural law. For instance, the equations for magnetic force treat all directions the same, but the force emanating from an individual magnet always points in some particular direction. Thus the symmetry of the equations in not reflected in a physical magnet. In like fashion, all the nine spatial dimensions are mathematically equivalent– the equations regarding them have symmetry– but in the observable world, three are

continued on page 4

Humanities Study Completed

by Ken Haynes

The following are the basic findings of the Humanities and Social Sciences Student-Faculty Committee:

1. We recommend that an honors program in the humanities be adopted.

Students with an interest in humanities find it difficult to receive an education that is continuous and structured within the humanities division, since courses are now offered with a great deal of flexibility. An honors program, in which participation is optional, which offers a structured education, and which may require additional courses, can solve some of the difficulties in obtaining a well-rounded education without changing the current flexibility of courses for other students.

2. We recommend that a writing program, as an adjunct to certain courses, be instituted.

Students perceive a need for learning the mechanics and structure of clear expository prose. A writing program which involves work outside of class with trained teachers of writing can fill the existing need of students to learn to write without stultifying current courses.

3. We recommend that introductory social sciences be offered consistently each term.

Since all students must take 18 units of introductory social sciences, a greater number of offerings is an advantage to the students. Particularly, courses in psychology and anthropology are not offered each term.

4. We recommend that courses in psychology and art history be expanded.

Students express a desire for courses in these areas, and the current offerings are rather narrow in scope.

5. We recommend that courses in the humanities and social sciences be offered at certain block times.

Students often have schedule conflicts with courses in HSS. A block offering of these courses ought to minimize the scheduling difficulties.

As the final reports have not yet been submitted, students with suggestions are encouraged to contact Ken Haynes in Page, 578-9971.

Strings

from page 3

much larger than the other six. The same is true for forces, all of which are equally powerful at extremely high energy levels or temperatures but display enormous differences under ordinary circumstances.

Supersymmetry is a symmetry under which the two major classes of subatomic particles can be mathematically interchanged. These two classes are know as fermions and bosons. Fermions include the particles known as quarks and leptons. (The electron is an example of a lepton, whereas the proton is made out of three quarks.) The other class, the bosons, includes gauge particles and is differentiated from fermions by a property physicists call spin.

According to supersymmetry, each boson and fermion should have a partner among the opposite class of subatomic particles. Which fermion gets paired with which boson? The obvious first guess is for the gauge particles to be the supersymmetry partners of the quarks and leptons. But that does not work; they do not pair up so neatly. Instead, it is necessary to postulate the existence of new particles to serve as partners for each known particle. The hypothetical fermionic partners of the gauge particles are given the general name of gauginos, with more specific names for specific cases. For example, the partner of the photon is called the photino. The bosonic partners or quarks and leptons are generically called squarks and sleptons. The partner of the electron is called the selectron. (I am proud to say that I am not responsible for this slanguage.) The gravitino is the supersymmetry partner of the graviton, the gauge particle that carries gravity.

The experimental search for these conjectural supersymmetry particles is being vigorously pursued. But meanwhile, supersymmetry is already proving useful to the theorists. Understanding that the graviton has a partner was a major step in advancing our understanding of superstring theories.

Certain calculations involving bosons and fermions used to produce infinities. Supersymmetry ensures that this does not occur. Instead, when bosonic and fermionic terms are combined, they counteract each other in a delicate pattern of cancellations. In supersymmetric string theories – superstring theories – these cancellations apparently ensure that well-defined finite results are obtained from the calculations.

In August 1984, Michael Green of Queen Mary College, University of London and I climaxed an intense and exhilarating five-year collaboration by discovering that supersymmetric theories in nine-dimensional space can circumvent certain quantum-mechanical inconsistencies called anomalies. However, this circumvention only works with two particular versions of the theory. These versions are named for their "symmetry groups," the specific kind of symmetry that an individual theory obeys. The two particular symmetry groups that word for superstring theory are designated in mathematical lingo, SO(32) and $E_8 \times E_8$.

These symmetries are all encompassing: All known elementary-particle symmetries can be contained in either one of them. We presented a superstring theory containing both open and closed strings with the SO(32) symmetry and gave evidence that it is free from anomalies and infinities. A few months later, two new superstring theories containing only closed strings, one with $E_8 \times E_8$ symmetry and a second example with SO(32) symmetry, were formulated by David Gross, Jeffrey Harvey, Emil Martinec, and Ryan Rohm at Princeton University. These developments have created great excitement in the theoretical physics community. For the first time, it has been demonstrated that requiring a consistent unification with gravity can resolve many of the ambiguities that have plagued quantum field theory. Not only are the two allowable symmetry groups determined, but so is the complete spectrum of elementary particles, all their interactions, and even the dimensionality of space and time.

A great deal of work is still required to relate superstring theories to phenomena observed in the laboratory. However, largely due to numerous insights of Edward Witten at Princeton University, the phenomenology of superstrings is progressing rapidly. The prospects, especially for the $E_8 \times E_8$ theory, appear extremely bright. A crucial step is to deduce a detailed geometric description of the six compact dimensions. This effort is pushing at the frontiers of mathematics and is resulting in a level of communication between physicists and mathematicians unprecedented in recent times.

The $E_8 \times E_8$ theory has some fascinating implications. Each E_8 identifies a separate symmetry group. One group gives rise to all known particles and forces; the second E_8 gives particles and forces that are hidden from observation. It is difficult to be very specific about the properties of the resulting particles and forces at this time. But if the pattern turned out to be the same for both of the E_8 groups, there would be some amusing consequences. All observable elementary particles would be duplicated by invisible counterparts – "shadow matter." Invisible planets, stars, and galaxies made of shadow matter would exist. The only way in which shadow matter could be detected would be through its gravitational pull, odd effects on the movement of stars or the bending of light passing close to an invisible galaxy. Astrophysicists have long known that several types of invisible "dark matter" must occur in the cosmos to account for various observed properties of galaxies. Matter associated with the second E_8 could be one of its important constituents.

The theory of superstrings is about to enter the period of experiment and confirmation. Scientists are hard at work trying to verify the effects the theory predicts. Some things will be almost impossible to test. For example, the existence of the six extra dimensions could be demonstrated by experiments in which particle collisions at high energies produce new

continued on page 5

IHC and ASCIT Highlights

by John Beck

IHC

An unheard-of 22 people were in attendance at this week's IHC meeting, presumably to see the fireworks expected in the Page-Fleming RF controversy and the Page-Dabney Discobolus controversy. They were on the whole disappointed, though, as everything was resolved calmly and without incident.

Several persons present expressed interest in what was going to happen between Page and Fleming. They had to settle, however, for the knowledge that the entire matter had been resolved in private by the new and old house presidents in cooperation with the MOSH.

Several members of Dabney House were present to argue their case in protest of their Discobolus Cross-Country race against Page last Sunday. They presented their claim that Page did not have a full team present at noon, and that they had not provided timers. Page tried to plead its case by claiming that they should have been allowed a 15-minute grace period. The IHC upheld Dabney's protest by a vote of 5-1, with Fleming abstaining. Dabney maintains possession of the Discobolus trophy and will host Lloyd in volleyball this weekend.

Chris Brennen and Stan Borodinsky presented a list of potential rooms to be built in the South Complex Basement during the upcoming rehabilitation project. They asked everyone in attendance to help rate the ideas on a 1 to 3 basis to get an idea of priorities. Rated high were music practice rooms, an art room, a dark room, a place for an automatic-teller machine, a bike shop, space for a copy machine, more laundry space, and a Coffeehouse.

Arrangements are going well for Sports Day, Sunday February 16. That's the day after tomorrow! About 100 alumni are expected to show up. A lot of wild events are planned, and everyone should have a good time. So come on out and join the fun!

Everyone agreed that the athletic department needs to get new flags for flag football. The old ones were condemned as bogus by a unanimous vote of the IHC. The IHC will ask Warren Emery to buy some new ones for us.

ASCIT

Tylis Chang requested $200 to put on a job fair for about 35 companies for the Society to Reduce International Violence on Earth (STRIVE). These are supposed to be companies with non-military contracts. The request was approved.

Richard Lawson requested $600 to publish the *Totem*, the Caltech undergraduate literary magazine. He hopes to print up 800 volumes of about 50 pages each. He was allotted $200, and told to return if he could not raise sufficient funds from other sources.

The annual ASCIT budget meeting will be March 4. Proposals will be due by February 28.

Sports Day Sunday

Preparations continue for the 1986 Sports Day, which will be held Sunday, the February 16. The festivities are sponsored by the Master's office, and will begin at 10:30 with soccer, tennis, and volleyball. Following a free lunch at noon on the lawn north of the gym, activities will resume with softball at 1:00, and basketball, swimming, and ultimate frisbee at 1:30. The day will conclude with a tug-of-war at 2:30, and a polyathlon at 3:30.

The polyathlon will consist of a series of four events for each team of three people. The first three events will be bike-riding, swimming, and beer drinking. Each team member will do one of these events. The final event of the polyathlon will be a four-legged race with all three team members.

Approximately 100 alumni are expected to participate as well as many students and faculty. Chris Brennen, Master of Student Houses, stressed the fact that there is no need to sign up in advance, and that an informal atmosphere will prevail.

Strings

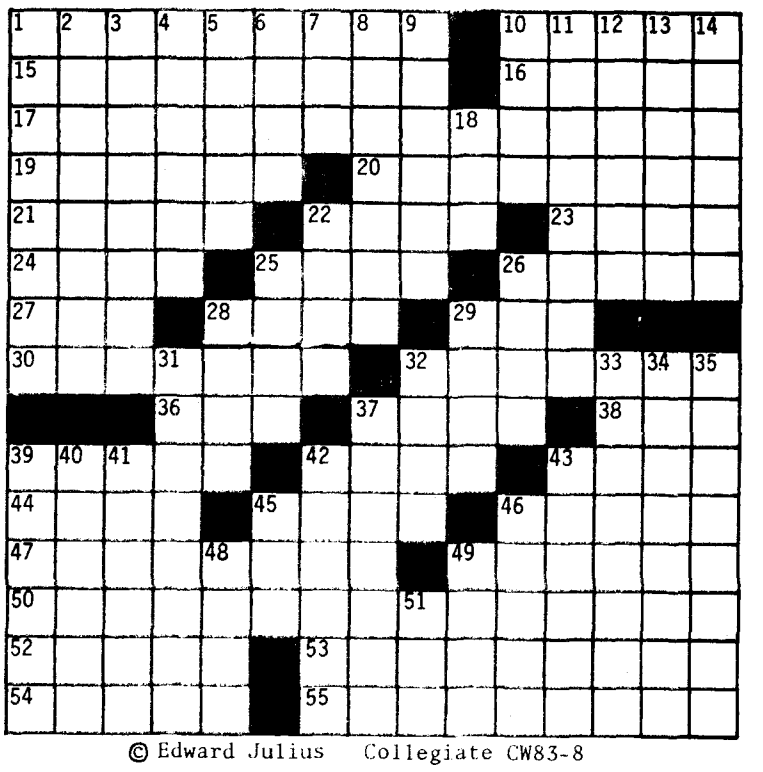
from page 4

kinds of particles with very specific properties. Unfortunately, small dimensions, like small particles, must be investigated in machines that employ enormous amounts of energy. The extra dimensions are probably so small that the energy required to explore them is far beyond what will be available to us in the foreseeable future.

But other things can be proved or disproved. The search for partners for each fermion and boson, as predicted by supersymmetry, is proceeding full blast. There are reasons for believing that their masses could be observed in existing or soon to be completed proton colliders. Hints of such particles in recent experiments are tantalizing. The confirmation of supersymmetry would be one of the most important discoveries in the history of modern physics.

Physicists have long had the dream of someday being able to understand mass and other properties of elementary particles from first principles. They are anxious to understand the structure of space and time at the tiniest distances and to know the reason for the existence of a very wide range of fundamental lengths ranging from the Plank length to the radius of the universe. There seems to be a good chance that, with the development of superstring theories, we are closing in on the answers to all these questions and more.

collegiate crossword



© Edward Julius Collegiate CW83-8

ACROSS

1 Houston ball park
10 Bondmen
15 Room on the anterior part of a ship
16 Early Latin version of the Scriptures
17 Star of 1926 Ben Hur (3 wds.)
19 —— oculi (eye muscle)
20 Setting for "Hamlet"
21 Roller used in printing
22 Fusses
23 Chemical suffixes
24 Equipment
25 Of an amide
26 "—— of thousands!"
27 Apt., dorm., etc.
28 The Emerald Isle
29 By way of
30 Disease-carrying flies
32 Hotel employee
36 Pollution control agency
37 The Bay State (abbr.)
38 Asiatic tent
39 Madison's VP
42 Adjectival suffix
43 Canadian province (abbr.)
44 Syrian city (var.)
45 Poker term
46 British elevators
47 Texas's nickname (2 wds.)
49 Way to obtain money (2 wds.)
50 Member of famous acting family (2 wds.)
52 Willow
53 Small airplane (hyph.)
54 In itself: Lat.
55 Nanny

DOWN

1 Fill with fear
2 Pain
3 Railroad inventory
4 Tenant or landlord
5 Happen
6 Raised platform
7 No longer in use (abbr.)
8 Blended with (2 wds.)
9 In one lump (2 wds.)
10 Spanish equivalent of "oui, oui"
11 Of a particular race or culture
12 Woman's name or '20s song
13 Traffic warnings
14 Most mentally sound
18 Part of ship's name
22 French friends
25 Length times width
26 Is unwell
28 Catch sight of
29 Sleeveless garment
31 Hydrocarbons found in solvents
32 Foundation
33 Sheet music symbol (2 wds.)
34 Exhausts
35 Applies wall coating
37 Actor Art ——
39 Fast gait
40 Girl's name
41 Painter of "Rowers' Luncheon"
42 Mired (3 wds.)
43 Military rank
45 Baseball city (abbr.)
46 Stratum
48 Dried up
49 Irish-Gaelic
51 Accelerate

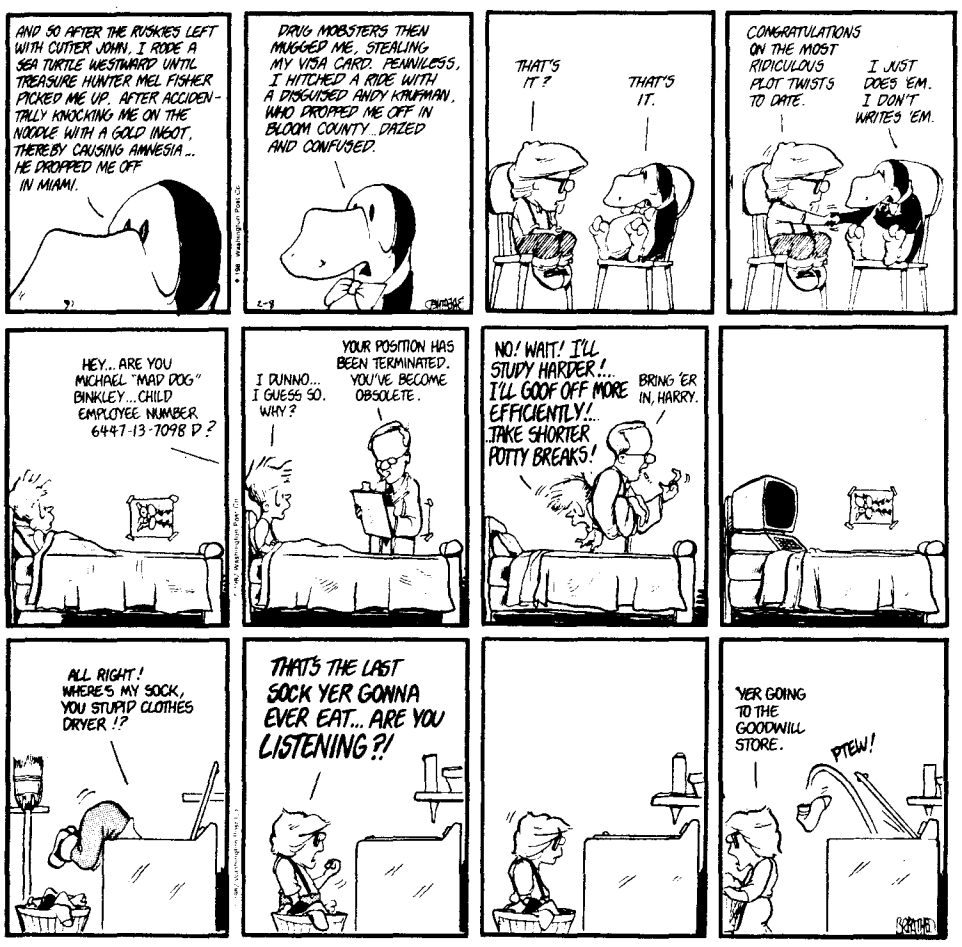
Dear BLOOM COUNTY Reader:

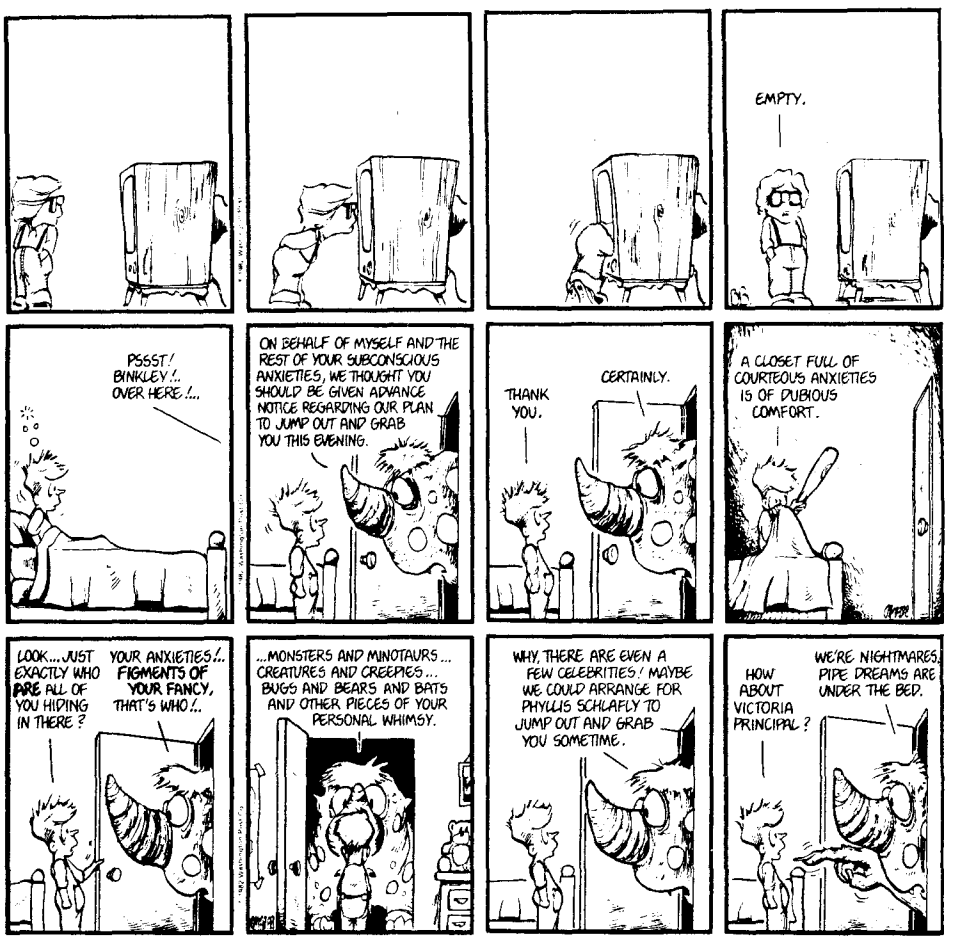
Berke Breathed has been injured in the crash of his ultralight airplane in New Mexico, but is in good condition after surgery. He is expected to be out of action from four to eight weeks. In the interim, he has suggested that his newspaper clients receive previously published but not widely distributed strips, daily and Sunday. We are enclosing daily strips for the two-week period, Feb. 10-22.

We and Berke apologize for the inconvenience, and thank you for your understanding and messages of support.

Wm. B. Dickinson
Editorial Director
Washington Post Writers Group

BLOOM COUNTY **by Berke Breathed**





Sponsored by the Caltech Y

Art History

from page 1

time lecturers. The lecturers may include professors from other universities, unemployed academics, or even Jay Belloli if he has the time (he is planning to set up a new gallery in Pasadena). The recommendation includes Dr. Wark's course as well as a full-year survey of the history of Western art, two advanced courses in Western art, and two courses in non-Western art. Presently there are no courses in non-Western art, so the proposal is not just a downscaled version of what we have now.

It is not clear how much of this program will actually be instituted, but it is reasonable to expect some offerings next year. In Frederic Wong's article, "Baxter Art Closes" (California *Tech*, 9/21/84), Dr. Goldberger is quoted as saying that Belloli's and Ward's eliminations did not signify a reduction in "our dedication to art education." We shall see.

If one is seriously interested in other art courses, there are a large number of both historical and practical courses available at Occidental and the Art Center College of Design; Caltech has a credit exchange program with both schools. Courses taken at these schools are available only on a pass-fail basis and apply only to the 36-unit general HSS requirement, not to the more specific 36-unit humanities requirement, however. Also, fitting Oxy courses into one's schedule is difficult because they usually meet four times a week, and Art Center courses are notoriously time-consuming.

Art courses have been popular in the past and, in my experience, very rewarding. It would be a shame if Techers were deprived of easy access to such courses; a horse won't drink if you don't lead it to water. One can only hope that a significant number of attractive courses will continue to be offered here in the future.

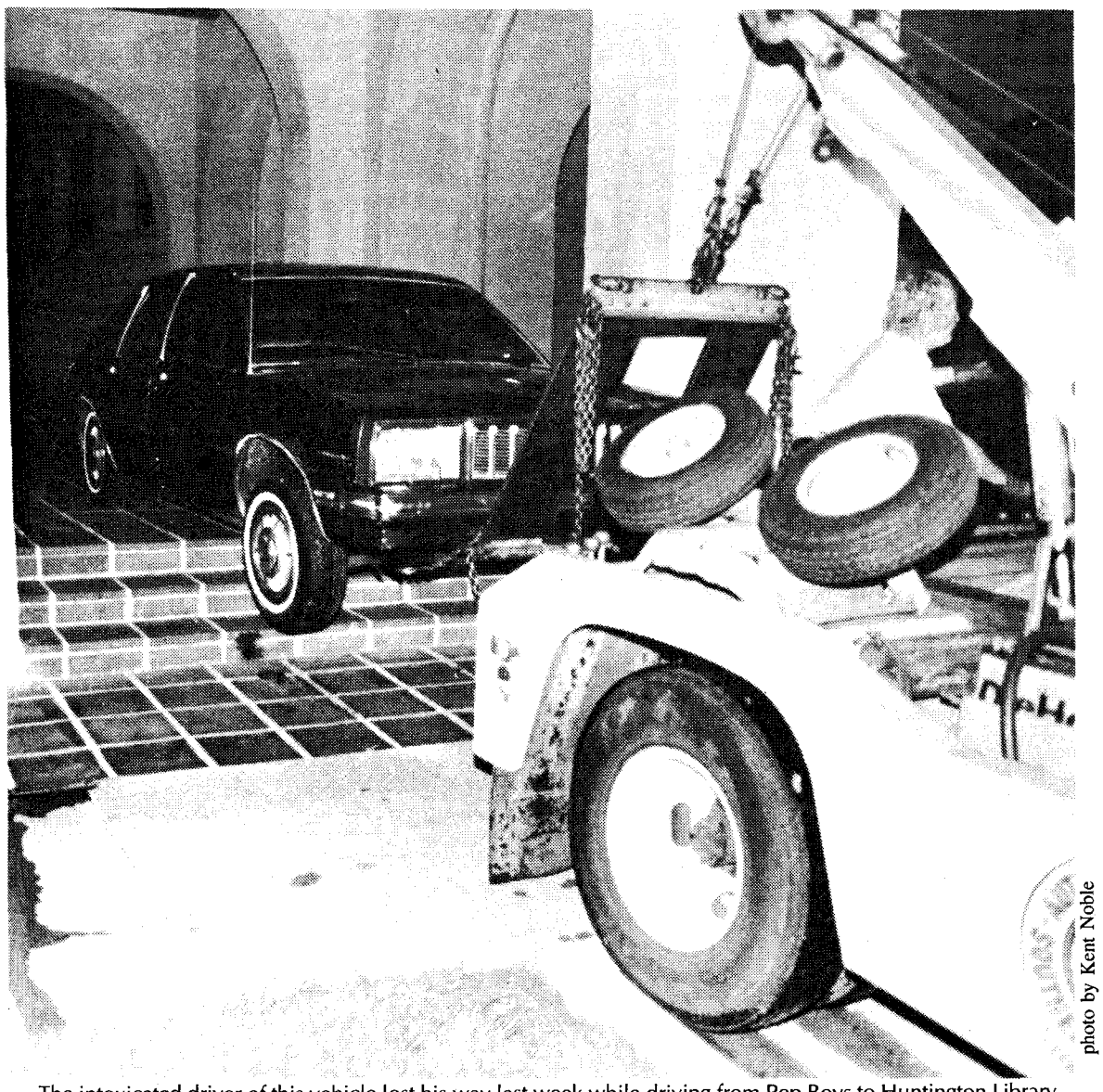


photo by Kent Noble

The intoxicated driver of this vehicle lost his way last week while driving from Pep Boys to Huntington Library. The car had to be towed out of South Mudd after its owner was arrested.

The Inside World

Fleming: The Page House Story: Once upon a time, Rambo moved into Page House and got himself a following of half-witted soldiers of fortune, which endeared him much to the rest of the Boys. Then he got them all syndicated and began with the moronic maneuvers campus wide, winning respect and admiration at every turn.

The Fleming House Story: Once upon a time, Chaz moved into Fleming...

In case anybody missed our Poet Laureate's latest work, it is reproduced here (without his permission):

My pet feeding dish
Is what I wish
For

–BJG

See you all at *Cats.*

–Al Fansome

Blacker: After three weeks in the Dungeons of Spinor, that evil muster of rotation, I awoke to find Naomi soothing my parched lips– with life giving water that is. Now back, via the unknown cave, I report that which was not naught of late. Yes, there was that titanic clash. Two houses strong and lean– and a yellow ball far stronger than each. Yet, when the clock struck 12, the Big Black Bug felled a crushing blow. Coming soon to a theatre near you– *The Final Victory.*

And once again it is time for the changing of the guard. Nolan goes back to the ocean from which he was spawned. Congratulations Nancy, the jacket is yours. And don't forget young Scott. Drink long and well my son.

But then came the greatest peril known to man. BROOMBALL! Yes, the terror of Spinor now seemed no more than a child's top. Many maniacal moles maurauding and molesting move mighty mole men and misses, but mostly, merrily making magnificent maneuvers modifying motion of the broomball.

Oh– we held Gumby for a couple weeks too.

–The Wanderer

Dabney: *The following is the text of the statement made yesterday by Larry J. "Bud" Hansen, Dabney House Deputy Pres. Minister:*

Due to the election problems, the House ordered a news blackout effective 1 February 86. The blackout was to remain in effect until such a time as election results could be reliably stated, and the possible fraud fully investigated.

At this time, I am unable to state the results of the election, except to say that the rumors from the outlawed "independent" counting stations should be disregarded, as they are largely contradictory to the official results being computed by the House Election Commission. Furthermore, I am not at liberty to divulge any preliminary findings from the team investigating alleged wrongdoing before and during the elections.

Be assured that the House is doing everything in its power to resolve these problems rapidly and with minimal violence and loss of life. As soon as additional information has been approved for the release, this office will make a full statement.

–J

Ruddock: The *original* Inside World is back, and bigger and better than ever! What's happening in the house? Inquiring Techers want to know. Are house elections open or closed? Who will be the new house BOC rep? How long has Mark Vagins been awake? What is the secret relationship between Ed and Vito? These and many other questions won't be answered, so there.

In the news: Fred aced (?) his Chem1b midterm after not going to class all term– what a blaze. Last Friday was a party night. Rudds finally showered Spaz for his birthday; everyone had his own special way of celebrating. Some watched a dirty movie, but the people blocked into Dancin's room may or may not have had the most fun. No one talked, but Cynthia *was* smiling when she came out. Hot buttered Betsy was good, too, don't you think, Craig?

Alley Four Flap Week quietly tucked itself in without a spilt drop. Taney says, "Be a man, not a sap; skip the band, use the flap." Baffled? Ask *him* about it, coming soon to a john near you.

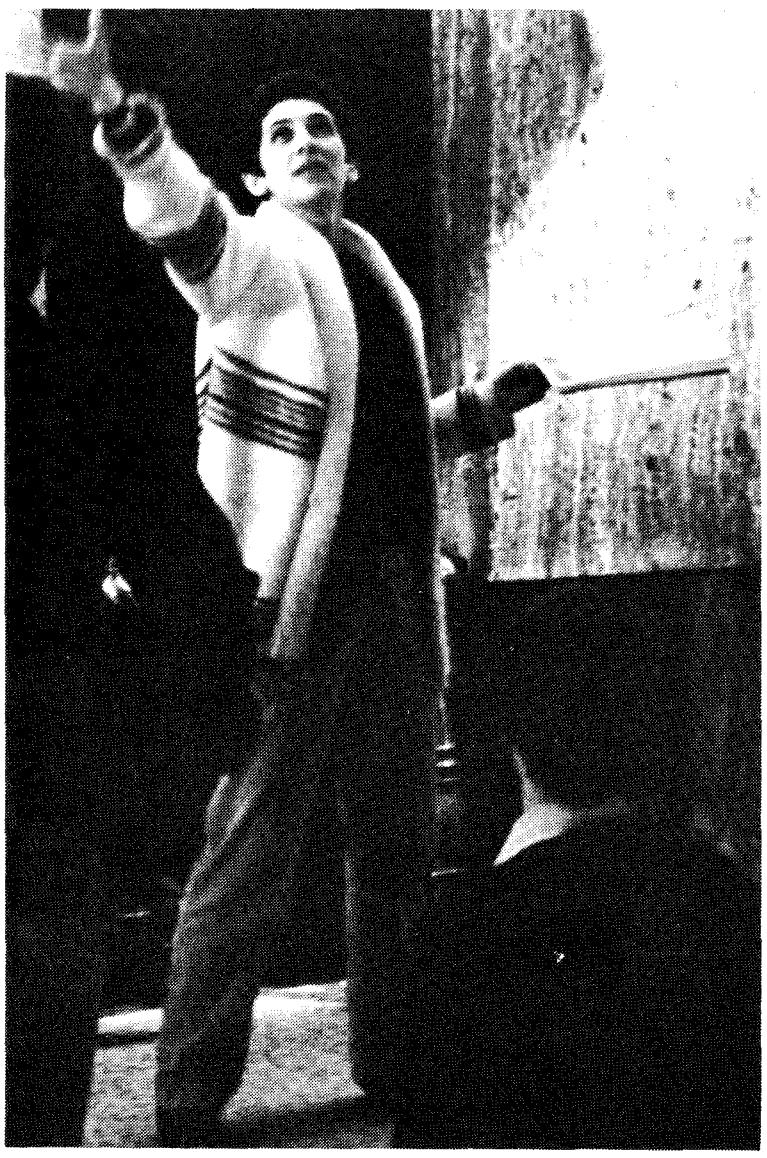
It's been a hot throbbing election week, but the best is yet to come. Everyone show up in the dining room tonight for pizza, beer, and impotent house offices– ice cream comes afterward. Underclassmen should make a special point of being there– you'll need as many as you can get if you want to come *close* to showering Dough-boy. Good luck– you'll need it. Vote in ASCIT runoffs too, but let's be careful out there.

Seniors hould go to sleep early after elections, since tomorrow... is San Diego road trip day! Party up, don't-call-me-dudes, but come back in time for Sports Day, here, and a snowball fight on Baldy between Phoenix and Saturn Alleys on Sunday afternoon. Ya Paul-key and I are the designated victims. If you're not too tired after all that, don't forget Interhouse volleyball–Let's keep the tradition!

Free at last, free at last; thank God Almighty I'm free at last.

–Wang-man, with a little help from $NaFO_2$

ENTERTAINMENT



Liz Oberstein, a modern dance instructor at Caltech, directs Tacit's most recent production– Kismet.

Science, Art, *Kismet*

A recent article appearing in the *Los Angeles Times* compared fifty of the world's great scientists to artists. The analogy was based on the premise that both artists and scientists begin by visualizing a form that has not previously existed and then creating that form to fill the void.

Liz Oberstein, who teaches modern dance here at Caltech, has found proof of this analogy in her students and particularly in working with the Caltech-JPL community as choreographer for TACIT's production of *Kismet*.

When Liz was asked to work on the choreography for *Kismet*, she was excited about the opportunity. She was already familiar with the music and knew that the elements contained in the music and imagery complemented her background and interests in modern dance.

Kismet offers unique opportunities for the choreographer and the dancer as several characters are completely developed through the medium of dance. The characters of the Ababu princesses, three Amazonian maidens brought in to wed the Caliph, for example, are entirely developed through their athletic, war-like dances. The Ababus dance their statements and the atypical musical imagery that accompanies them allows them to stress their strength and humor. Two other minor characters, Zubidiah of Damascus and Samaris of Bangalor, are also fully developed through dance. Zubidiah, a seductive contender to the Caliph's hand, and Samaris, a princess of Bangladesh, have one dance each in which to state their prupose and build the character that they wish to project to the audience. Liz said that these solos developed quickly, drawing principally off of the skills of the individual dancers as they created their characters.

Another opportunity that *Kismet* offered the choreographer was involvement in blocking the scenes. Many of the scenes in *Kismet* contain a full or partial chorus and Liz felt it important to participate in the blocking process in order to keep the "mass movement" interesting and thematic. "I felt my role was mixed with blocking large scenes; I wanted to help paint the overall picture."

A good example of the overall picture that Liz hopes to achieve in *Kismet* is in the Harem scene in which Liz plays with counterpoint in the dancing in order to create "a sense of busyness with unity." Various groups of dancers are involved in separate dances on the stage with the common goal of hypnotizing and seducing their guards. Although several sets of motion are simultaneously occurring on stage their common goal unites them in a visually and emotionally exciting realization of the scene.

In creating the dances for *Kismet* Liz said that she listened carefully to the music but did not choreograph the dances measure by measure. Rather, she created each dance separately and then fit it back into the music, paring off or adding on when necessary. Not choreographing note for note– "mickey-mousing it" as she calls it–, allows each dance to be conceived and learned as a whole on its own and encourages participation of the dancers in the choreography.

The participation of the dancers has been the key in Liz's choreography. Although she initially wanted to have all of the dances planned before she actually started rehearsing, she soon found that the creative energy of the dancers was good for building collective ideas. As Liz put it, "It's been very exciting for me to collaborate with people whose lives evolve in a scientific community... People have been very receptive to my ideas; my ideas have all fallen on fertile ground." Liz again stresses the analogy between artist and scientist: "There is a common ground... a basic intelligence tying us together."

ENTERTAINMENT

photo by Kent Noble

Earthquake Survivors— These arches are real Throopers. Originally the facade on Throop Hall, they are being incorporated into the new Beckman Lab of Chemical Synthesis.

You'll Love the F/X

by Nick Smith
F/X
Orion Pictures
Directed by Robert Mandel

If you want somebody killed, you hire a professional killer, right? Well, who do you hire if you want to *convince* people you've killed someone, without actually doing it? You hire the best movie special effects technician you can find, according to the premise of *F/X*.

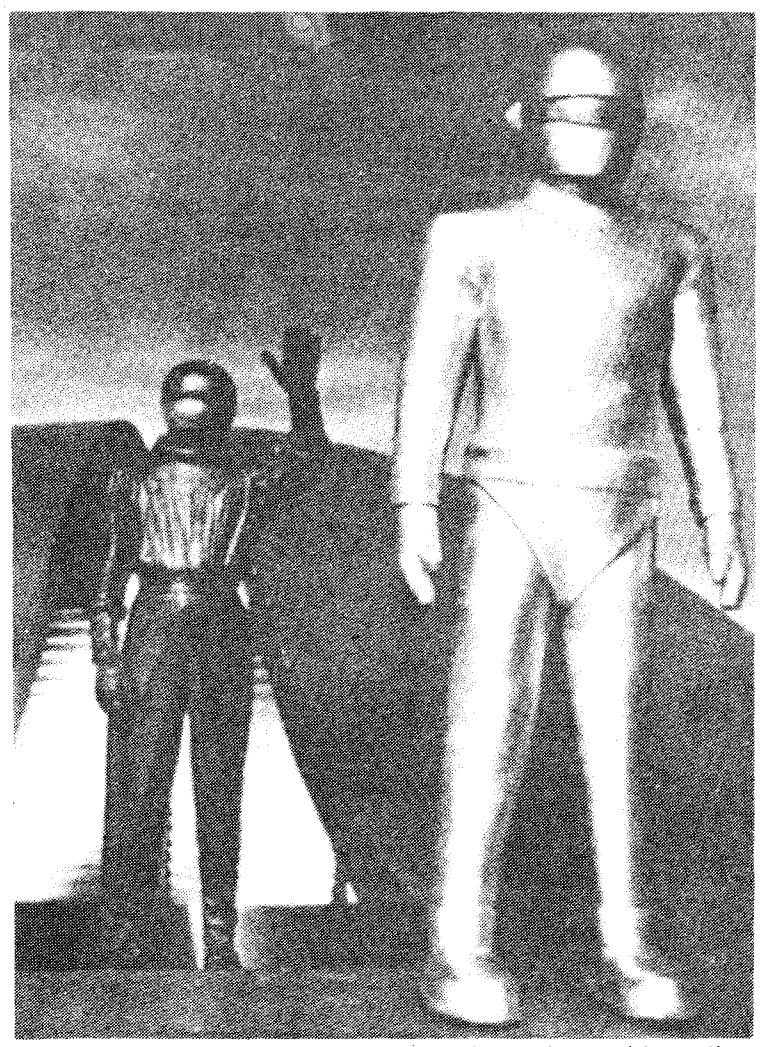
Bryan Brown plays Rollie Tyler, a wizard at creating fake scenes of mayhem in horror movies. He's approached by the Justice Department to stage a fake killing in a public restaurant. The whole thing is being done to protect a mobster who has turned government witness. Well, the money's right, and a few qualms over the circumstances are easily overcome by Rollie. What could go wrong? A lot, and *F/X* becomes an exciting adventure movie, along with providing more ideas for great RF's than *Real Genius*.

Brian Dennehy (the alien leader from *Cocoon*) plays a tough, unstoppable police detective who finds himself in a baffling case. Mason Adams (he played Charlie on *Lou Grant*) is the Justice Department chief who pulls the strings. Rollie finds himself caught up in a bizarre web of plots, murders, and "murders", one in which Rollie is considered a loose end to be tied up. Permanently. A lot of other good actors and actresses make appearances, but they might as well be scenery compared to Brown, Dennehy and Adams.

Robert Megginson and Gregory Fleeman turned in a script with remarkably few plot holes, and those few are explainable. The visual effects and photography were well done, making almost every special effect convincing. The only flaw here is that, just like in the old *Mission: Impossible* episodes, they faked a couple of scenes that involved full facial masks. A pity, because the other effects were good, especially when Rollie created one effect that *he* couldn't tell from the real thing.

F/X uses a few standard plot lines, questioning the morality of protecting a bad guy who changes sides, the safety of giving the Justice Department *carte blanche* in dealing with organized crime, and the politics of police departments, where a polite hack is more successful than an abrasive supercop. Still, the whole thing is put together well, and sustains a high level of suspense throughout.

The moral of *F/X*: never get a special effects man mad. Go see it.



The earth will stand still tomorrow when the Southern California Skeptics present "The UFO Verdict: Examining the Evidence." See announcement on last page.

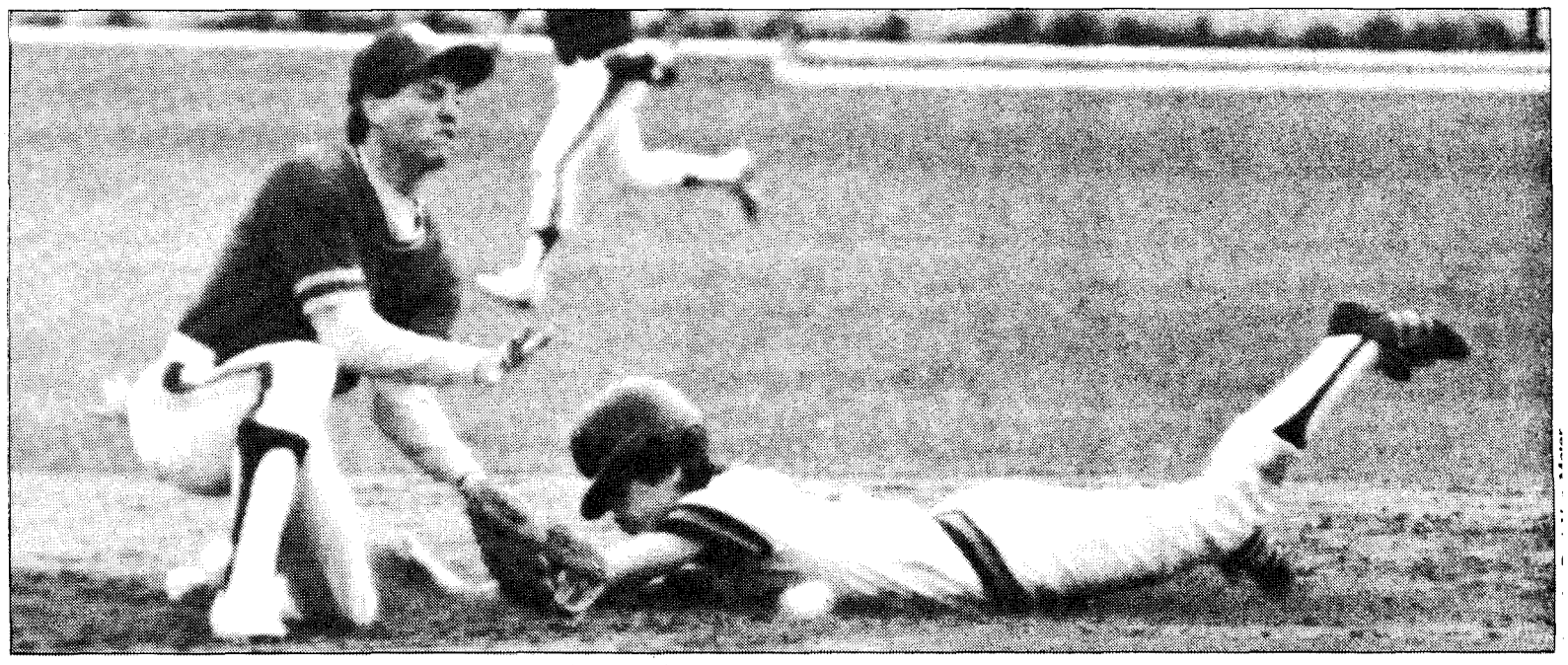
Mafia Film to be Shown in Baxter

Cortile Cascino, a documentary film about the poverty in Palermo, Sicily, and its relationship to the Mafia there, will be shown in Baxter Lecture Hall Thursday, February 20. The movie will begin at 7:30, and is being presented in connection with Professor Robert Rosenstone's history class in documentary film making. The class is being taught in cooperation with Melon Lecturer, Jill Godmilow.

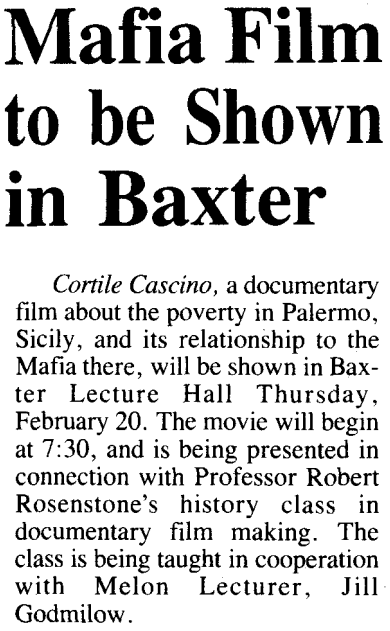
This film was originally made in 1961 for an "NBC White Paper," but was never released by the network due to its politically sensitive nature. The director of the film, Bob Young will make a personal appearance.

Young has won numerous awards for his film work, including the Peabody Award for the films *Sit-in* and *Angola: Journey to a War.* Other films include *Nothing but a Man* and the well-known prison documentary *Short Eyes.*

For more information call x6624 at the Public Relations Office.



Thief!— Brandon Mymudes steals second base for Caltech in the Beavers' 11-6 victory over PCBBC on Tuesday afternoon.



Investment Fund

The Student Investment Fund will disburse up to about $4,000 for projects of broad interest to the students. The disbursements should not be used for the furtherance of any political course or making up any deficit incurred, nor for funding scholarships. Instead they should preferably be used for capital investments. Please submit proposals to

Sing Ung Wong
222 S. Chester Ave.
Pasadena, CA 91106
Attn: SIF Disbursements

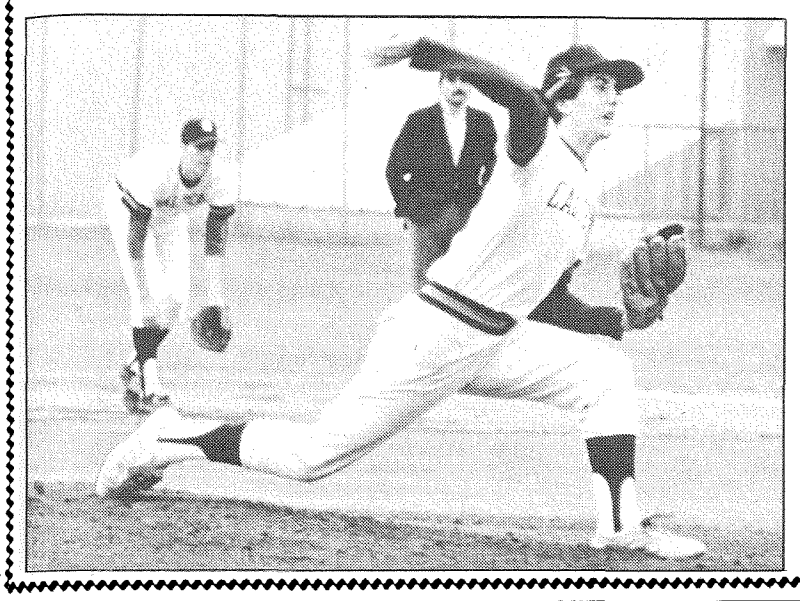
Call Sing Ung at x6180 or talk to any SIF member for details.

Real Genius Screening

Director Martha Coolidge and other people affiliated with the filming of *Real Genius* will attend a screening of the movie at USC and hope lots of Techers will attend. The screening will be Tuesday, February 18 at 9:30 p.m. in Norris Cinema Theatre. DKA, the organization responsible for the screening, has given permission for Techers to take over the projection booth. Bring popcorn and bring your bunny slippers!

Admission is $2.50 but will be waived for people who bring working lasers. If you are able to comply with this provision, please contact Astrid Golomb on Tuesday at (213) 743-6797, or Bruce Tiemann in Ricketts House.

SPORTS



Hurler— Freshman Brian Colder pitched a brilliant baseball game on Tuesday to lead Caltech to their first win of the season. The Beavers defeated Pacific Coast Baptist Bible College 11-6.

photo by Rod Van Meter

WEEKLY SPORTS CALENDAR

Day	Date	Time	Sport	Opponent	Location
Fri.	2-14	1:00 pm	Golf	La Verne	Whittier
Fri.	2-14	All Day	Wrestling	NCAA Div. 3 West Regional	Wisconsin University
Sat.	2-15	All Day	Wrestling	NCAA Div. 3 West Regional	Wisconsin University
Sat.	2-15	10:00 am	Swimming (M/W)	Pasadena City College	Caltech
Sat.	2-15	12 noon	Baseball	Christ College	Christ College (2)
Sat.	2-15	1:00 pm	Women's Tennis	Cal Lutheran	Cal Lutheran
Sat.	2-15	1:30 pm	Men's Tennis	Claremont-Mudd	Claremont (V & JV)
Sat.	2-15	7:30 pm	Basketball	Whittier JV	Caltech
Tue.	2-18	3:00 pm	Baseball	The Master's College	Caltech
Tue.	2-18	3:00 pm	Men's Tennis	Pomona-Pitzer	Caltech
Tue.	2-18	9:30 pm	Ice Hockey Club	UCLA	Pasadena Ice Center
Wed.	2-19	3:00 pm	Women's Tennis	Whittier	Caltech
Wed.	2-19	7:30 pm	Basketball	La Verne JV	Caltech
Thu.	2-20	1:00 pm	Golf	Whittier	Redlands
Thu.	2-20	All Day	Swimming (M/W)	SCIAC Championships	South Gate
Fri.	2-21	All Day	Swimming (M/W)	SCIAC Championships	South Gate
Sat.	2-22	All Day	Swimming (M/W)	SCIAC Championships	South Gate
Sat.	2-22	11:00 am	Track	Claremont & Whittier	Occidental
Sat.	2-22	12 noon	Baseball	Pacific Coast Baptist Bible	PCBB (2)
Sat.	2-22	1:00 pm	Women's Tennis	La Verne	La Verne
Sat.	2-22	1:30 pm	Men's Tennis	Redlands V & JV	Redlands
Sat.	2-22	7:30 pm	Basketball	Pacific Coast Baptist Bible	Caltech
Sun.	2-23	12 noon	Fencing	Cal Poly & Occidental	Cal State Long Beach
Sun.	2-23	1:00 pm	Women's Soccer	Spinoffs	Caltech

Caltech Hockey Fall to CSUF

photo by Rod Van Meter

Ice Wars— George Yates, captain of the Caltech Hockey Club, is held back by a Cal State Fullerton opponent and his stick in Tuesday evening's match.

by Marty Zimmerman

Tuesday night the Beavers put out a strong effort but were nevertheless defeated by Cal State Fullerton, the top team in the league. Though the team was very physical, the hitting was clean and there were only two penalties in the game – none by Caltech.

The game was never really close, but the score was nearly even for awhile. This was thanks mostly to the fine play of goalie Peter Dowd, who had a magnificent game. During the first period Fullerton had 21 shots on goal, and Peter stopped 20 of these.

Midway through the second period, however, Caltech's luck ran out as Fullerton scored four goals in under two minutes, two of these goals coming only 15 seconds apart. The final score was 11-0.

Peter finished the match with 51 saves – an incredible number reflecting both his skill in the net and the poor work of the Caltech skaters in their own zone.

Next week's match against the UCLA Bruins is the final regular season game of the year. This should prove to be a good game because the Bruins are not one of the top teams in the division. Thanks go out to all of the fans who came out this week.

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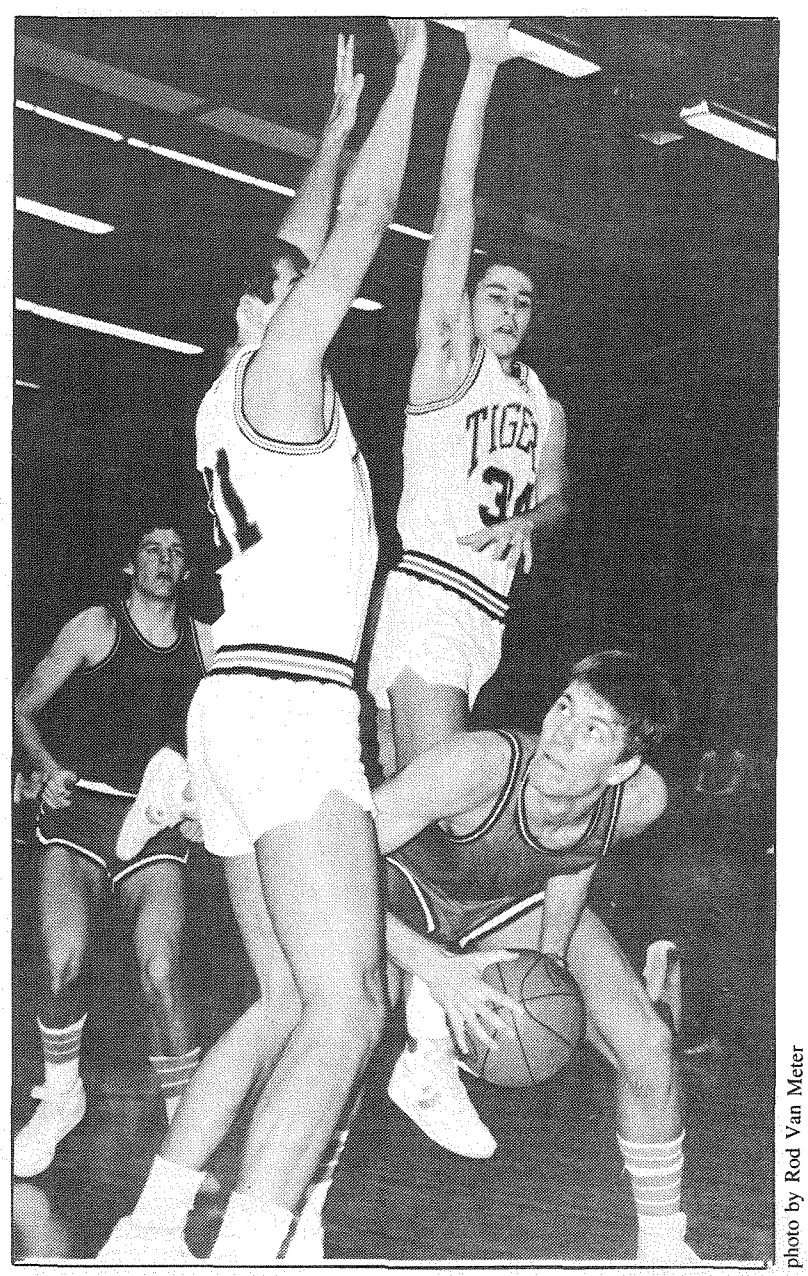

photo by Rod Van Meter

Towers— Center Brett Bush finds himself in trouble in the game vs. Oxy.

WHAT GOES ON

UFO Lands—Film at 11

Are UFOs products of advanced alien civilizations or of sloppy journalism? Who's covering up more facts and fallacies, the Pentagon or the New York *Times*? Are aliens really investigating military bases and the best fishing spots? Find out tomorrow in a fascinating lecture in Baxter Lecture Hall.

Phillip Klass, senior editor of *Aviation Week and Space Technology* and an internationally recognized authority on the subject of UFOs, will discuss "The UFO Verdict: Examining the Evidence." The lecture will take place in Baxter Lecture Hall on Saturday, Feb. 15 at 2:00 pm. Free and open to the public. The lecture is sponsored by the Southern California Skeptics and the Caltech Y.

Phillip Klass is the author of *UFOs: The Public Deceived* (The Los Angeles *Times* called it "A fascinating and detailed analysis") and *UFOs Explained* as well as hundreds of articles concerning UFOs.

Enterprise Forum

The Caltech/MIT Enterprise Forum will be held on Tuesday, Feb. 18 at 7:00 pm in Baxter Hall. Thomas Tisone, President of Nouvas Manufacturing Technology Company of Santa Ana, will present his business plan to a panel of technical, financial and marketing experts. Nouvas was founded in 1982 to manufacture and market assembly and test equipment, work stations and components into the factory automation market. Free to Caltech studetns with ID.

Methods in Math

The second talk of the "Methods in Mathematics" is "Polya's Method of Counting Hydrocarbons" by Dr. Phil Hanlon. This method is a powerful method for counting certain kinds of graphs. The talk will be given at 7:30 pm on Tuesday, Feb. 18 in 151 Sloan. Refreshments will be served after the talk.

See *Kismet*

Tickets for *Kismet* are on sale now at the Caltech ticket office. They are $5.00 for students, $7.50 for staff and faculty. Performances are Fri. Feb. 21 and 28, Sat. Feb. 22 and March 1, and Sun. Feb. 23 at 8 pm, and Sat. and Sun. March 1 and 2 at 2 pm. *Seating is reserved* and they're going fast, so buy your tickets now.

Career Day

The Annual Caltech Career Day will be Thursday, February 20 in the Winnett Student Center. Open House hours will be from 11 am through 3:30 pm. During this time over 30 organizations will have representatives who are ready, willing and eager to talk with students of ALL levels about all kinds of career and employment questions. Come and gather information on employment requirements, current company projects or summer hire policies and programs *or* put on your three-piece suit and pursue serious interview opportunities. For more information or to see the list of organizations, come down to the CDC, 08 Parsons-Gates.

Squash Racquets Club

All those interested in playing squash at a recreational and/or competitive level, please contact either Leo Merken (440-9092) or Salim Khan (304-0719, Marks House). Currently, due to the unavailability of courts at Caltech we would have to use the exhorbitantly priced facilities of the Pasadena YMCA. If enough people are interested, however, there is a very good chance of getting the club subsidized by Caltech.

Summer Here or There

GTE Laboratories will conduct the Industrial Undergraduate Research Program of summer internships for upper division undergraduate students in science, mathematics and engineering. Deadline: March 10, 1986. For information on this and other summer programs, here or abroad, drop by the Career Development Center, 08 Parsons-Gates.

BOC Rep-at-Large

The Board of Control will soon select two representatives-at-large. Anyone interested should sign up in any of the student houses. Signup sheets will be until 5 pm *today* [nice of them to give a lot of notice, eh?]. First round interviews will be held Monday, February 17th.

Concerted Orchestra

The Occidental-Caltech Symphony Orchestra will be performing its second concert program of the 1985-86 school year on Tuesday, February 18 and Wednesday, February 19 at Thorne Hall, on the Occidental campus, and Garland Theatre, on the Polytechnic School Campus (on the corner of Cornell and Wilson Ave.). The concerts will be at 8:00 pm and will feature guitarist Darryl Denning in the *Guitar Concerto* by Vivaldi, as well as the Orchestra, under the direction of Dr. Allen Robert Gross, in *Symphony no. 35* by Mozart and *Billy the Kid* by Aaron Copland. The concert is free and open to the public. For more information, please call (213) 259-2785.

Der Junge Törless

All are invited to a showing of *Der Junge Törless* in Baxter Lecture Hall on February 17 at 7:30 pm. Based on a novel by Robert Musil, young Törless is brought up in a boarding school and sees how his fellow schoolmates sadistically torture a classmate of his. The film is played mainly by unknown actors and was a multi-prize winner.

Coin Auction

A coin auction will highlight the February 19 meeting of the Caltech-JPL Numismatic Society. Included in the sale are examples of old American coinage no longer in circulation from cents to silver dollars. Often there are items of interest for the collector of foreign coins. Bargains are available to those prepared to engage in energetic bidding to enhance their collections. All Caltech-JPL personnel and their families are welcome to attend meetings held the third Wednesday of each month at 7:30 pm in room 168 of the Church Laboratory Building.

Scholarships for Blind

The National Federation of the Blind Scholarship Committee is offering scholarships for blind students who excell in their field of study and who have financial need. For further information please contact the Financial Aid Office, Room 10 Parsons-Gates. Application deadline: March 31, 1986.

Optical Money

SPIE—The International Society for Optical Engineering, is offering scholarships. Awards will *not* be made on the basis of need. Selections will be based upon an assessment of the student's potential contribution to optical or optoelectronic applied science and engineering.

For further information and applications, please contact the Financial Aid Office, room 10, Parsons-Gates. Application deadline: May 5, 1986.

Memorial Math Talk

Dr. Ivan Niven, Professor of Mathematics at the University of Oregon, will deliver the Leonidas Alaoglu Memorial Lecture on Tuesday, February 18 at 4:15 pm in 22 Gates. The lecture will be on "A Problem of Ulam on the Binary Search Algorithm." Niven, whose primary research has been in the area of number theory, is the author of seventy papers and seven books, including co-authoring a classical number-theory text with Herbert S. Zuckerman. Niven is also the immediate past president of the Mathematical Association of America.

The Leonidas Alaoglu Memorial Lecture was established by friends and family of the late Leonidas Alaoglu in recognition of his great talents, his distinguished contributions to mathematics, and his long friendship with Caltech. The Institute is privileged to honor his memory with a lecture each year by an outstanding mathematician.

Uranus Encounter

No, this announcement isn't late.

Mr. Michael Urban will present a lecture entitled "Uranus Encounter" at 7 pm on Saturday, February 22 in the Von Karman Auditorium at JPL.

Mr. Urban is leader of the Advanced Software Development Group for the Voyager Project at JPL. He will talk about the Voyager Project with emphasis on the preliminary results of the Uranus Encounter.

The lecture is one of many activities sponsored by the Organization for the Advancement of Space Industrialization and Settlement (OASIS). The organization is a non-profit educational group which promotes space development.

The public is invited; there is no admission charge. For more information about this lecture or other OASIS activities call F. Wiley Livermont at (818) 700-8382.

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