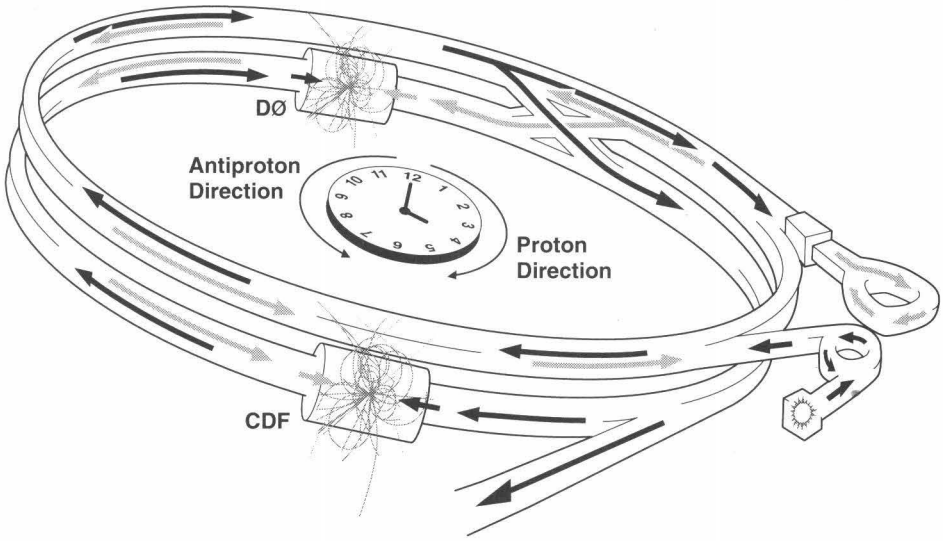
FermiNews

The Newsletter of the Fermi National Accelerator Laboratory

THE TOP QUARK MAY HOLD THE KEY TO EXCITING NEW PHYSICS

The search for the top quark has been underway ever since the bottom quark was discovered at Fermilab in 1977. This search has not been an easy quest. For nearly 20 years it has dominated the efforts of thousands of people worldwide and has turned out to be one of the greatest challenges faced by experimenters in high-energy physics.



THE FERMILAB TEVATRON IS THE ONLY ACCELERATOR ABLE TO WORK AT THE ENERGY LEVELS REQUIRED TO PRODUCE TOP QUARKS. ONE OF THE GOALS OF EXPERIMENTERS AT CDF AND D0 IS TO FIND THE TOP QUARK AND MEASURE ITS MASS.

WHAT'S SO SPECIAL ABOUT THE TOP QUARK?

Large international experiments at CERN (Geneva, Switzerland), DESY (Hamburg, Germany), KEK (Tsukuba, Japan), SLAC (Stanford, California) and FERMILAB have all searched for the top quark. Each experiment searched for many years and involved a large number of universities and laboratories.

Physicists have made predictions about the mass of the top quark based on mathematical models and the experimental evidence gained from past searches. A little over a decade ago, many physicists believed that the top quark would be observed in experiments then being conducted at DESY. At that time the mass of the top quark was predicted to be about 15 GeV/c^2.

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TOP QUARK

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Since the search began, experimental evidence has led to a steady rise in the mass limit of the top quark. Recent results from the CDF and D0 experiments show that the top quark mass must be at least 130 GeV/c^2. (See Table I)

"Scientists now know that the top quark is at least that heavy because if the top quark were lighter than 130 Gev/c^2, we would have already discovered it," says G.P. Yeh, CDF.

HOW ARE TOP QUARKS PRODUCED?

Today, the Fermilab Tevatron is the only accelerator able to achieve the energies necessary to confirm the existence of the top quark. If the mass of the top quark is less than 180 GeV/c^2, it should be discovered at Fermilab in the near future. One of the goals of CDF and D0 is to find the top quark and determine its mass.

Tops are produced in pairs when a light quark in the proton and a light antiquark in the antiproton annihilate to form a top-antitop pair. Since the Standard Model predicts that the top should almost always decay into a W particle and a bottom quark, we expect a top-antitop event to produce a W^+W^- pair and bottom and antibottom quarks. This assumption must be tested. The top is so massive, it might decay in ways not included in the Standard Model. "Nature is the ultimate arbiter; she tells us if we are right or wrong," says Stephen Parke, RD/Theory Department.

If current predictions are correct, the Tevatron and its upgrade, the Main

EXPERIMENT	DATE	MASS
e^+e^- experiments		
PETRA at DESY PEP at SLAC	1984- 1985	15-22 GeV/c^2
Tristan at KEK	1988	26 GeV/c^2
SLC at SLAC	1989	41 GeV/c^2
LEP at CERN	1990	45 GeV/c^2
$p\bar{p}$ experiments		
Tevatron at FERMILAB and Sp$\bar{p}$S at CERN	1988	49 GeV/c^2
Sp$\bar{p}$S (UA-1) at CERN	1990	60 Gev/c^2
Sp$\bar{p}$S (UA-2) at CERN	1990	69 GeV/c^2
Tevatron (CDF) at FERMILAB	1990	72-77 GeV/c^2
Tevatron (CDF) at FERMILAB	1992	91 GeV/c^2
Tevatron (D0) at FERMILAB	1994	131 GeV/c^2

Table I: There has been a steady progression in the mass limit of the top quark from 15 GeV/c^2 to the most recent published limit of 131 GeV/c^2. The Standard Model requires that the top mass be less than about 200-250 GeV/c^2. If this mass range can be completely explored then either the top quark will be discovered or the Standard Model will be shown to be incorrect.

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PEOPLES TESTIFIES FOR HEP BEFORE SCIENCE SUBCOMMITTEE

On January 26, 1994, the Science Subcommittee of the House Science, Space and Technology Committee held a hearing on the future of high-energy physics research in the United States. Director JOHN PEOPLES testified before the subcommittee, along with panelists Roberto Peccei, past chairman of the American Physical Society's Division of Particles and Fields, and Frank S. Merritt of the Enrico Fermi Institute of the Universtiy of Chicago. Previously, Martha Krebs, DOE's director of Energy Research; John Gibbons, director of the Office of Science and Technology Policy, and Robert Eisenstern of the National Science Foundation testified as part of the first panel.

The panelists emphasized the importance of maintaining sufficient funding for the base high-energy physics program. "The most logical and current steps for the U.S. program in high-energy physics are to complete in timely fashion the Fermilab Main Injector and the Stanford B-Factory (and) to provide full operational funding for these facilities once they are completed in order to achieve the most and best physics research," said Gibbons.

John Peoples said, "The United States has a superb capability for forefront research in elementary-particle physics for the next decade—but it can be realized only if there is sufficient funding to make efficient use of our existing world-class facilities. Research in particle physics over the past 60 years has produced a remarkably successful theoretical picture describing matter and energy as built of certain constituents, interacting through specific forces according to known physical laws. Yet despite its success, this picture also raises profound questions that only new experiments can answer. These questions present great opportunities for discovery. Throughout most of the long period of its development, the U.S. led the world in making contributions to the understanding of matter and energy. Today, the U.S. is still one of the leaders in this global field of research. In spite of the termination of the SSC, the U.S. can make many important contributions to elementary-particle physics for the remainder of the decade. But, after that, we will not remain among the leaders in the ensuing decades unless we rebuild our capability to construct and operate world-class facilities."

John added that the funding for the base program is no longer sufficient to "allow achievement of the great potential for discovery in the U.S. and it certainly does not allow for new projects. Nevertheless, some superb opportunities exist and they can be realized with a modest increase in funding."

There was also general agreement by the panelists that the U.S. high-energy physics program would benefit from the United States participation with CERN in the construction of the Large Hadron Collider (LHC). "The SSC has been terminated and we know that research at the energy frontier will not proceed by that route in the U.S. for the foreseeable future. The LHC proposed by CERN is scheduled for completion early in the next century. While it has only a third of the energy that had been planned for the SSC, it offers the best prospect for U.S. experimentalists to work at the energy frontier in the next decade," said John. Krebs agreed and spoke of a "vision of the future" that could include the LHC.

"The United States has a superb capability for forefront research in elementary-particle physics for the next decade—but it can be realized only if there is sufficient funding to make efficient use of our existing world-class facilities."—*John Peoples*

John said that U.S. participation in the LHC will probably require a contribution of roughly $500 million to CERN for the construction of LHC and of the two detectors. "This would require a 10 percent increase in high-energy physics funding, in addition to funding for the base program over the 10-year period between 1995 and 2005—a very small number compared to the funds previously allocated to the SSC," John commented.

The future of the program is now being assessed by a subpanel of DOE's High Energy Physics Advisory Panel chaired by Sidney Drell. They will issue a report in May.

The American Physical Society's Division of Particles and Fields has also established a series of working groups. They will issue a report in about a year.

Full text of John's testimony can be obtained from the Publications Office, WH15SW, by requesting TM-1876.

TOP QUARK

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Injector, should produce a large sample of top quarks. From these studies physicists will be able to test the validity of the Standard Model. "The Standard Model appears to be true. Right now we are just confirming that people who have come before us are right. But, because the top quark is so massive, there is the possibility we are on the verge of discovering completely new physics," says Stephen.

WHY IS THE TOP QUARK SO HEAVY?

Why the top quark is so heavy remains a mystery and the answer to that question may lead to a whole new era of physics. "Partly because it must be so massive, the top quark may shed light on the origin of mass, one of the most urgent questions particle physicists can address," says John Huth, CDF.

It is remarkable that the top quark, if it exists, is so massive. The minimum top quark mass of 130 GeV/c^2 means that the top quark is heavier than nuclei of 53 of the 107 elements in the Periodic Table, including tin and silver. In contrast, the bottom quark, which is the heaviest among the first five quarks, has a mass of only 5 GeV/c^2. The proton has a mass of 0.9 GeV/c^2. — *G.P. Yeh.*

The top quark is by far the heaviest of all the fundamental particles. It is currently predicted to be about forty times heavier than the second heaviest quark, the bottom quark. (See Table II)

Although we do not know why the top quark is so heavy, some physicists believe that the mechanism that causes mass is somehow more closely connected to the top quark than to any other particle. Various models and theories, including the Standard Model, seek to explain why quarks have mass. Precisely measuring the mass of the top quark may give us real insight into what causes mass. That is why studying the top quark is so exciting. "We don't know if the top is the Yeti or just the footprints of the Yeti," says Chris Hill, RD/Theory Department. "The Standard Model is not complete. We need something to explain the quark masses," says Stephen. Understanding the origin of mass would be "an achievement on a par with the greatest scientific strides in history like Newton's establishing the universal law of gravitation or Einstein's connection of energy to mass and the speed of light," says Chris.

The CDF and D0 collaborations have set their sights on the discovery of the top quark. After they find it, their focus will shift to the determination of its mass and the observation of its major decay modes.

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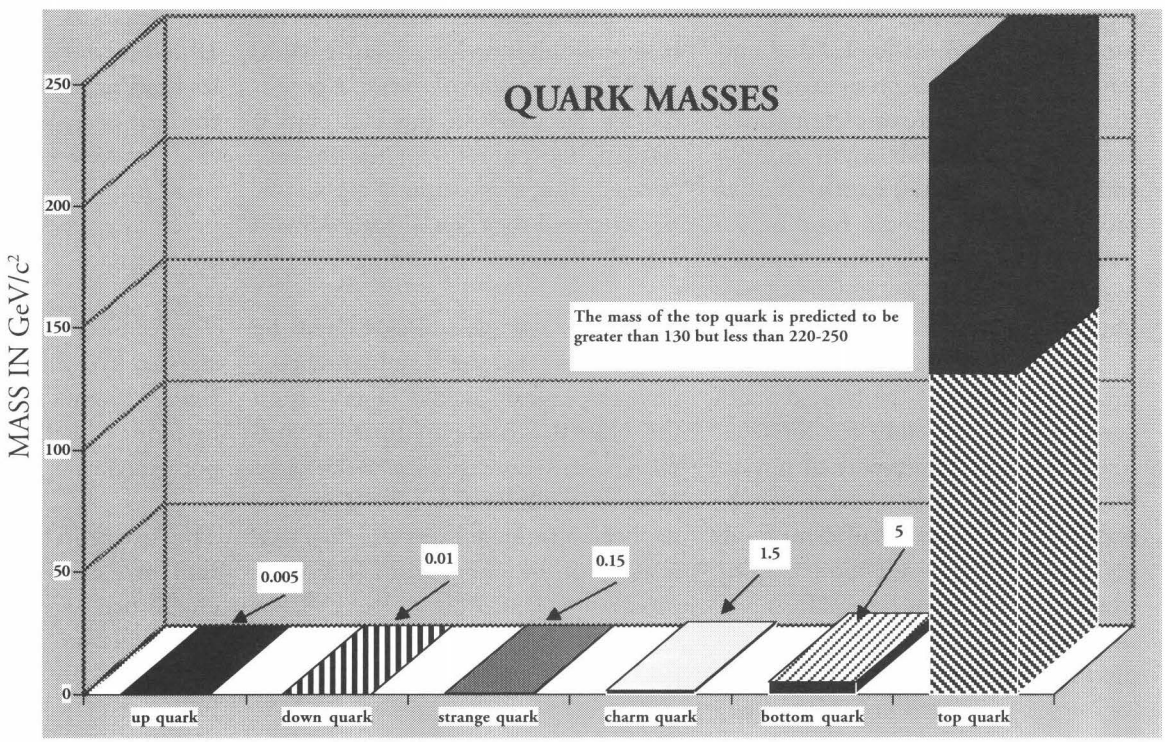

Table II

QUARKS

FERMILAB'S DEER POPULATION ON RISE

Fermilab's deer population is continuing to grow, according to a recent aerial count of the site by ROD WALTON of ES&H. Three hundred and forty deer were counted this year during the March 1 helicopter survey. This is an increase from last year's count of 305 deer.

"This is an 11.5% increase in one year," said Rod. "If this rate of increase continues unchecked, the deer population could double in less than six years. And that is a lot more deer than we can handle."

Rod said he was concerned by the small size of some of the deer during the count. "This may be due to decreased growth because of nutritional stress, or, more likely, it may indicate a large number of yearlings, which will likely begin reproduction next year." Either situation is not good, for the deer and for the Lab, Rod added.

Rod noted the distribution of deer has also changed since last year. Since the Main Injector project began, the deer population appears to have shifted into the center of the ring. There were 159 deer inside the ring the day of the count—a density of 140 deer per square mile. "The optimum density is somewhere in the neighborhood of 10 to 15."

Rod indicated he was somewhat surprised by the increased deer population. "I wouldn't have been surprised if I saw less deer (during the count) than last year because I haven't seen many deer while driving on site." But, as Rod explained, one reason for the fewer sightings could be the good growing season last year. There was ample food for the deer and there was little need for them to move around the site to find it. Although deer may have traveled less throughout the site, deer accidents with vehicles increased from nine in 1992 to

19 in 1993.

Rod said the Laboratory does not have enough statistics on the deer population growth to know what can be done to regulate their population right now.

"We won't do anything until we have a better idea of what is going on. We will be looking for the natural environment to curb the population. We'll wait and see."

MAIN INJECTOR ENCLOSURE CONTRACT AWARDED

The contract for the construction of the Main Injector Enclosure was recently awarded to a local construction company. Wil-Freds of Naperville was awarded the contract March 18 for the largest single piece of civil construction at the Laboratory since its initial building.

The Enclosure work will be done in two phases over 22 months and will employ about 350 workers from local communities. This project is the seventh bid package awarded since work on the Main Injector began in July 1992.

The enclosure project entails carving out a 10,600-foot oval ring to a level between 20 and 30 feet below grade. When complete, the interior dimensions of the enclosure, which will house the accelerator itself, will be typically eight feet high by 10 feet wide.

Director JOHN PEOPLES said, "I am delighted with the continued support of DOE for this project. I believe this contract award is an important milestone as we upgrade Fermilab's accelerators for exciting physics research in the near future."

TOP QUARK

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According to John Huth, "We do not search for the sixth quark merely to fill in a blank. Without the top quark, the Standard Model collapses. The Fermilab Tevatron can settle the issue by actually producing and measuring the mass of the top quark. The situation is tantalizing because we may actually be entering a new era in which the Standard Model begins to self-destruct and our understanding of basic forces will actually be increasingly challenged."

This is a second in a series of *FermiNews* articles written by Laboratory staff on the search for the top quark.

People & Events

ENGLER RETIRES

NORB ENGLER, a long-time employee in Technical Support, retired from the Lab March 31. Norb started working at Fermilab as a contractor in January 1971. He became a permanent employee in November of that year.

In his retirement, Norb said he plans to "do nothing." "I look forward to having more time to boat and motorcycle and be 'Mr. Mom'—take my wife to work, do things at home.... It's going to be nice."

Norb said he first took the job at the Laboratory thinking it would be a temporary position, but it turned out to be a permanent position—22 years worth. "It's been a good 22 years. I've learned a lot and many people helped me. This is the one place I've worked where the people I've worked with were colleagues—that made it a nice place."

ARTS SERIES PRESENTS

The Choreographer's Showcase: Joseph Holmes Chicago Dance Theater, Winifred Haun & Dancers, am/FM

The Fermilab Arts Series presents the Choreographer's Showcase, highlighting some of the best dance talent in the area. This year's showcase brings back two familiar yet quite different companies and presents a new force in the dance community. Don't miss this unique sampling of great Chicago dance on Saturday, April 16 at 8 p.m. in Ramsey Auditorium. Tickets are $10.

A beloved mainstay in Chicago is Joseph Holmes Chicago Dance Theater. Celebrating its 20th year, this modern jazz company performs all original works, often using specially commissioned music.

Winifred Haun & Dancers burst onto the Chicago dance scene in 1991 and has since captured the attention of both audiences and critics, winning two Ruth Page nominations for Choreographer of the Year. The company presents emotionally charged and compelling dance.

am/FM blends two distinctly American

Winifred Haun & Dancers

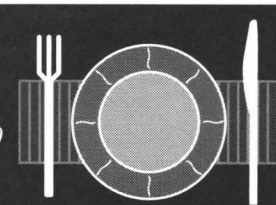
dance forms: tap and modern, to create exciting and innovative performances.

For reservations, call xARTS weekdays from 9 a.m. until 4 p.m.

TORNADO SEMINAR COMING

The Fermilab annual tornado seminar will be held Saturday, April 9, 1994 in Ramsey Auditorium. Sessions will be held at 1 p.m. and 7 p.m. As in years past, meteorologist Tom Skilling from WGN-TV will be the featured speaker. Among others scheduled to speak include Bill Hirt from the National Severe Storms Forcast Center in Kansas City, Missouri and Jim Allsopp from the National Weather Service, Chicago.

Chez Leon Menu



Lunch (Wed) $13.00 • Dinner (Thurs) $23.50
Reservations: x4512

Wednesday, April 6 • *Gnocchi w/tomato and basil sauce, chicken breast stuffed w/prosciutto and fontina, sautéed spinach w/lemon and garlic, mocha choco-chip soufflé*

Thursday, April 7 • *Plantain soup w/Arequipas de Yuca, red snapper Creole, coconut rice, chayote & cilantro salad, guava paste w/cheese, expresso ice cream*

Wednesday, April 13 • *Puree Gloria w/fresh pineapple chunks, vegetable & cheese strudel, mixed green salad, lemon buttermilk tart*

Thursday, April 14 • *Grilled shrimp w/coriander sauce, lamb kebabs w/peanut sauce, steamed jasmine rice, vegetable of the season, citrus caramel flan*

STOCKROOMS TO CLOSE

The Fermilab Stockrooms will be closed for annual inventory on the following schedule:

■ Wilson Hall Stockroom:
Closed Friday, May 13 at 12 noon. Reopen Monday, May 16 at 12:30 p.m.
■ Site 38 Stockroom:
Closed Monday, May 16 and Tuesday, May 17 all day, both days.

WELLNESS COMMITTEE SCHEDULE ANNOUNCED

The Wellness Works Committee has announced its spring schedule of events. Mark your calendars for these "healthful" events.

■ Wednesday, April 6, 1994: Informational meeting on Weight Watchers, noon to 1 p.m., Curia II.
■ Tuesday, April 12, 1994: Blood pressure checks, Wilson Hall Atrium, 11:30 a.m. to 1 p.m.
■ Wednesday, May 18, 1994: Employee Health & Fitness Day. (Watch *Ferminews* for further information.)

Harper's Index

Average number of sesame seeds on a Big Mac:

178

Total value of the 96,000 refund checks returned to the I.R.S. as undeliverable last year:

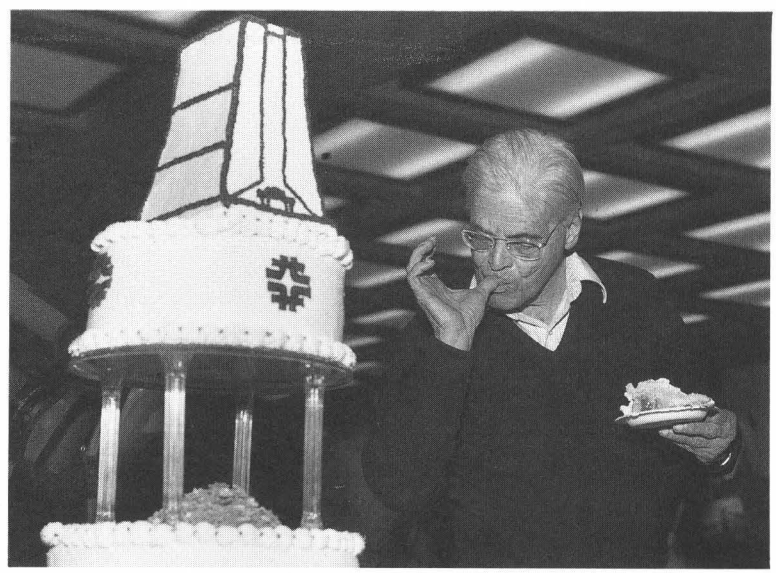
$50,000,000

DO YOU WANT TO QUIT?

The Wellness Works Committee is organizing a support group for those who are quitting smoking. The first meeting is Monday, April 4 at noon in the Comitium. The group will meet twice weekly (Tuesdays and Thursdays), at noon, during April. On Thursday, April 7, a clinical psychologist knowledgeable on cessation techniques, will speak to the group. At the first meeting, we anticipate voting on "The Great Fermilab Smoke Out Date"—the day in which everyone will be ready to quit smoking (hopefully in early to mid-April). At this point you're probably thinking, "This is goofy, I'll just quit on my own." But guess what? Apparently group "quits" have a much greater success rate than other techniques. Other information and support we will present include nutrition to help cravings, ex-smokers advice, perhaps utilizing a buddy system and, of course, the dreaded relapse. Don't put it off, spring is the best time of year to quit! —*Audrey Hopper*

NO PAIN, NO GAIN

Join the spring aerobics class Mondays and Wednesdays from 5:30 until 6:30 p.m. at the Recreation Facility. The class offers a combination of low impact and step aerobics and toning exercises. Men, women and beginners are welcome. Class begins April 11. The cost is $2 per class. If interested contact Jean at x2548. You must be a current gym member to enroll in the class.



Director Emeritus Robert Wilson Honored

Former director Robert Wilson enjoys his birthday cake at the international symposium and tribute in honor of his 80th birthday held at the Laboratory March 4. The day-long symposium featured talks and reflections by many of Wilson's colleagues and friends. A video, created by Fermilab's Visual Media Services detailing Wilson's professional life, was also presented. Alvin Tollestrup, John Peoples, Chris Quigg, Heidi Schellman, Leon Lederman and Lillian Hoddeson were among the many presenters at the symposium who offered their reflections and outlined the contributions Wilson has made to Fermilab and to the world of physics.
(The cake was designed and made by Liz Stupak, a Fermilab cafeteria attendant.)

LIBRARY NEWS

PURCHASE SUGGESTIONS SOLICITED

The Library is interested in finding out what publications are important to the Fermilab community. Please send recommendations for the Library's collection to: E-mail: LIBRARY@FNLIB.FNAL.GOV or MS 109.

AMNESTY GRANTED TO ALL

In a gesture of magnanimity, the Library is allowing the return of overdue materials for a period of time during which we will guarantee no fines or imprisonment. Here is a chance for you to go through your workplaces and hunt down all the things you have borrowed (or taken)—especially bound periodical volumes. Why not do it today? Bring everything back to the Library and enjoy all the extra space you will have. Remember to deposit returned materials in the book drop slot at the front desk.

SEARCHING FOR PREPRINTS

To get a list of the most recent preprints received, connect to the Library's catalog by doing either: SET HOST FNLIB or TELNET FNLIB.FNAL.GOV. Username=Library. Use the catalog's "search mode" and search by the latest Tuesday, e.g.: find preprint and cataloged 29-MAR-1994.

CLASSIFIEDS

■ VEHICLES

1984 Cadillac Cimarron, 52k miles, 4 dr., loaded, very good condition, $3,500. Call Barbara at x3492 or 708-859-8699.

1981 Toyota Celica, in good condition, starts in any weather. Call Mark at x8263.

■ MISCELLANEOUS

Ladder/boat rack for S-10/Ranger, black, good condition, $100. Call 708-554-1337.

23" cubic ft. refrigerator, harvest gold, G.E., $100 o.b.o. Call Sue at x3762 or after 4:30 p.m. at 708-377-2526.

Brand new ALR 486 DX2 66Mhz computer w/full warranty (w/on-site service), 4MB RAM, built-in video (1MB VGA), ports (1p, 2s & mouse), & disk controller, keyboard & 1.44MB floppy, no HD or monitor, won by a Mac user in raffle, $995. Call Tom at x2121 or 708-406-1687.

Whirlpool heavy duty, 3 cycle, 5 temp gas dryer & J.C. Penny heavy duty washer, both large cap./good condition, $300 for set. Call x8599.

Vintage IBM PC (ca. 1984) w/some upgrades, incl. 20 MB HD, B&W monitor, keyboard, TI printer, WordPerfect, in original boxes, perfect condition, $100 o.b.o. Call Tom at x4458 or 708-443-8604.

■ REAL ESTATE

Spacious 2 story colonial in Batavia on beautiful 1/2 acre w/view. 4 bed., 2.5 bath, 2.5 (could be 3) car garage, 1st floor laundry, full basement, many extras, special by-owner price $179,900. Call Tom at x2121 or 708-406-1687.

NEW IN STOCKROOM

■ 1780-0694 Disc, recording, micro, Apple Mac., formatted 1.40 MB, double sided, high density, 3.5 in. 3M P/N 40759.

FermiNews

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