FermiNews

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What Is Electroweak Symmetry Breaking, Anyway?

At high-energy physics labs, including Fermilab, the search is on for the Higgs boson.

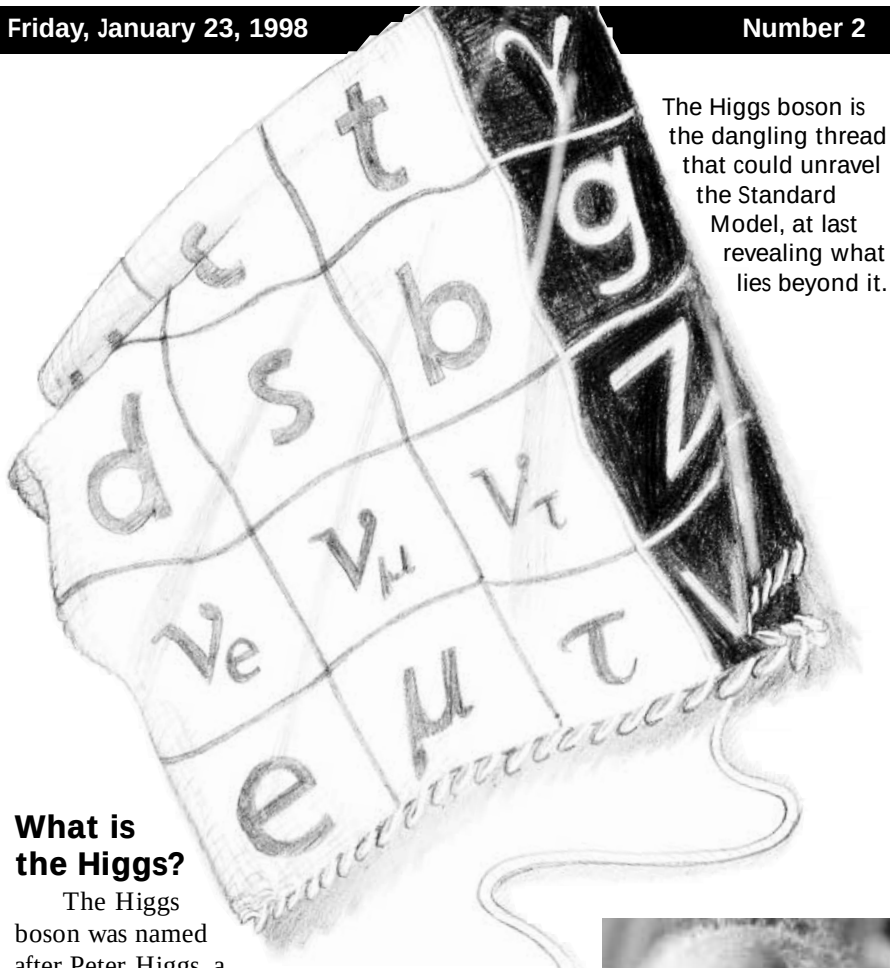
By David Kestenbaum

"I drive the sea!"
~Captain Ahab, peg-legged whale hunter, Moby Dick

"We will find the Higgs.... I promise*!"*
~Gordy Kane, theoretical physicist, University of Michigan

It is only once in a long, long while that a discovery causes a complete rewriting of the textbooks. But physicists think that will happen in the coming decade. They are on the verge of uncovering the Higgs boson, a particle heavier, perhaps, than any yet observed. Among physicists, its name carries the power of myth and legend. Nobel Prize winner Leon Lederman has also dubbed it "The God Particle." The Higgs is the last undiscovered particle predicted by the Standard Model, the accepted model of much of the universe—the dangling thread in an almost perfect fabric. Give it a tug, physicists say, and the whole Standard Model could unravel.

But what exactly is this particle? That's what *everyone* wants to know.



The Higgs boson is the dangling thread that could unravel the Standard Model, at last revealing what lies beyond it.

What is the Higgs?

The Higgs boson was named after Peter Higgs, a Scottish theorist who, in the early 1960s, was among the first to find it hiding in the equations that would become the Standard Model. Physicists know that the Higgs, or something like it, must exist because otherwise nothing would have any mass. Mass is vital—most obviously because it keeps things still. Without mass, the universe would be a chaotic sea of particles zipping about at the speed of light. Molecules would not hang together. Life would never evolve. Fortunately, protons, neutrons and electrons—the particles that make up everyday atoms, and us—have some heft. That heft lends organization to the universe. It provides planets to live on and allows the sun to shine. Mass buoys life.

The Higgs works its weighty magic through an invisible field that pervades all of space. The field clings, like a kind of cosmic

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Photo by Bob Palmer

Physicist Peter Higgs of the University of Edinburgh, Scotland

Higgs

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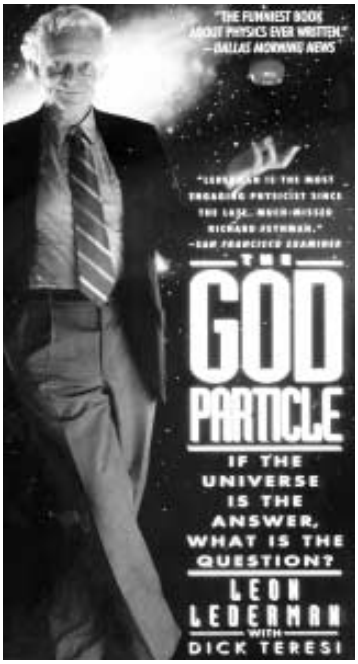

"I was planning to call my book 'The Higgs Particle,'" says physicist Leon Lederman, "but the editor said that no one had ever heard of Higgs."

molasses, to all particles. That cling creates drag, and that drag makes particles seem heavy, hard to move. Heaviness is what we call mass. The Standard Model calls for all the carriers of the electroweak force to have the same—or "symmetric"—zero mass, in order to allow the unification of the electromagnetic and weak nuclear forces into a single electroweak force. Yet we know that, unlike the massless photon, which carries the electromagnetic force, the *W* and *Z* bosons, which carry the weak force, in fact have non-zero masses: the "electroweak symmetry" of boson masses is thus broken. In physicist-speak, the Higgs is the particle that hides the symmetry of the Standard Model, shifting the equations in a crucial way so that once-massless particles can have mass without throwing everything else out of kilter.

Physicists talk about the Higgs as if they knew it intimately, but don't be fooled. "The Higgs" is just a Band-Aid. They know that something like it has to be there or else the Standard Model goes haywire, but no one knows exactly what form it will take. The Higgs has been called the Holy Grail of particle physics. It has also been called the rug of ignorance under which the problems of the Standard Model have been swept. One eminent theorist has referred to the Higgs as "the toilet of the Standard Model; every house must have one, but no one likes to talk about it."

The Standard Model's breaking point

The Higgs sits at the center of one of the most remarkable accomplishments in physics history—the development of the Standard Model. The Standard Model is a "theory of almost everything." It does not describe gravity, but it covers everything else, from the reactions that fuel the sun to the forces that hold a snowflake together. For the past 25 years, its predictions have matched experimental data, decimal place for decimal place, with amazing precision. The Standard Model has been poked at with everything from small desktop experiments to huge particle accelerators—some encircling the area of a small city—and it has yet to break. But break it must.

Physicists look on the Standard Model with a mixture of reverence and frustration. Since they put it together, they have always known that it is incomplete. First, it does not incorporate gravity. Second, and equally bothersome, it raises as many questions as it

Fermilab Photo

Fermilab theorist Chris Hill says "a single Higgs is just dumb."

seems to answer. Why, for instance, are there four forces and not six, or one? Why are there only the particles that we see, and no more? What accounts for the crazy quilt of masses that particles possess? Deep inside the Standard Model, physicists think, something is wrong. There must be a larger, more elegant theory, a "theory of everything." And different theories have very different Higgs structures: it's one of the first places they leave their fingerprints. Find the Higgs, or whatever is there, "and it will smash open the Standard Model," says Fermilab theorist Chris Hill.

Imperfect ideas, like old clothes, begin to fray first at the edges. And so it is with the Standard Model: while it perfectly describes most things at earthly energies, without something Higgs-like, its predictions for very high-energy events degenerate into nonsense. For instance, at very high energies like those that particle accelerators will achieve in the next decade, the Standard Model predicts that things happen more than 100 percent of the time. Rationality is restored to the universe when something like the Higgs steps in. The Standard Model "blows up just down the road," says Henry Frisch, a University of Chicago physicist working on the CDF experiment at Fermilab. "Something weird is going on, right in our neighborhood." The question is, what?

Hopes for the Higgs, dreams of everything

Take a poll in, say, the Fermilab cafeteria on what exactly the Higgs is, and you could very well start a food fight. The 25-year reign of the Standard Model has given physicists plenty of time to propose successors, and each has its cheerleaders and its critics. Everyone's goal is a "theory of everything," an economic, simple theory that works at all energies, for all time, even going back to the searing temperatures of the early universe when everything was compressed into a single point. With that in hand, physicists could pack it up and retire to talk about the old days, like faded baseball stars. But opinions differ wildly over what that mother-of-all-equations might look like, and they're counting on the Higgs to point the way.

Single Higgs

In the simplest scenario, the Higgs is a single particle. But a single Higgs would be a short-term fix, not a long-term cure for the Standard Model's ills. As Chris Hill puts it, "A single Higgs is just dumb. It doesn't explain anything."

In particular it doesn't work toward a simpler theory. It doesn't explain for instance, how the four forces we observe in nature (gravity, electromagnetism, strong nuclear and weak nuclear) might somehow be components of a single force. And current data show that the four forces do look more and more alike at very high energies.

"When you see something like that, there's usually a reason for it," says Fermilab theorist Joe Lykken. But this so-called "unification" does not come easily, and requires more than just a single Higgs.

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Photo by Reidar Hahn

"Something weird is going on right in our neighborhood," says University of Chicago physicist and Fermilab experimenter Henry Frisch.

Twenty-One Tons of Broken Symmetry

Photo by Fred Ullrich

by Sharon Butler, Office of Public Affairs

Artisans of antiquity secretly spoiled the fearful symmetry of their magnificent columnar creations, but Fermilab's founding director Robert Wilson was more direct. He built irregularities right into his sculpture's original design and called it "Broken Symmetry."

For Wilson wasn't seeking to appease the gods; he was hoping to represent one of the deepest principles of nature—that the breaking of an inherent symmetry accounts for the matter and forces we see today.

Viewed from directly above or below the center, the massive, David Smith-inspired sculpture that straddles the roadway at Fermilab's Pine Street entrance is perfectly symmetrical. But viewed from anywhere else, the artwork loses its native balance.

Constructing the giant winged sculpture to Wilson's specifications was no mean feat. For welders like Roger Hiller, it was an oddball project. They had plied their trade in railheads and steel mills—not landscape art. Jerry Peterson, the foreman at the time and now supervisor of Fermilab's Machine Shop, remembers that the project involved more work than anyone anticipated.

Per Wilson's instructions, the welders assembled Broken Symmetry in part from the armored steel plates of the U.S.S. Princeton, a battleship that had served in World War II, the Korean conflict and later the Vietnam War.

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David Schramm, University of Chicago Astrophysicist and Friend of Fermilab

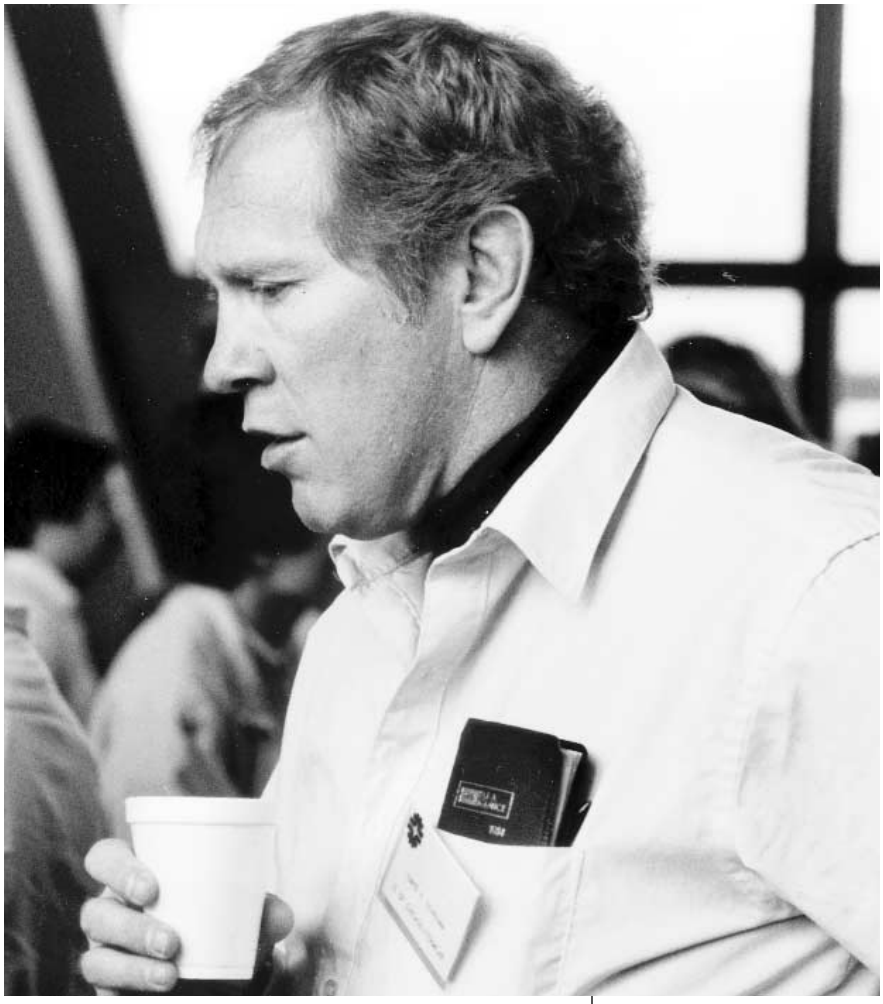
By Rocky Kolb, Theoretical Astrophysics Group

David N. Schramm, Louis Block Distinguished Service Professor in the Physical Sciences Division at the University of Chicago, was killed December 19, 1997, when the twin-engine plane he was piloting crashed outside of Denver, Colorado. He was 52 years old, and was survived by his wife, Judy Ward Schramm, known to many at Fermilab as assistant to former Fermilab directors Robert Wilson and Leon Lederman.

Schramm had a long association with Fermilab. He had been a member of the Board of Overseers of Universities Research Association, Inc., since 1991, a member of the Board of Directors of Friends of Fermilab for more than 10 years, a "user'' in Fermilab's Theoretical Astrophysics Group since its inception in 1983 and a collaborator in the Fermilab Theory Group as well as the Theoretical Astrophysics Group.

"Dave brought his love of cosmology to Fermilab, gave a bit of it to all of us, and now we have a much deeper appreciation of what we can learn from the cosmos," said Fermilab Director John Peoples. "We will miss him."

Known as "Big Dave'' or "Schrammbo'' to his friends and colleagues, Schramm's enthusiasm for life was every bit as large as his enthusiasm for science. He was a National Collegiate Athletic Association champion heavyweight Greco-Roman wrestler while an undergraduate at the Massachusetts Institute of Technology and coached wrestling teams while a graduate student at the California Institute of Technology and a faculty member at the University of Chicago. An avid outdoorsman, he hiked and climbed mountains in Colorado, as well as in South America, the Caucasus, the Alps, and the Tatras. He set the skiing standard for physicists around the world. Flying was a big part of his life, and he was proud of the fact that he was the President and Chief Pilot of Big-Bang Aviation. We may never know the truth to the legend that hidden under his usual open-collar shirt, its breast pocket bulging with pen and appointment book, was a secret blue shirt with a prominent red "S.''



Fermilab Photo

David Schramm at a conference on astrophysics held at Fermilab in 1984.

Big Dave played a big role in the establishment of astrophysics at Fermilab. In the late 1970s he was part of the unsuccessful effort to convince the National Aeronautics and Space Administration to locate the Space Telescope Science Institute at Fermilab. Although NASA sited the Space Telescope at Johns Hopkins, Dave didn't lose sight of the promise of astrophysics at Fermilab. He helped convince then-director Leon Lederman to establish a theoretical astrophysics group at Fermilab. Living on the Fermilab site from 1983 to 1984, he was a guiding spirit as the group developed into the world's center for particle cosmology. Schramm also interacted with Fermilab through his position on the Advisory Council of the Sloan Digital Sky Survey.

In addition to a close association with Fermilab, Schramm was a frequent long-term visitor at CERN, the European Laboratory for Particle Physics. He was also associated with the

Stanford Linear Accelerator Center, serving as chair of the Senior Oversight Committee of GLAST, the Gamma-Ray Large Area Space Telescope.

Schramm won many honors and awards. He was a member of the National Academy of Sciences, a fellow of the American Physical Society, the American Academy of Arts and Sciences, the American Association for the Advancement of Science and a foreign fellow of the Hungarian Academy of Sciences. His many awards include the Julius Edgar Lilienfeld Prize from the American Physical Society, the Helen B. Warner Prize from the American Astronomical Society and the Richtmeyer Memorial Award from the American Association of Physics Teachers.

Astrophysicists find it hard to remember a conference in their field where Schramm was not a speaker or a member of the organizing committee. He was one of the first to explore the particle physics-astrophysics frontier. Through his scientific contributions and tireless effort, he played a major role in establishing particle astrophysics as an emerging research field. Along with Gary Steigman and James Gunn, Schramm in 1977 showed that there could be no more than four families of the subatomic particles known as neutrinos. In the late 1980s, Schramm, Steigman and others constrained the number to fewer than four—that is, to the three known neutrino families.

"Like all of us, I will miss David," said Director Emeritus Lederman at Schramm's December 26 funeral in Aspen, Colorado.

"[I will miss him] not only for his friendship of the past 20 years, not only for the advice given and taken, not only for his instruction in how to get up the mountain, how to run a university, or how to understand the connection between an abundance of helium in the universe and the lifetime of the Z zero.... I will miss him as someone to get mad at—to yell at.

"Of course, before yelling I always put on my glasses. David would never strike anyone wearing glasses...."

Lederman added that he had just received a fax reporting "that David is in a terrific argument with God about what happened before the Big Bang. The blackboard is covered with equations, and the fax says that David is forcefully explaining to God why string theory is not incompatible with inflationary cosmology. It says here that, during this heated argument, God is wearing glasses."

Schramm was a very effective spokesperson and champion for Fermilab, astrophysics, particle physics and basic research. With his death, Fermilab has lost an advocate, a colleague and a friend.

A memorial service for David Schramm will be held on Saturday, January 31, at 2:00 p.m. in Rockefeller Memorial Chapel, 5850 Woodlawn Avenue, on the campus of the University of Chicago. A reception will follow the service. David's many friends in the Fermilab community are invited to join the celebration of his life and accomplishments. ■

Schramm, wearing his signature open shirt, talked with a colleague in Fermilab's cafeteria in 1984.

Fermilab Photo

Photo by Reidar Hahn

Drasko Jovanovic as he will always be remembered, surrounded by his students from Saturday Morning Physics.

Jovanovic Retires

…and leaves a vacuum at Fermilab's weekly seminar.

by Sharon Butler and Luann O'Boyle, Office of Public Affairs

They called him many things: the soul of the Laboratory ("that's S-O-U-L, not S-O-L-E," a colleague said); a constant of nature; more poetically, "one ever-fixed star"; and more plainly, "a pretty nice guy to know." They roasted and toasted him, and showered him with gifts: mementos of a career that spanned 30 years at the nation's premier high-energy physics laboratory.

When Drasko Jovanovic formally retired in December, the festivities at his reception and the standing-room-only crowd at his farewell lecture left no doubt that he was one of the best loved physicists in all of Fermilab.

Jovanovic was famous for his Saturday Morning Physics for selected high-school students—a series of 10 lectures / demonstrations covering such topics as leptons and hadrons, and the special theory of relativity. Over the years, he shared his passion for the subject with 5,000 youngsters, one of whom was Tom LeCompte, now a physicist in the CDF collaboration. LeCompte told the assembled well-wishers that in Jovanovic's class he learned for the first time that science was fun and that science was something you did, not something you read about in a book. He learned, moreover, that science was something *he* could do.

Jovanovic was perhaps just as famous for his pointed questions at the Friday afternoon wine-and-cheese seminar he helped launch (now no longer with wine or real cheese). As theoretical physicist Chris Quigg remarked, few speakers escaped without Jovanovic's "gently helping to uncover the one or two missing elements in their education." Indeed, many speakers, "having unsuccessfully tried to bluff their way past Jovanovic, left the seminar saying, 'Who is that guy?'"

Jovanovic's farewell talk was titled "A Brief History of Fermilab," better described as an idiosyncratic and anecdotal account.

He remembered his first encounter with Robert Wilson, back in the 1960s, when the man had just been appointed director of the National Accelerator Laboratory, as Fermilab was then known. The occasion was the state's presentation to Wilson of the deed to the site. Jovanovic recalled Wilson's saying: "I visited this land, I grabbed a bit of the earth and put it in my mouth and tasted it as any good farmer would, and I thought, yes, this is good land for building an accelerator." Jovanovic was appalled. "My God," he thought, "are we really going to build an accelerator?"

Doubts about the future Main Ring surfaced later, too, when Jovanovic came to Fermilab in 1971. "Everyone was silent, morose. The machine was not working," Jovanovic said. A sign might have been posted at the entrance gate, he said: "Electromagnetism is not practiced at this site." Soon after he arrived, he, too, was commissioned to repair the ever-failing bending magnets.

"You had to cut the vacuum pipe on both ends (with a hack saw)," Jovanovic remembered. "Then you had to cut away the copper conduits supplying power, take out the old magnet, put in the new one, re-weld it, and pump out the vacuum chamber again."

With 120 magnets already having failed by December 1971, the staff had such extensive practice, Jovanovic recalled, that the whole procedure took a mere five hours.

Late one evening, he remembered, Wilson wandered into the control room, and, on hearing of the latest magnet failures, pulled out of his pocket a copy of the Chanson de Roland, in seventh-century French. He recited a key passage in which the hero proclaims that he would give his life for his God and King. The implication, Jovanovic said, was clear.

And who knows, perhaps because of the Chanson de Roland, Jovanovic said, the new accelerator reached an energy level of 200 BeV in February 1972—as of that date, the world record.

Of course, Jovanovic said, Wilson kept pressing for still more. Now he wanted a beam intensity of 10^{13}. "It was an absolutely ridiculous number," Jovanovic told the audience, "but no one dared tell Wilson. That would be like going into the Catholic Church and saying you don't believe in the Immaculate Conception."

Jovanovic ran through a list of the early experiments at Fermilab, grading them with hand-drawn pictures of yellow lemons and tiny red stars. The neutron cross section experiment got a very big lemon; the hyperon experiment, three stars; his own elastic scattering experiment, half a lemon.

Photographs of Jovanovic with political and scientific luminaries amused the audience: There was Leon Lederman on his knees before Jovanovic (from Lederman, Jovanovic said, "I learned obedience").

But one photograph was missing, the one of Jovanovic with the Pope. People still talk of the time Jovanovic visited Rome to plead with the Vatican to exonerate Galileo.

Remarkably, no one raised a hand during the whole of Jovanovic's talk—even though, as Quigg remarked, this was "payback time" for those who had been "tortured" by one of Jovanovic's piercing questions.

Perhaps they feared they'd be there until midnight, as Jovanovic threatened they would be if they dared ask a question.

Or perhaps they simply felt they could never fill his shoes. ■

Photo by Reidar Hahn

Sporting a "Support the SSC" button in 1988, Jovanovic lectures in the Leon M. Lederman Science Education Center.

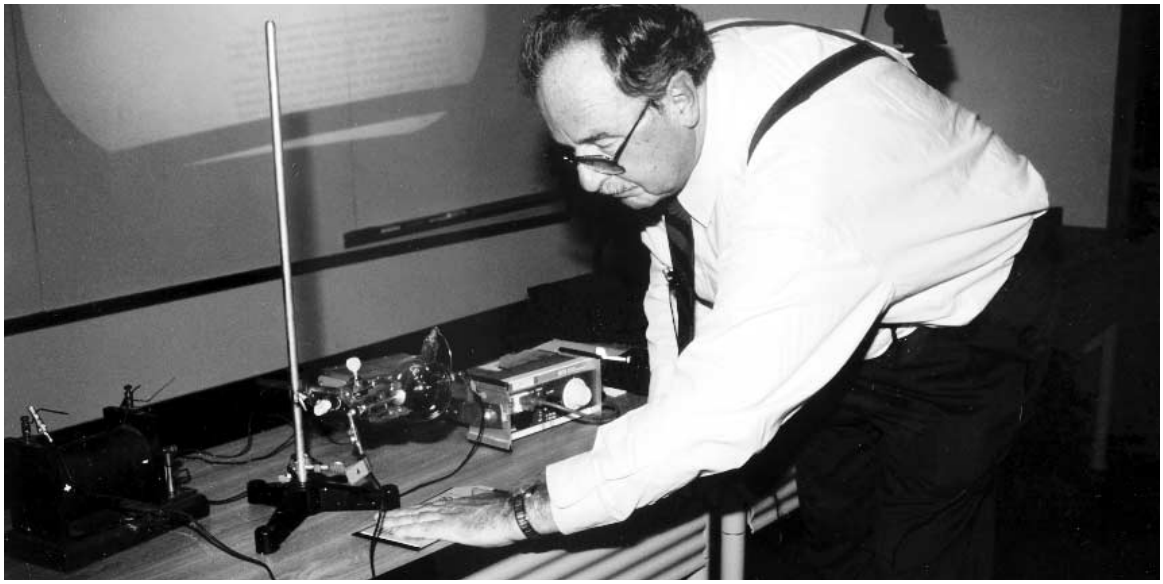


Photo by Reidar Hahn

Jovanovic's grand finale at his farewell lecture: a demonstration of the world's first accelerator, similar to the one W.K. Röntgen constructed in 1895 to generate x-rays. The demonstration was a popular feature of Saturday Morning Physics.

Higgs

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Supersymmetry

By far the most popular theory, called supersymmetry, predicts that there is not one Higgs particle, but five. Supersymmetry passes two important tests: (a) it ties the four forces together and (b) it stands up at very high energies. Critics contend, however, that supersymmetry makes things uglier, not simpler. In addition to five Higgs, it also requires dozens of new particles, not one of which has yet been seen.

Technicolor

In technicolor theory, the Higgs is neither one particle nor five particles, but two smaller entities swimming side-by-side. The Higgs doesn't have to be anything mysterious, technicolor advocates say, it could just be two quark-like particles (such as the recently discovered top quark) bound together with a new fifth force. This theory is elegant, but not without its detractors. While technicolor avoids the ungainly proliferation of particles demanded by supersymmetry, it fails to explain why the forces of nature seem to unify at high energies.

So how do we find the Higgs?

While the Higgs or something like it certainly exists, finding it will not be easy. In fact the way is so murky as to have inspired a book called "The Higgs Hunter's Guide," a kind of road atlas that describes the many possible incarnations of the Higgs and how to track them down. But physicists are not about to let the Higgs slip through their fingers. Currently, thousands of scientists from all over the globe are engaged in a heroic, systematic search for the Higgs. After years of careful planning and design, they are closing in. Within the decade someone will ensnare the Higgs. Who bags this prize will depend on its mass.

Different experiments work at different energies. The heavier the Higgs, the higher the energy of the collisions required to produce it. If the Higgs is "light," meaning that its mass is less than that of an entire silver atom, it could

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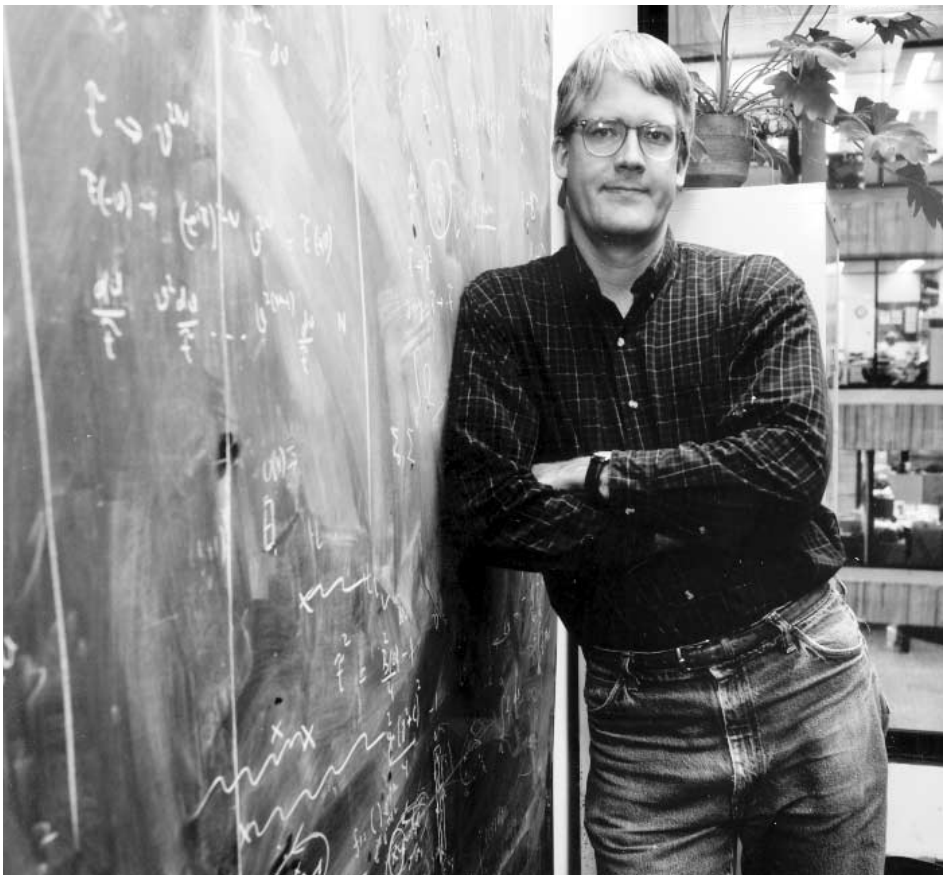
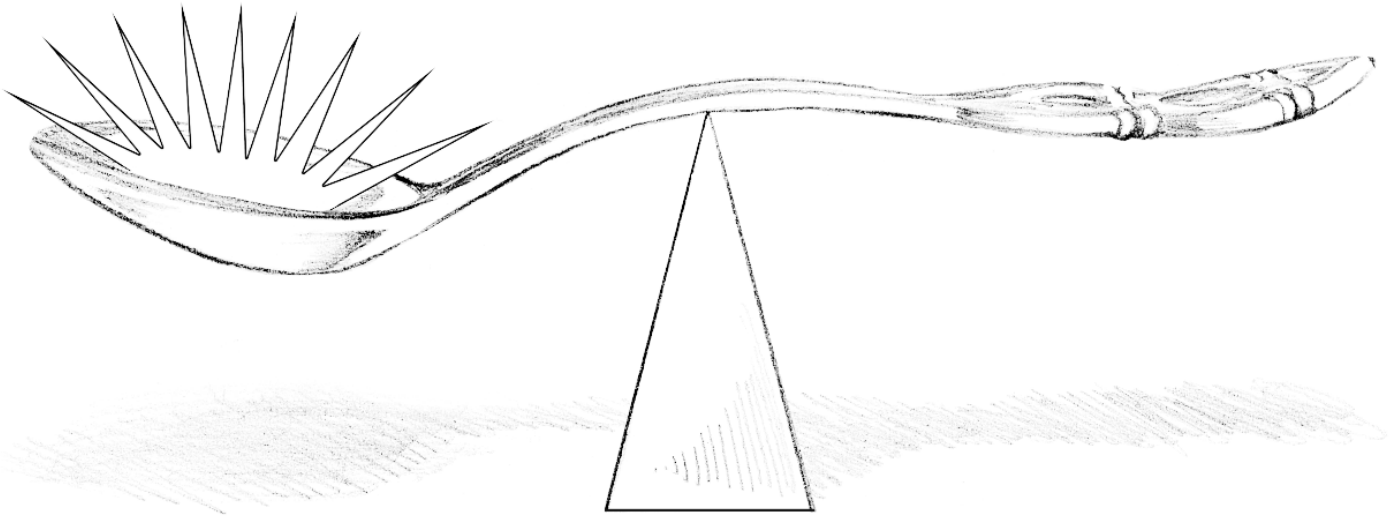


Photo by Fred Ullrich

Fermilab theorist Joe Lykken, who studies supersymmetry, admits, "Come 2005, I could be in the library trying to learn technicolor."



If the Higgs boson proves lighter than an atom of silver, physicists at CERN's LEP accelerator in Geneva may discover it soon. If it is slightly more massive than silver, Fermilab experimenters may find it at the Tevatron before 2005.

Broken Symmetry

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Fermilab purchased the scrap in 1972 for use in constructing radiation shielding around the Main Ring. In incorporating the metal into Broken Symmetry, Wilson was not simply adopting the construction materials of the "junk sculpture" of his day. He had loftier ambitions: to turn "swords into plowshares."

But the huge slabs of battleship steel spread flat on the ground out in Fermilab's "boneyard" presented special problems.

To the welders' surprise, clouds of thick gray smoke billowed up as they began cutting one section. Linoleum from the battleship's floors, it turned out, was still glued to the underside.

And the battleship's high-carbon armored steel was so hard that they had to use special tools to rip it apart.

For Peterson, the biggest concern was just getting the massive sculpture out of the building. He had to divide each wing of the sculpture into three parts small enough to fit through the Machine Shop's doorway.

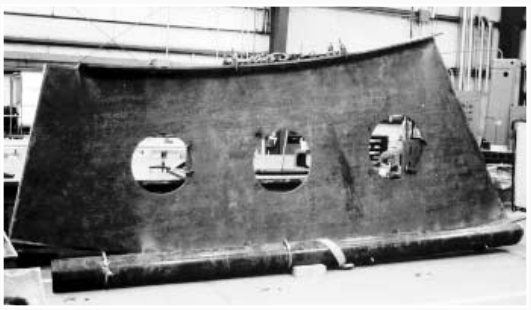
He also worried about getting the curvatures right as he cut the shapes of each segment with a red-hot torch tethered to a rotating centerpoint.

Complicating matters, the Illinois Department of Transportation required that the Machine Shop comply with certain state safety regulations, since the sculpture would loom over a roadway. Fermilab's welders had to take a standardized test for certification; fabrication drawings had to be reviewed and numbered; sample welds had to undergo ultrasonic and magnetic analyses.

And then there was Wilson, who routinely stopped by after hours to scribble modifications on a Kimwipe box or urge the staff to Herculean efforts. According to Hiller, Wilson was out there at the Machine Shop "dang near every day checking on progress."

When Mac Neal cranes finally raised the sculpture into place in June 1978, Wilson elaborated on the idea behind its design: "The twofold mirror symmetry about the east leg, indicated by the red and the black, is nearly perfect. The more basic underlying threefold symmetry is perfect at the base, but deteriorates with height and is completely broken at the top of the arch. However, when viewed from directly above the center, or directly below, the arch again appears to be perfectly symmetrical."

Pleased with this and his other creations melding art and physics, Wilson once said: "I was never so much a sculptor as I was at Fermilab." ■



Fermilab Photos

A piece of Broken Symmetry in Fermilab's Machine Shop.

For welders, the sculpture was an oddball project.

Perfect symmetry breaks down.

Photo by Fred Ullrich

From Pucks to Particles: A Writer's Path to Fermilab

Photo by Reidar Hahn

Mike Perricone catches up on particle physics research at CDF.

By Mike Perricone, Office of Public Affairs

Hockey players skate around in circles promoting high-speed collisions in a refrigerated environment.

Little did I know that my first career, comprising 20 years of hockey reporting, was actually an apprenticeship for my third career, in high-energy physics.

In between were those eight challenging and rewarding years of my second career. I left my sportswriting job at *The Chicago Sun-Times* late in 1989 just before the birth of my daughter, Jenny Rose. I set out to become an at-home father while my wife, Joan, continued her career as an executive.

I had envisioned a well-planned day of regular meal times and regular nap times for Jenny, and regular writing times for me while Jenny slept peacefully or gurgled happily in her crib nearby. The reality was a baby who didn't sleep much, didn't eat much, didn't gurgle much—in fact, didn't do much of anything except cry. Day and night after day and night.

Those chaotic early days were chronicled in a weekly newspaper column, "Jenny's Dad," which was later expanded into the book, "FROM DEADLINES TO DIAPERS: Journal of an At-Home Father." Jenny was my constant companion during the writing—usually, propped in a backpack, either sleeping or crying while I stood hunched over the keyboard like some crooner in a bad lounge act.

But the column got done every week. And the book landed us all an appearance on "The Oprah Winfrey Show." Jenny is now eight years old, a second-grader in a Montessori school in Chicago, and a constant bundle of energy with a great heart and a great laugh. Also a great deal of independence, which brings me to my third career, here in the Public Affairs Office.

I studied four semesters of physics from 1968 to 1970 at Rensselaer Polytechnic Institute. But I knew my engineering future was in jeopardy when I found my study-time was pre-empted by flipping back and forth in Resnick and Halliday, to the high-speed flash photograph showing the deformation of a baseball when it's struck by a bat (which is the way my head often felt when I was trying to study).

Sports were the downfall of my engineering plans but the genesis of my first career. I unofficially majored in sports broadcasting at RPI; my classrooms were the radio station and the hockey rink. After I graduated, my real degree was conferred when I went to work for the local newspaper, *The Troy Record*, covering RPI hockey and other college sports. I made a quantum leap to Chicago in 1977, to begin 12 years of covering the NHL's Chicago Blackhawks for *The Chicago Sun-Times*—12 years, eight coaching changes, no Stanley Cups and a few threats of bodily harm from players and executives around the league.

But time and space work together in mysterious ways. All my journeys of the past 30 years have led me to a place I might have imagined as that kid in Brooklyn, New York, who spent his time between baseball games dreaming of becoming a scientist or an engineer.

In a way I could never have predicted, I feel as if I've completed my own circle. I have different skills to bring with me this time around, skills honed in a long reporting career. I hope those skills can add strength to the message of why it's so important to explore the smallest spaces and particles of nature, and help those outside science understand that, as important as it is to find new answers in our research, it is equally important to find new questions. ■

Coming up flat against the barrel of a bat in the Resnick and Halliday days.

Photo by Dr. Harold E. Edgerton, (The Harold E. Edgerton 1992 Trust, Courtesy of Palm Productions, Inc.)

Higgs

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Photo by Jenny Mullins

Fermilab theorist Chris Quigg announced in a 1997 talk that he had discovered the Higgs boson—in London. Higgs Boson is the name of a British New Wave music group, whose album cover appears on the screen.

turn up at the LEP collider at the CERN laboratory in Geneva, Switzerland, probably before 2000. But if the Higgs is slightly heavier, it could instead be discovered here at Fermilab sometime before 2005. And if the Higgs is heavier still, it might not appear until CERN switches on its Large Hadron Collider, which will replace Fermilab's Tevatron as the highest-energy accelerator in the world. The LHC would certainly ferret out the Higgs by 2007. Still, what this colossal, cooperative effort will turn up is anyone's guess. And, for physicists who have waited their whole careers to see what lies behind the Standard Model, it seems almost too good to be true—even if their own pet theories turn out to be wrong.

"I think we are just coming to grips with it," says Joe Lykken, who has devoted himself to supersymmetry. "Come 2005, I could be in the library trying to learn technicolor."

Even better, the Higgs might turn out to be something completely unexpected. "It's hard to imagine that we've missed something," says Boston University theorist Ken Lane, given all the mind-years at work on the problem, "but it would be *great*." ■

David Kestenbaum received his Ph.D. in physics from Harvard in 1996. He did his thesis research as a member of Fermilab's CDF collaboration. He has recently begun a six-month stint in Washington as a science writer for Science.

CALENDAR

JANUARY 23

Fermilab International Film Society presents: *The Young Poisoner's Handbook*, Benjamin Ross (director), UK / Germany (1996). Admission $4, at 8 p.m., Ramsey Auditorium, Wilson Hall.

JANUARY 31

Fermilab Art Series presents: Jerry Gonzalez and the Fort Apache Band, $19. Performance begins at 8 p.m. in Ramsey Auditorium, Wilson Hall. For more information or reservations, call 840-ARTS.

FEBRUARY 8

Barn dance at the Village Barn from 7–10 p.m., with live music by the Chicago Barn Dance Company. Contra, square, & circle dances. All dances are taught. All ages & experience levels are welcome. You don't need to come with a partner. Admission $5. Children under 12 are free. For more information, contact Lynn Garren, x2061, or Dave Harding, x2971.

FEBRUARY 12

Brown bag seminar: Depression Across the Life Cycle: Differences in Experience & Treatment. Martin Lemon, Ph.D.; Katherine Hedl, M.A., LCSW; Debra Carloti, M.P.S of Sun Prairie Clinical Services. Noon–1, 1 West Conference Room.

FEBRUARY 13

Fermilab International Film Society presents: *Careful*, Jeff Solylo (director), Canada (1992). Admission $4, at 8 p.m. in Ramsey Auditorium, Wilson Hall.

FEBRUARY 15

Barn dance at the Village Barn from 7-10 p.m., with live music by the Fiddling Zealots of Oak Park & calling by Bill Sudkamp. Contra, square, & circle dances. All dances are taught. All ages & experience levels are welcome. You don't need to come with a partner. Admission $5. Children under 12 are free. For more information, contact Lynn Garren, x2061, or Dave Harding, x2971.

ONGOING

NALWO coffee mornings, Thursdays, 10 a.m. in the Users' Center, call Selitha Raja, (630) 305-7769. In the Village Barn, international folk dancing, Thursdays, 7:30–10 p.m., call Mady, (630) 584-0825; Scottish country dancing, Tuesdays, 7–9:30 p.m., call Doug, x8194.

ONGOING

Conversational English classes, 9–11:30 a.m., Thursdays in the Users' Center.

CLASSIFIEDS

FOR SALE

■ '96 Saturn SC1, automatic, dark green, P/S, P/W, P/Lock w/remote,cruise control, am/fm radio with tape and CD changer, fog lamp, a/c, 21K miles. $12,800 obo. More details at http://osksn2.hep.sci.osakau.ac.jp/~sada/car4sale.html. Contact Masayoshi, x2176 or sada@fnal.gov.

■ '93 Ford Escort LX wagon, 5 spds, air, AM/FM cassette, PS, PB, PWR mirrors, luggage rack, rear defroster/wiper, garage kept, well maintained, 88K highway miles. Asking $4,800. Call Nona Fenner, (815) 286–7327 or x4142.

■ '92 Dodge Dakota extended cab pickup, LE package, V6, ac, ps, pb, alloy wheels, aluminum cap, running boards, AM/FM cassette, 94K miles. Good condition, $8,200. Contact Scott, x4340 or holm@fnal.gov.

■ '89 Dodge Grand Caravan, loaded, no rust, very well maintained, new brakes, 118K miles. Asking $3500. Contact J. Chapman, 734-764-4440 or umjwc@fnald.fnal.gov.

■ '88 Plymouth Voyager SE, black cherry, 7 passenger, V6, new tires, looks great and is very reliable. Asking $3,000. Contact Jerry, x4571, (630) 801-9408, or Jerryz@fnal.gov.

■ '86 Honda Civic CRX, 98K miles, in good condition (no rust). Price, $1,500. Contact Jurgen, x5151 or jurgen@fnal.gov.

■ American Racing Equipment aluminum wheels (4), 15" x 8", with P275/60R15 BF Goodrich T/A radial tires. Fits full-size Chevy truck (5 lugs). Never used in winter. $400. Contact: x4396, (630) 859–8596 or pritchard@fnal.gov.

■ Antiques for sale, prices far below appraised value. Over 20 pieces of furniture (chests, tables, chairs, sideboard, cabinets, lamp table, etc.) in walnut, cherry, oak, rosewood, & antique wicker. Also 50 pieces (tools, glassware, kitchen items, etc.) priced from $2–20. Located near St. Charles. Call (847) 741-7539.

■ NordicTrak exercise machine, Achiever model, oak frame and skis. Like-new condition. $350. Contact Mike, x4412 or shea@fnal.gov.

■ Craftsman 5 HP "Easy Start" self-propelled lawn mower used one season. Purchase price, $236; asking $150. Toro Electric start snow blower. Asking $150. Patio furniture-table, umbrella & 4 chairs, $125. Contact Dick, x3156 page 312 or worland@fnal.gov.

FOR RENT

■ Rent w/option to buy. Home in Summerlakes, <1 mi. from Fermilab. 3 BR, 1-1/2 baths, 2 stories w/attached 1-car garage. LR, DR, kitchen, fireplace & more. For details, contact Henry, x4157, ehschram@fnal.gov or (630) 665–2434.

WANTED

■ Coach/player/referee for mid-day basketball pickup games. I'm seeking retirement due to age (40). If interested, please contact Gordon A. Gillespie Jr, x8630 or gordieg@fnal.gov.

■ A small house to buy or to rent with option to buy. Must have a basement. Contact Albert, x3863 or MS 222.

■ Housemate to share St. Charles home close to river and bikepath. Laundry and 1/2 garage included. Own phone line and TV jack installed. Long or short term. $500/month and 1/2 utilities. References please. Small security deposit required for long term. Contact Katie, x3630 or (630) 377–9024 (leave message) or ohman@fnal.gov.

MILESTONES

BORN

■ John "Jack" Kingsley, January 1, 1998, to Beth (LSS/Library) and Torrence Anderson.

ENGAGED

■ Deborah Quintero, I.D. # 4521 (PPD/Technical Centers), to Bruce Bonifas, on December 24, 1997.

RETIRED

■ Stanley Tawzer, I.D. # 177, on January 30, 1998, from the BD/BE/RF& Instrumentation Group.

■ Ethel Gonczy, I.D. #3310, on January 30, 1998, from the TD/ Engineering and Fabrication Group.

HONORED

■ John Carson and Gregory Kobliska, recipients of the Employee Performance Recognition Award for work done on the Main Injector magnets.

LAB NOTES

New Stock Items

■ 1315-0360 Toner, Cartridge HP Laser Jet 5SI and 5SI MX. For HP Personal Laserwriter HP P/N C3909A only.

■ 1350-0340 Box, shipping, corrugated fiberboard, double wall, style construction regular slotted, 350 PSI Burst 24" X 24" X 16".

■ 1790-0100 Pallets, oak hardwood, 48 X 40X 3/4, 4-way notched stringers 5 at 4 and 2 at 6 Top, 3 at 4 and 2 at 6 Bottom, all ends, boards and stringers to be sealed with sealtite.

■ 1790-0200 Crate, wirebound, knocked down flat with skid, 30" H X 42" W X 34" L with tops, Wisconsin Box Co. p/n WB-42.

Winter Games 1998

Winter Games 1998 sponsored by the Fermilab Recreation Office encourages you to become more active this winter by earning medals for minutes of exercise. The program begins February 1.

■ 30-day program with a Winter Olympics theme

■ More than 50 activities to choose from

■ Exercise minutes earn medals

■ Olympic trivia, hearty recipes, fun games and more

■ Prize drawings

■ Exciting incentives

■ Getting started

Registration forms and program packets can be picked up at these locations: at the Recreation Office, x2548, x5427, WH15W; or on January 13 at the Body Fat Testing in the Atrium by the Credit Union from 11:30-12:30; on January 20 at the Blood Pressure Screening in the Atrium by the Credit Union from 11:30-1:00; on January 27 at the Good Mornings Seminar in 1 West from noon to 1.

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Please send your article submissions, classified advertisements and ideas to the Public Affairs Office, MS 206 or e-mail ferminews@fnal.gov.

FermiNews welcomes letters from readers. Please include your name and daytime phone number.

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