Christmas house tour in Atherton, Woodside: Cover, Section 2

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How right was Einstein?

Francis Everitt is principal scientist on a project to test Einstein's general theory of relativity.

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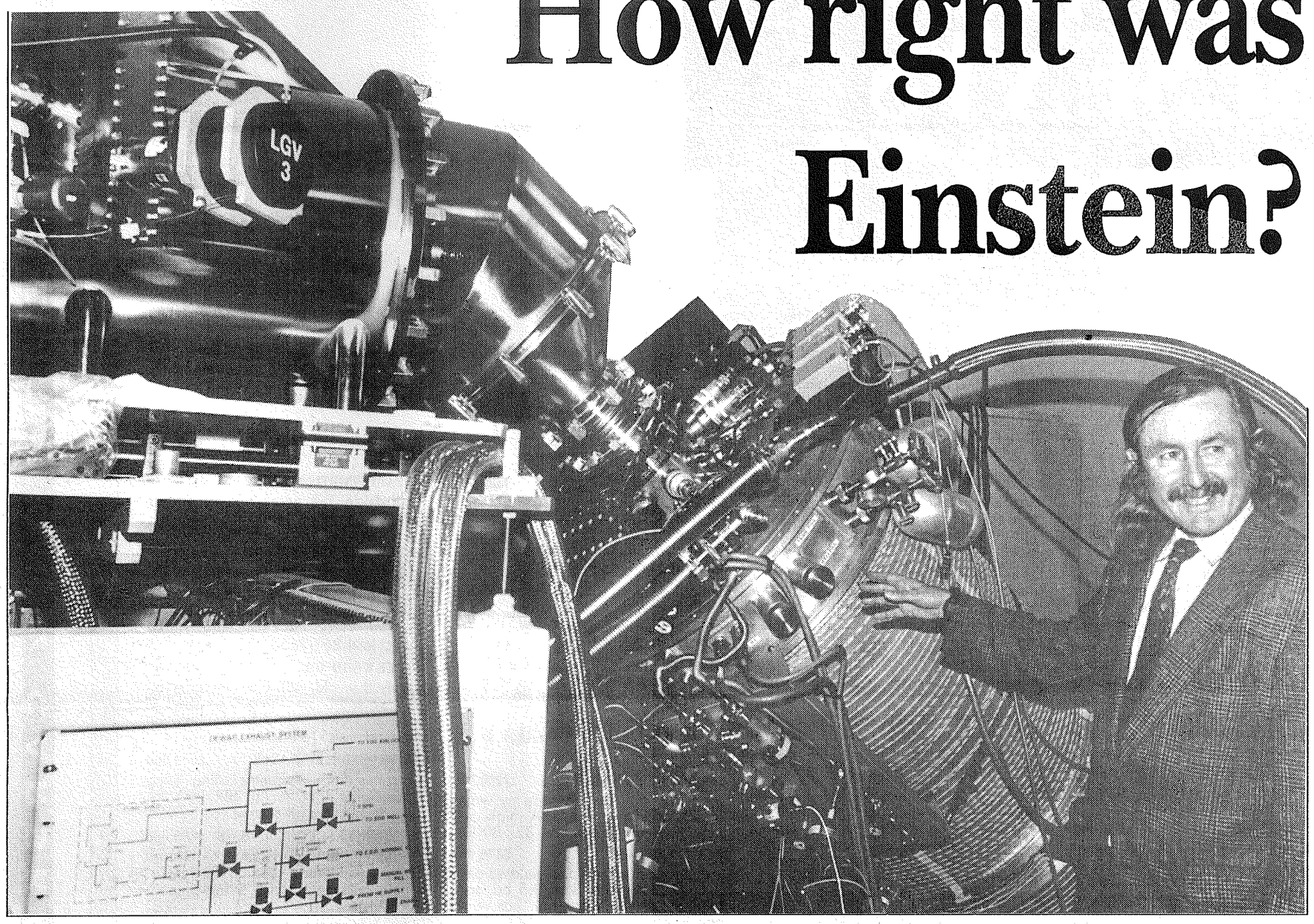
How right was Einstein?



PHOTOS BY CAROL IVIE

Dr. Francis Everitt with a mock-up of Gravity Probe B, which will test Einstein's General Theory of Relativity in a satellite to be flown in 1999. Inside the mock-up, two super-round quartz gyroscopes are spinning at 10,000 revolutions per second in a 200-gallon tank of liquid helium carefully aligned with the axis of the earth.

Francis Everitt has spent 30 years developing a test for Einstein's general theory of relativity. A result of that work — a machine called Gravity Probe B — will fly on the space shuttle in 1995 and in its own satellite in 1999.

By MARION SOFTKY

There's not a computer in sight in Francis Everitt's corner office at Stanford.

Teetering piles of paper, a whiteboard scrawled with equations, a cardboard cutout of Einstein on the window sill, and a book about scientists and religion on the coffee table surround the man who is leading one of the most fundamental experiments in pure physics of this half-century.

Dr. Everitt, a soft-spoken bachelor from Los Trancos Woods, doesn't need computers to challenge Einstein. He needs brains and persistence and skill with people. Also a large organization and money.

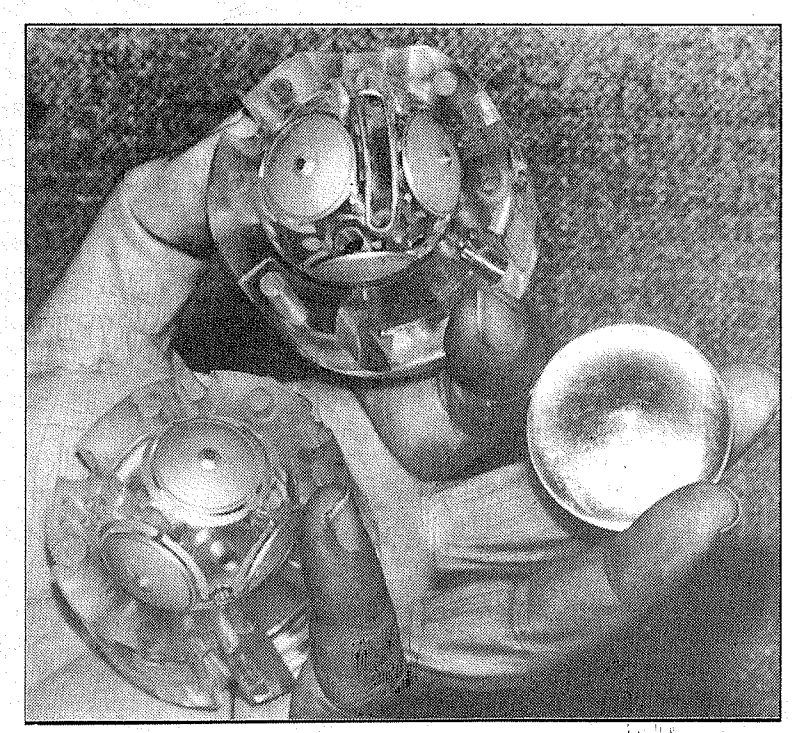
"I don't play around with computers. Other people are far more capable," he says with characteristic English understatement.

For 30 years Dr. Everitt has been plugging away at an experiment in space to test two key aspects of one of the most hallowed scientific theories in history: Einstein's General Theory of Relativity.

If all goes according to schedule, "Gravity Probe B" will fly on the space shuttle in 1995, and then in its own satellite around the poles in 1999. In a tank containing 500 gallons of liquid helium, four superround gyroscopes will spin at 10,000 revolutions per second at a temperature 1.8 degrees above absolute zero.

Precise magnetic measurements will test whether the warp of space and time created by the rotating earth will deflect the axis of the gyroscopes away from the fixed star to which it points, as predicted by Einstein's theory.

Frank McDonald, chief scientist at NASA, called it "the most challenging test we'll undertake this



Model of a gyroscope that scientists say will be the most perfect sphere ever made. Plated with niobium and suspended electrically within two matching pieces, the gyroscope will be used to determine whether the rotating earth distorts space and time as predicted by Einstein's general relativity theory.

'Ptolemy invented a universe and it lasted two thousand years. Newton invented a universe and it lasted 200 years. Now Dr. Einstein has invented a new universe and no one knows how long this one is going to last.'

— George Bernard Shaw 1930

Fitting Einstein's theory with the rest of physics

By MARION SOFTKY

People who have observed the Foucault Pendulum in the Academy of Sciences in Golden Gate Park probably don't realize that it is the direct ancestor to Gravity Probe B.

As the massive ball swings relentlessly back and forth on its ceiling-high cable, it knocks down pegs — one after the other every 15 minutes or so — as the earth rotates beneath it.

While working with his pendulum, the French physicist, Foucault, also invented and named the gyroscope. He realized it would provide an even better means to demonstrate the earth's rotation.

"In a certain sense, this is where we spring off," says Stanford Professor Francis Everitt, principal investigator for Gravity Probe B, which will test certain aspects of Einstein's General Theory of Relativity.

For Foucault, the task was straightforward. Spin a gyroscope, point it at a "fixed" star, and let it rotate. It will keep pointing at the star while the earth turns under it, because there's nothing to make it change direction, Dr. Everitt explains.

Enter Einstein and the Special Theory of Relativity.

"One of the things that happens in physics is that you solve one problem and find that you've created another one," says Dr. Everitt. "And that's exactly what happened to Einstein."

Special relativity, which holds that no signal can travel faster than light, ran head on into Newton's theory of gravity, which says that the gravitational force acts instantaneously. "According to Newton, gravity wouldn't take eight minutes to get from the sun to the earth; it would come instantly," Dr. Everitt explains.

By the time Einstein finished reinterpreting Newton's theory of gravity in terms of distortions of space and time created by the masses of stars and planets, physics was very different. "This wasn't just a small change to Newton's ideas; it was a huge change," Dr. Everitt says.

Since Foucault, and even Einstein, there have been immense advances both in technology and physics: more perfect gyroscopes, the understanding of physics at very low temperatures, and science in space, as well as quantum mechanics and extraordinary advances in understanding the behavior of atomic and sub-atomic particles — based to a major extent on special relativity.

"Particle accelerators have developed an understanding of certain branches of physics, but they still left the whole mystery of how to fit Einstein's theory together with the rest of physics. That's still as mysterious as ever," says Dr. Everitt. "It doesn't fit with the rest of physics."

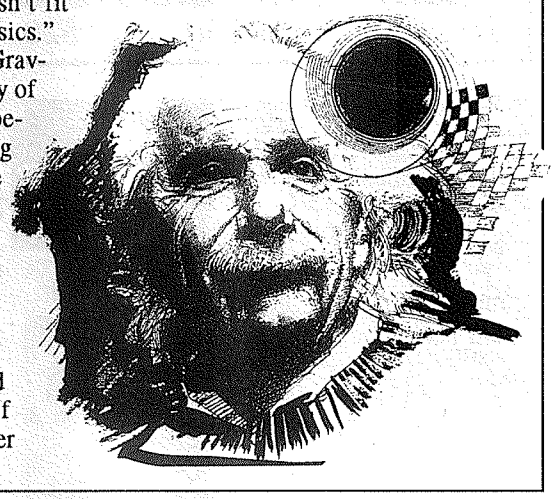
Dr. Everitt sees Gravity Probe B as a way of building a bridge between the conflicting disciplines of the very large and very small. "Here is the first new dedicated experiment exploring the bridge between particle physics and Einstein's theory of gravity from the other side," he says. "There are specific reasons for thinking that Einstein's theory may break down in ways our experiment can detect."

The gyroscopes in Gravity Probe B will measure two subtle effects of Einstein's theory. As conceived by the late Stanford Professor Leonard Schiff, one will measure whether the warping of space-time as a result of Einstein's theory will tilt the gyroscopes away from the star toward which they point.

The other will test an effect called "frame dragging." Dr. Everitt tries to explain, "As the earth rotates, according to Einstein, it will drag space and time around with it. That seems a very peculiar idea, and I'm not going to fully explain it."

Dr. Everitt refuses to speculate on whether Einstein's theory will hold up or be proved wrong in these experiments.

"I want to discipline myself not to guess the answer," he concludes. "The great danger is you can kid yourself. We are trying a great many ways so we don't kid ourselves."



millennium." With solid support of the scientific community, including four Nobel prize-winners not at Stanford, the durable project has survived half a dozen funding cuts.

"It's been canceled six times," says Dr. Everitt, principal investigator on the project that he estimates will cost about $350 million. While this amount is "stupendous" compared to his private income, it is still small compared to other "big science" projects, such as the Hubble Space Telescope, which cost billions.

Stanford recently announced it will award a $100 million subcontract to Lockheed Missiles and Space Co. to build the actual spacecraft.

Just how right was Einstein?

Einstein actually created two theories of relativity, Dr. Everitt notes.

Special relativity, which gave us the world's most famous equation, E=MC squared, has been proven billions of times over. Every time an atom bomb goes off, or a nuclear power plant generates heat, or a speeding electron smashes an atom at Stanford's linear accelerator, it proves special relativity again.

General relativity, however, has not been well tested.

Gravity Probe B will check two aspects of the theory, first announced in 1916, to which Einstein devoted most of his life. He spent 40 years trying to connect the theories of electromagnetism with gravity. Instead of treating gravity as a force, as Newton did, general relativity holds that mass affects the structure of space. "Gravity distorts both space and time," says Dr. Everitt.

"General relativity is really Einstein's theory of gravity to replace Newton's theory of gravity," he explains. "Unlike special relativity, the theory of gravity is not at all well-tested. And that's what we're testing."

Because Einstein's theory also does not mesh well with more modern discoveries of particle physics, many scientists think the experiment may prove Einstein partially wrong.

If Einstein is proved right, physicists will look elsewhere for answers to their problems. But if Einstein is wrong, physics will be in an uproar. All sorts of theories, from black holes to the origin of the universe will need a new look. "This might be a breakthrough to a new and more satisfactory kind of physics," Dr. Everitt says.

But how will it affect ordinary people? Aside from the media thrill of denting one of the great icons of science, not a whole lot. "No, it will not directly affect lives," says Dr. Everitt. "What may affect everyday lives are some of the technologies that have come out of Gravity Probe B."

'This might be a breakthrough to a new and more satisfactory kind of physics.'

From little to big science

It will take just 40 years from the time the late Leonard Schiff dreamed up two new ways to test Einstein's theory until a rocket roars into space carrying his experiment.

"It's been a long, long haul," says Dr. Everitt, who began working on the project when he first came to Stanford in 1962. "I had not the slightest idea it would last 30 years. It's just as well not to know because I might not have got started."

In 1959 Dr. Schiff, a professor of physics at Stanford and resident of Ladera, confided his idea to another Stanford physicist. The late Dr. William Fairbank, also of Ladera, was a pioneer in the physics of very low temperatures. He in turn recruited Dr. Robert Cannon of Stanford's Department of Aeronautics and Astronautics.

The two joined Dr. Schiff in a classic meeting at the former men's swimming pool at Stanford. After an exciting and synergistic exchange of ideas, the three decided the experiment might fly.

"That collaboration between disciplines was absolutely central to the success of the project," says Dr. Everitt.

Dr. Everitt provides continuity between laboratory tests of a far-out idea in the 1960s and the "big science" project under way today. "This is absolutely not a one-man program," he emphasizes.

Besides senior scientists who have devoted most of their professional lives to it, Gravity Probe B employs more than 40 graduates and undergraduates from seven departments, he says. It has produced 50 doctoral dissertations.

Other key scientists with Gravity Probe B include program manager Brad Parkinson of Los Altos; John Lipa of Portola Valley; and Jim Lockhart of Menlo Park.

A walk through the rabbit warren of temporary buildings where components are being tested gives a vivid idea of the awesome precision needed for each. Entering a laboratory where two gyroscopes are being tested in a mock-up of the satellite, the visitor has to polish shoes in an automatic polisher and step on sticky mats.

Why? To keep the experiment super-clean, Dr. Everitt replies. The fused-quartz spheres spin inside a spherical container just 1/1000 of an inch bigger. "So you can imagine what one speck of dust could do," he says.

The spheres themselves are a technological wonder. Plated with niobium, the 1.5 inch-diameter balls are one million times more accurate than any gyroscope ever made before; the spheres are perfect to within one millionth of an inch.

But then the experiment, called "frame-dragging," needs an accuracy equivalent to measuring the angle between two sides of a human hair at a distance of 10 miles.

Dr. Everitt is particularly thrilled with the spinoffs from 30 years of research on the frontiers of technology.

For example, a graduate student invented a device for measuring the tilt of a spacecraft that can also measure precisely the tilt of a landing airplane.

"You start out with Einstein, and you end up with an idea that may have bearing on landing airplanes more precisely," Dr. Everitt says. "It's a mixture between an academic enterprise and a Silicon Valley startup company."

A very human enterprise

"The human enterprise certainly interests me a lot," says Dr. Everitt

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How right was Einstein?

(Continued from previous page)

carefully. He's recently written an article for a book titled *Big Science* on the transition from little science to the major project underway today.

"One begins a laboratory research experiment and eventually has to make the transition to a flight program," he says. "That's an enormous cultural shock for the people involved — but not as much as the cultural shift from England to the U.S."

Dr. Everitt himself has made a cultural shift from the young physics student in England who wanted to do individual science and not be involved in a group. "I never imagined when I was learning physics in England that I would spend considerable time on Capitol Hill in Washington D.C.," he says. "I can't even say I knew then exactly where Washington D.C. was. I knew it was somewhere north or south of New York, but that's about it."

Since those days he has built an impressive track record by thinking clearly, organizing scientists, and convincing bureaucrats and politicians. "I have never had any time of boredom," he says. "My job has changed about six times over."

But Dr. Everitt's growing responsibilities are infringing on his personal time. Although he still runs about 30 miles a week, he's been too busy to run marathons and pursue another hobby, jewelry-making.

> ***'It's a mixture between an academic enterprise and a Silicon Valley startup company.'***

"I still have a dream of doing another marathon," he says, "But you can't really commute to Europe and Washington and still lead a completely normal life."

Dr. Everitt recounts the time he was running in the hills above his home in Los Trancos Woods. "Sometimes when you're running, you're slightly dreamy," he says.

Glancing down, he saw, just where his foot was about to land, a large rattlesnake sprawled across the trail. "I don't know what happened, but I did a great Nijinsky leap, and landed about a foot beyond it," he recalls. "Since then I look down a little more often."

Somewhat of a philosopher, Dr. Everitt still finds time to write articles on the history of science. His first article on religion recently appeared in the book, *Can Scientists Believe?* by Sir Nevill Mott. It is titled: "Faith and Mystery in Science; Reason and Scepticism in Religion."

What keeps him going, year-after-year on the same project?

He replies instantly, "The love of the chase."

Then he ponders. "You're actually asking a very deep question: what is scientific motivation?" he says.

Noting that some scientists are driven by competition or the search for pattern and beauty, he reflects on his own motivation: "Thinking through a very difficult experiment and how all the bits fit together has a certain architectural quality."

Early Menlo video to be shown at party

A 10-minute video on the early days of Menlo Park, going back to the 1930s, will be shown at the annual meeting and Christmas party of the Menlo Park Historical Association on Sunday, Dec. 5.

The public is invited to the program, which starts at 2:15 p.m. in the meeting room in the lower level of the Menlo Park Library.

Dr. Jeffrey Burns, the new archivist of the Archdocese of San Francisco, will show the video and discuss the archives, now housed at St. Patrick's Seminary in Menlo Park.

Following the program will be the Christmas party and refreshments.

La Honda holiday event

The La Honda Fire Brigade will hold its annual holiday boutique from 10 a.m. to 4 p.m., Saturday, Dec. 4, at the fire hall on Highway 84. There will be hand-crafted gifts by local artists, Christmas ornaments, home-baked goodies, paper goods, T-shirts, jewelry, quilts and potpourri.

Food will be provided by the La Honda Fire Brigade kitchen.

★ In the Service ★

Marine Lance Cpl. **Joshua O. Kinney,** a 1992 graduate of Woodside High School, was recently promoted to his present rank while serving with 3rd Battalion, 12th Marines, 3rd Marine Division, Camp Butler, Japan. He joined the Marine Corps in 1992.