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Across the Spectrum

THE FLORIDA STATE UNIVERSITY COLLEGE OF ARTS AND SCIENCES

**Setting fire to
imagination**

Legendary scientist Harold Kroto looks back on 10 years at FSU and a career spent inspiring others



On the cover

"I think some of the best work I've done has been here with my colleagues at FSU," says Harold Kroto, the legendary chemist and Nobel laureate who is concluding a decade at Florida State. See page 10.

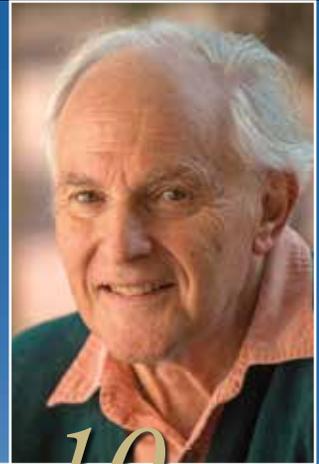
Across the Spectrum

THE FLORIDA STATE UNIVERSITY COLLEGE OF ARTS AND SCIENCES

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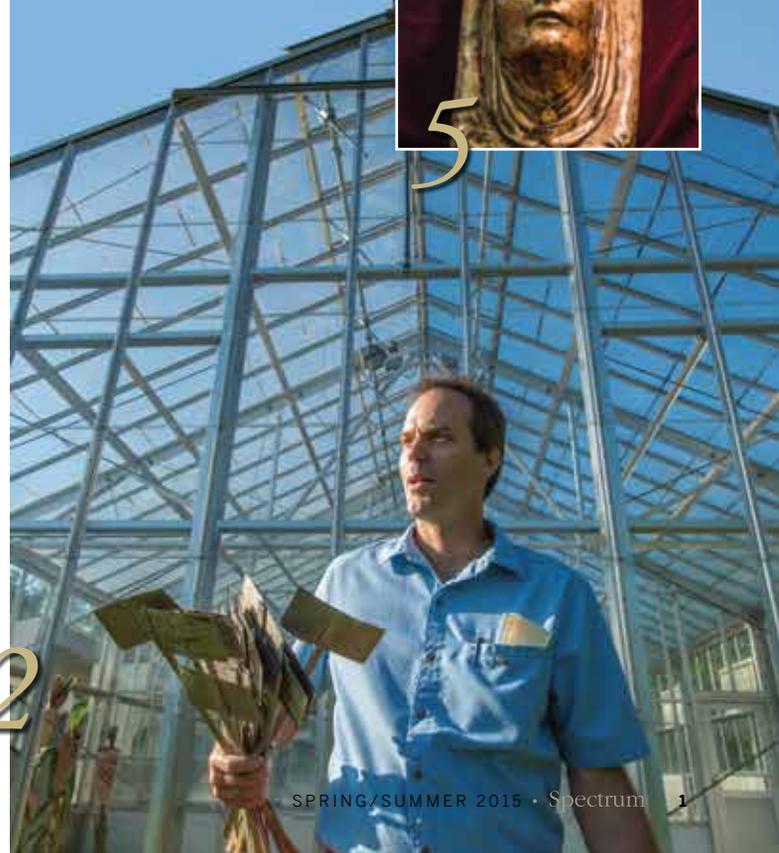
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Creative giant

Legendary educator Harold Kroto looks back on 10 remarkable years at FSU

By Kristen Coyne

A few big anniversaries await Sir Harold Kroto this fall.

First, September will mark 30 years since he and colleagues at Rice University discovered C_{60} , a surprising, elegant form of carbon that would open a new field of chemistry, give rise to nanoscience and nanotechnology, and set fire to the imaginations of countless scientists, science buffs and students. Second, it will be 30 years this November since news of that discovery broke in *Nature*, fixing for Kroto a path toward the Nobel Prize in Chemistry, decades of research devoted to the new molecule and, eventually, Florida State University.

Add to that Kroto's 76th birthday in October and you're talking a lot of cake and candles.

It's a fitting image — both literal and symbolic — for contemplating Kroto. First, that career-making C_{60} , which once only existed in the minds of a few imaginative chemists, can be found, as it turned out, in stars and sooting flames. Symbolically, those flames bring to mind the spark the renowned chemist and professor has lit in minds the world over.

Kroto is a chemist who does graphic design, a player of tennis, a defender of freedom of speech,

a globe-trotter, art lover, oenophile and — last but not least — total skeptic. But of all his accomplishments within and outside chemistry, his power to light a spark, to embolden others to pursue science — or whatever their passion — may well have the most far-reaching impact.

"He inspires people," said Paul Dunk, a research associate at the National High Magnetic Field Laboratory who has worked under, then alongside, Kroto since his undergraduate days at FSU. "That's what he does."

He has been doing it with creativity, energy and style at Florida State for a decade, first within the Department of Chemistry and Biochemistry, where he is a Francis Eppes Professor, then among the broader campus population through the annual "Opening Minds" lecture series.

"We just decided to come here and try it out for five years," Kroto said matter-of-factly. "We've been here 10."

There will be no second decade for the laureate, however. Kroto recently announced plans to return home to England, making this past semester at FSU his last. The transition has been a chance to reflect on his remarkable life — a son of immigrants who rose to receive the highest award in his field, a scientist whose passion for

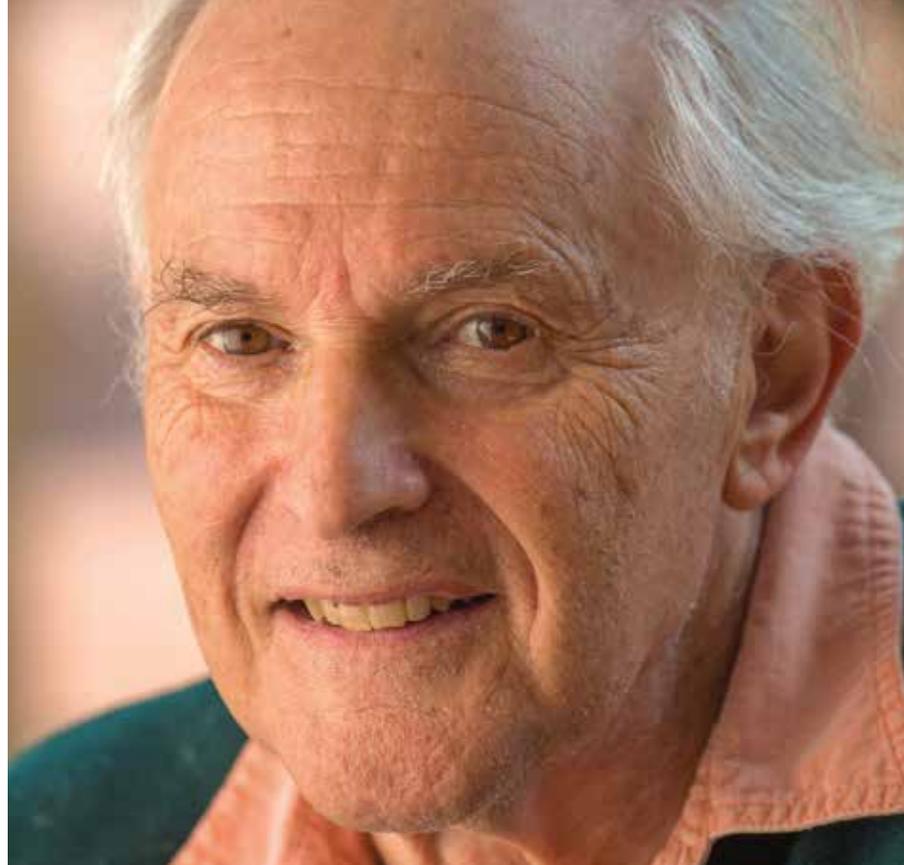
knowledge has overflowed into many other domains and, above all, a teacher with both a great drive and a great gift for his craft.

Luring a Laureate

Kroto's road to Florida State began a dozen years ago, when the university began the hunt for a high-profile hire in the Department of Chemistry and Biochemistry. Then-FSU President Sandy D'Alemberte asked: Wasn't there a National Academy of Sciences member who could be tempted to Tallahassee?

Naresh Dalal, department chair at the time, and colleague Alan Marshall felt they could up the ante: Why not go for a Nobel laureate? They knew that a chemist of that stature could bring enormous benefits to the department: prestige, great press, top-notch graduate students and postdocs, first-rate faculty, higher rankings and more funding. A good word from a prize-winner confers a certain "luster," said Marshall, a Robert O. Lawton Distinguished Professor. It's as if laureates receive a kind of Midas touch along with their golden medal.

They drew up a list of prospects, with an eye for scientists nearing retirement who might consider a second career at FSU. It did not take long to home in on Kroto. Both men had



Ray Stanyard

known Kroto since their paths had converged in the 1960s and '70s at the University of British Columbia and the National Resource Council in Ottawa, Canada. Short on office space, UBC assigned Kroto a desk inside Marshall's lab. Marshall's first impression: Kroto was "bubbling over with energy and enthusiasm, and able to convey it to other people."

By the late 1980s, both men were rising stars in the field. Marshall was at Ohio State University developing a powerful analytical technique that would later land him at the MagLab. Kroto had co-discovered C_{60} , which he dubbed Buckminsterfullerene (or, less formally, buckyballs). The feat had not yet won the Nobel Prize (that came in 1996), but it had ignited a research frenzy. Scientists by then had learned the soccer ball-shaped buckyball belonged to a larger class of carbon molecules of varying shapes — all with promising properties and potential. Kroto's *Nature* paper was well on its way to becoming one

of the most cited chemistry papers of the decade.

One day in the late 1980s, when Kroto visited Ohio State to give a talk on buckyballs, Marshall sat in. What he saw, Marshall said, was a "spellbinder" — part comedian, part magician — who drew from a broad knowledge of the world to describe his molecule's remarkable structure and properties. From his pedagogue's hat, Kroto pulled Leonardo Da Vinci drawings, the scutes of turtle shells and beachball-size buckyball models that he lobbed at his audience with relish.

"He comes up with stuff like that," shrugged Marshall from his MagLab office, where a few of his own buckyball models perch on shelves. "If you just talk straight science to people, it rolls off."

Once their sights were set on Kroto, Dalal and Marshall hatched a plan. First invite Kroto to give a guest lecture at FSU; later, ask him to

teach a guest course; finally, when the time was right, pop the question. Along the way, sprinkle in some wining and dining, a few friendly tennis matches, advice on golf lessons for Kroto's wife, Margaret, and tours of the MagLab.

"You have to create circumstances where he can see what's going on at FSU," recalled Dalal, the Dirac Professor of Chemistry and Biochemistry, "and that things are exciting, and he could do what he wanted to do and accomplish his goals at FSU."

After several years of courting, they all but bent down on one knee, according to Dalal: "Tell us what you need and we'll do everything you need, if you come."

The Kroto's deliberated. Would they like Florida? Before FSU called, the globe-trotting couple had never even set foot in the state. In the end, swayed by the prospect of MagLab collaborations with Dalal and Marshall, they said, "We do."

Nobel Exposure

Now there was a new challenge.

"After we got him to come here the question was, 'What do you do with this guy?'" recalled Marshall. "It was a waste of everybody's time to have him teach regular sequence courses."

They decided the "Nobel touch" was so potent that a little would go a long way.

"Eventually we hit on the idea that we would like *every* chemistry student to see him once," said Marshall, "so that everybody who comes through here would have a Nobel exposure."

To that end, Kroto has given guest lectures in chemistry classes each semester. Dunk has seen the effect many times.

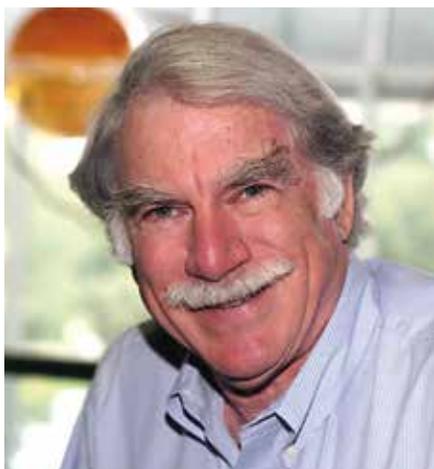
"It's really a big dose of inspiration," he said, "and I think that really plays a huge role."

For students who weren't yet alive when C_{60} was discovered, it's trippy to meet one of the men behind the buckyball. Found everywhere from the covers of chemistry textbooks to jewelry, bibs and Google doodles, it's as iconic a science image as the double helix or Einstein's $E=mc^2$. With the possible exception of H_2O , few molecules get this kind of love.



Ray Stanyard

Kroto may be leaving Florida State, but he won't be going alone: Margaret, his wife of 52 years, will be by his side.



Longtime colleagues of Kroto, FSU chemistry professors Naresh Dalal, top, and Alan Marshall hatched a plan a dozen years ago to lure the Nobel laureate to FSU.

But Kroto is no brainier-than-thou scientist. Just as his Buckminsterfullerene is more chummily known as a buckyball, he insists on being called Harry — never mind that knighthood and Nobel. With his academic-casual attire, gregarious nature and reflex to swing his feet up on the nearest perch, he's very approachable — even to the lowly undergrad.

After Kroto arrived on campus a decade ago, then-undergrad Dunk got up the gumption to ask for a meeting. Dunk was surprised by the celebrated scientist's prompt reply. He soon found himself in a long discussion with Kroto, who addressed him as an equal. When at one point the chemist jumped to his feet to draw on the white board, Dunk stood at attention. "And I thought the British were stuffy," cracked Kroto, urging the student to retake his seat.

Kroto's Nobel touch has been felt across the FSU campus. He has been an influential guest at the table when the department entertains prospective graduate students or faculty, said Dalal and Marshall. He has helped secure more grants, nominated colleagues for prestigious awards and contributed to a rise in published papers.

"He's always available by phone or email wherever he is, and always ready to help," said Dalal. "My group has benefited tremendously having him around. We have started new areas of research, which should help develop new materials for nanotechnology."

Chalk it up to the Nobel's trickledown effect.

Going Global

After a half dozen years of working his Nobel magic in the department, Kroto was eager to start reaching outward. In 2012, targeting a broader audience, he launched his "Opening Minds" lecture series featuring presentations not only on science, but also on art, education, philosophy, religion, the Enlightenment and, above all, on humanity and social responsibility. After a successful first year, Kroto repeated the event in 2013 and 2014.

"A larger venue is what I wanted — more students who were thinking," said Kroto. "I wanted them to start *thinking* rather than coming here just to get grades. I thought that was important."

The Opening Minds lectures provided an outlet for many of the key messages Kroto has distilled over his career, such as:

A scientist is a skeptic. Don't believe anything until you see reliable proof.

Great science, like great art, comes from bringing together unexpected things in novel ways.

Work at what you love and you are bound to do good work.

Only do things where your best effort satisfies you personally; in fact, never put in a second-rate effort.

Science is about finding truth, and that's more important than anything else.

Drawing people from all corners of campus and the community, the Opening Minds lectures helped Kroto impact a fresh audience. But he wanted to reach farther still.

Kroto always had a sense of being part of a larger world. The only child of German immigrants who fled the Nazis (his father was Jewish), Kroto learned from a young age to negotiate different languages and cultures. Also, despite his family's limited means, he was able to attend a first-rate school where he learned a lot about the world beyond North West England. When he arrived at the University of Sheffield to study chemistry, his international science career began to take shape.

By the time he arrived at Florida State, Kroto had been sidelining as a kind of science ambassador for years, traveling the world to teach and inspire young people to pursue science. From his Tallahassee base, he has kept up a speaking schedule many would find grueling: In 2013 alone, Kroto made nearly 100 presentations, most of them abroad.

Steve Acquah, who runs a Web-based educational outreach program founded by Kroto called GEOSET (www.geoset.fsu.edu), has watched the master teacher in action many times.

"His level of energy — I think it really startles everybody," said Acquah. "To see him just jump in there and go, 'Alright everybody, let's get in there! Let's do something special today! Let's make a buckyball!'"

Kroto is quick to fall on hands and knees to join the fun at one of his workshops. With vivid memories of working in his father's balloon factory and playing with erector sets, he believes hands-on learning is critical.

"I *made* things," Kroto said, recalling his ability to spend hours at a task. "I learned construction and how to make things rigid. You see kids now totally disconnected from the immediate environment. You see them in a restaurant — the parents are chatting and the kid is playing on his iPhone or iPad . . . I think there are far too few able to *make* things with their hands, and I think that should come back."

Still, Kroto appreciates the power of online learning to reach students with limited access to education. At FSU, students and faculty use his well-equipped GEOSET studio to record presentations on science — or any other topic they are passionate about — and share them with the world. This is exactly the type of program, Kroto said, his Nobel clout is worthy of, a "platform to talk to students about issues I think are important."

“The Nobel Prize is not very useful for science, particularly,” he said, “but it *is* useful to be able to be listened to, at least, on issues.”

These issues extend beyond science; Kroto has also brought his Nobel to bear on human rights issues, spearheading with fellow laureates an open signed letter advising against the Iraq war and condemning the flogging of blogger Raif Badawi in Saudi Arabia and with friend from his schooldays the actor Ian McKellen as well as nearly 30 Nobel laureates protesting homophobic legislation in Russia.

“You can take the attitude, I guess, if you’re a Nobel Prize winner that, ‘Science is what I do, I’m not interested in anything else,’” said Margaret Kroto. “Then you can take the attitude, ‘Well, I *can* be influential in things that matter.”

The Call of the Arts

Creativity is one of the things that matters to Kroto. His father steered him toward science, and he was good at it. But at school and university, he also began a lifelong love for the arts. When he first arrived on the Sheffield campus, Kroto was surprised to find a school of architecture: It had never occurred to him you could earn a degree in something like that.

“I often think that I would have been more comfortable in arts and architecture,” he said. But as his success in science grew, he still kept some time for tennis, graphic design, guitar and other artistic pursuits. Although Kroto finds science creative, it has built-in constraints: You can only discover what actually exists.

“I’ve always felt, when I’ve been doing graphics, I’m in charge,” said Kroto, whose two sons grew up to be artists. “And when you’re doing science, the universe is in charge, and you’re trying to find out what the rules are.”

In 1985, after discovering the existence of C_{60} , Kroto and his colleagues were wrestling with the rules of its mysterious structure. Among other images floating in Kroto’s mind was the 20-story geodesic dome from the 1967 World’s Fair in Montreal that he and his wife had once visited. Kroto had once dreamed of collaborating with its architect, Buckminster “Bucky” Fuller, to explore mutual interests in science, art and social responsibility. But then the University of Sussex offered Kroto a job, and his artistic aspirations were set aside. The

dome, though, left an impression, and, in a beautiful convergence of science and art, helped inspire the insight into the cage-like structure of C_{60} . But even that landmark discovery, says Kroto, feels less powerful than the pure self-expression of art.

“The discovery we made (C_{60}) — it would have been made within six months to a year if we hadn’t made it,” insisted Kroto. “I don’t see it as anything particularly personal, except for the name. I named it after Buckminster Fuller. That’s the only bit of me personally that’s involved in this whole thing.”

Time of Transition

Like Fuller’s dome, the Kroto’s Tallahassee home is unique, beautiful and light-filled. The Japanese-inspired structure affords a lake view through a wall of windows. An indoor fountain creates a peaceful feel; above it hangs a nearly life-size take on Da Vinci’s Vitruvian Man, almost certainly Leonardo himself — an image Kroto has customized for one of his lectures, placing Leonardo inside a buckyball.

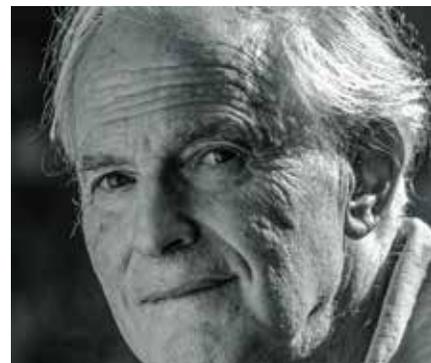
Stretched out on a recliner, a cup of tea by his side, Kroto reflects on his FSU years. Looking off into space as if back in time, he considers his recent research — with Prashant Jain, Tony Cheetham and Dalal on two-dimensional nanolayers in magnetic structures, with Marshall and Dunk on the unusual properties of carbon vapor, and with Steve Acquah on nanotechnology.

“I think some of the best work I’ve done has been here with my colleagues at FSU,” he said. “Very beautiful, well up there intellectually with my previous work, so I am very happy with that. We have been very happy here and made many many close friends.”

Although the upcoming move consumes a lot of time, Kroto seems determined to keep teaching. Using his office as a virtual classroom, he has recorded and uploaded dozens of educational videos in recent months that reflect his broad interests — the Big Bang, photography, books banned by the Nazis, Immanuel Kant — and the uncanny ways they sometimes intersect. In a video about German artist Paul Wunderlich, Kroto points to a detail in a painting. Rogue tufts of white hair hovering around his head, Kroto talks

as if discovering the painting for the first time: “What a magnificent, imaginative conjunction of ideas! Again, synthesis — bringing things together — is the way to a really creative result.”

The talking-head setup has its limitations, but Kroto’s enthusiasm helps transcend them. He raises an eyebrow, scrunches his face, shakes a finger at the imagined student perhaps half a world away. He leans into the camera, brown eyes blazing, as if straining to reach right through the screen to set that unseen mind on fire.



Ray Stanyard

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