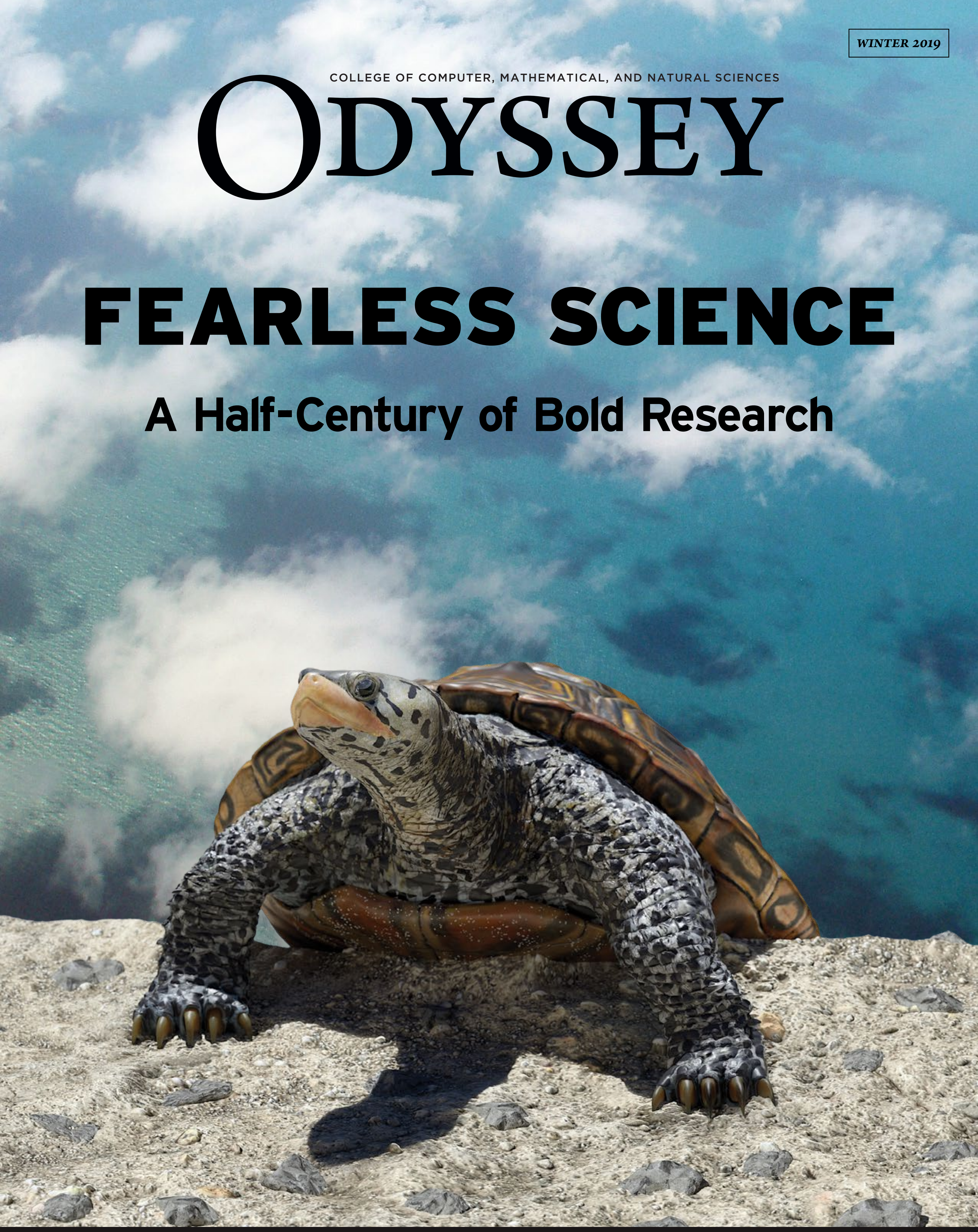
WINTER 2019

COLLEGE OF COMPUTER, MATHEMATICAL, AND NATURAL SCIENCES

ODYSSEY

FEARLESS SCIENCE

A Half-Century of Bold Research



Meet Our New Dean

Dear Science Terps,

As I reflect on my first year as dean of this college, I continue to be amazed on a daily basis by the extraordinary talents, discoveries and generosity of our alumni, students, and faculty and staff members. In this issue, we highlight just a few of them.

We feature Peter Stifel, an associate professor emeritus in geology who recently pledged $250,000 to sustain the department's senior thesis program in perpetuity. We also introduce you to new faculty members Ming Lin and Dinesh Manocha of computer science and Sean Carroll of biology. These outstanding, accomplished scientists have all been appointed to named faculty positions that were created thanks to the generous donations of alumni and friends of our college.

And beginning on page 4, we celebrate a half-century of fearless science. We present exciting research discoveries from our vibrant departments and research institutes and centers. The topics range from blindness in fish and touch screens to comets and chaos.

We have an opportunity to build on these successes with the launch of the university's $1.5 billion campaign *Fearless Ideas: The Campaign for Maryland.*

With your help, we will boost our need-based and merit scholarships and grow our cadre of named chairs and professorships, which allow us attract and retain outstanding faculty members. We will also expand our research programs and initiatives in areas such as data science, cybersecurity, environmental security, virtual and augmented reality, and quantum computing.

We hope you will join us. Your support helps ensure that our college continues to advance the sciences and have a positive impact across Maryland, the nation and the globe.

Amitabh Varshney
Dean
College of Computer, Mathematical, and Natural Sciences

Photo by John T. Consoli

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ON THE COVER

Illustration by Léandre Hounnaké

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Art direction by Faye Levine

FEARLESS SCIENCE

Every great scientific advance begins with an "aha" moment. Discovery is driven by a desire to push boundaries, answer questions and pursue fearless ideas.

At the University of Maryland's College of Computer, Mathematical, and Natural Sciences, we have always been driven by fearless science.

Reaching back more than a half-century, the stories that follow highlight some of the most exciting scientific discoveries made by faculty members in the college.

Some may be familiar to you. If you were on campus in the mid-2000s, you probably remember UMD's lead role in NASA's history-making Deep Impact mission to comet Tempel 1. You may also know that the first researcher to apply the term "chaos" to mathematical problems resides in our Department of Mathematics.

But did you know that a UMD computer scientist was the first to develop high-precision touch screens for mobile devices? Did you know that a UMD chemist synthesized a molecule that would later form the basis of a popular smoking cessation drug?

Read on for these and more stories of fearless science—one from each of our departments. Along the way, we'll also highlight two faculty members and two alumni who were awarded the Nobel Prize. All of these discoveries made a lasting impact on the researchers' chosen fields, with many having profound societal implications.

BY MATTHEW WRIGHT

Illustration by Léandre Hounnaké

MY FEARLESS IDEA

FOUND A BROKEN RULE IN BIOLOGY

2019

2010: Leslie Pick

Every animal begins life as a single cell, with a complete DNA "blueprint" of the animal it will become—be it an elephant, a tortoise or a fruit fly. This single cell will first divide into two, then four and then eight identical cells. At some point, as the cells continue dividing, this ball of identical cells will begin to take on a distinct shape. Each new cell assumes a more specific role as the animal begins to develop tissues, organs and limbs.

How does each cell "read" the DNA blueprint to get its instructions? What signals does the DNA send in some cells and not others? Developmental biologists puzzled over these questions until the early 1980s, when several different research groups independently discovered two key groups of genes, known as segmentation genes and homeobox genes (Hox genes). These discoveries eventually earned those researchers the 1995 Nobel Prize in physiology or medicine.

Around this time, UMD Entomology Professor Leslie Pick and colleagues at other institutions began studying segmentation genes, which promote the formation of a series of body segments in the early insect embryo. Diagrams of these segments look a lot like thin stripes painted on a jellybean.

Once these segments are clearly determined, Hox genes specify which features each segment will develop. In the case of a fruit fly, one segment might grow a pair of legs, while others will sprout wings, eyes, antennae and other parts.

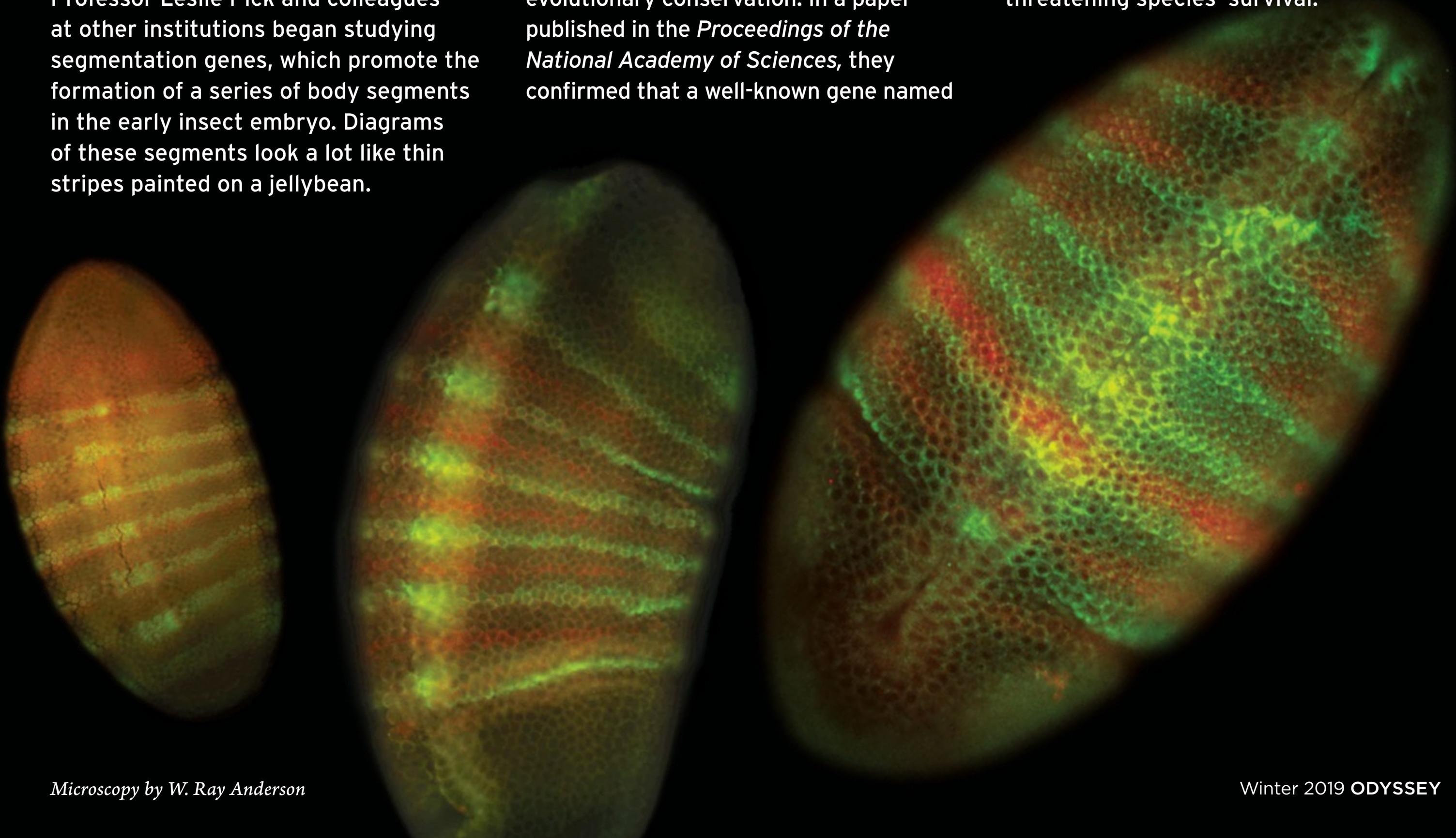
Developmental biologists soon learned that Hox genes are common across a wide variety of animals and have probably changed very little since complex animals first evolved. Biologists use the term "evolutionarily conserved" to describe genes that fit this description.

"Hox genes were first identified in fruit flies, through mutations that resulted in a lot of crazy body shapes. A leg might grow where an antenna should be, for example," Pick said. "At first it was thought to be a weird thing that only happened in insects. So it was a total surprise to learn that all animals have Hox genes. This raised the question of what makes animals different from each other."

In 2010, Pick and her team discovered an unexpected exception to this rule of evolutionary conservation. In a paper published in the *Proceedings of the National Academy of Sciences,* they confirmed that a well-known gene named *fushi tarazu,* first characterized in fruit flies as a segmentation gene, once functioned more like a Hox gene at an earlier point in evolutionary history.

The truly remarkable part of their discovery, however, was that this change didn't only happen once. The *fushi tarazu* gene changed multiple times across various species of arthropods—the group that includes all insects, crustaceans and arachnids. This was particularly surprising because most changes to Hox and segmentation genes are lethal when researchers make them experimentally in the lab.

"We found that in nature, animals have been able to thrive despite these major changes. We helped challenge the classic idea that if animals share a characteristic, they get there through the same genetic pathways," Pick said. "There's so much more genetic variation than we expect. Our challenge now is to understand how this type of genetic variation occurs in nature without threatening species' survival."



Microscopy by W. Ray Anderson

OUR FEARLESS IDEAS

OPENED EYES TO FISH VISION

2000s: Karen Carleton and William Jeffery

Vision has a profound effect on the way many animals engage with the world, helping them to find shelter, search for food and assess potential mates.

In some cases, color preference plays such a strong role in animal mating that it drives the evolution of new species. Biologists suspected that this effect, known as "sensory drive," may have spurred the evolution of the dazzling color palettes seen in some families of fishes, birds and other colorful animals.

UMD Biology Professor Karen Carleton was among the first researchers to provide empirical evidence for evolution via sensory drive, by studying cichlid fish that hail from the freshwater lakes of Africa.

In a study published in 2008 in the journal *Nature,* Carleton and her colleagues demonstrated that female cichlids living at different depths preferred different coloration in their male suitors. The researchers also tracked genetic changes to demonstrate that differences in female visual sensitivity drove the evolution of new species.

"Fish near the surface experience a broader spectrum of color, while deeper down, the light shifts toward red," said Carleton. "We showed that female fish living up high prefer to mate with blue males, while females that live deeper want to mate with red fish."

But for some fish that make their homes deep in caves, eyes can be a liability. Eyes consume a lot of energy—even when not in use—and occupy a lot of space. With no sun to light their way, cavefishes' eyes have degenerated into vestigial structures, much like the human tailbone or the leg bones found in some pythons and boa constrictors.

UMD Biology Professor William Jeffery has been studying *Astyanax mexicanus,* a species of blind cavefish found in northeastern Mexico, for more than 20 years. He has identified genes responsible for various aspects of normal eye development and characterized how these genes create differences between cavefish and surface-dwelling members of the same species with functional eyes.

In 2000, Jeffery co-authored a study published in the journal *Science* in which the researchers restored the eyes of cave-dwelling *Astyanax* simply by transplanting a normal lens from a surface-dwelling relative. The result demonstrated that the evolutionary loss of eyes may be flexible—and perhaps even reversible.

"All cave vertebrates start to develop eyes, but then the eyes stop growing and degenerate. Right when the eye needs the most oxygen, it's cut off, suggesting that cavefish purposely destroy their eyes. I never expected to find this," Jeffery said. "Our work showed that the lens plays a role in development by inducing the formation of other structures in the eye, including the retina."

Together, Carleton and Jeffery's work reveals that animal visual systems have taken some surprising twists and turns through the course of evolution.

"Nonhuman vision is almost always more complex and elaborate than we realize. Many fishes see colors we don't," Carleton said. "Now with genomic techniques, we can rapidly survey how much diversity there is and how rapidly sensory systems can evolve."

(Fish photos, top to bottom) Cichlid by © Mirkorosenau/Dreamstime.com, cichlid by Karen Carleton, surface Mexican cavefish by Joel Sartore/The Photo Ark and blind Mexican cavefish by Kuttelvaserova Stuchelova/Shutterstock

MY FEARLESS IDEA
IMPACTED A COMET

2005: Michael A'Hearn

2006: Professor John Mather won the Nobel Prize in physics (see p. 15)

Comets have captured people's attention for centuries. As comets approach the warmth of the sun, they begin to release gases and debris, creating a large extended atmosphere and a long tail that can stretch for millions of miles.

Although many comets become visible to the naked eye as they pass by Earth, scientists had few opportunities to look closely at a comet's nucleus—the icy, dusty center of solid matter. They certainly had never seen a comet's interior. That changed in 2005, when a groundbreaking NASA mission named Deep Impact, led by the late Distinguished University Professor of Astronomy Mike A'Hearn (1940-2017), flew a spacecraft near the comet Tempel 1 and launched an impactor module about the size of a washing machine into the surface of the comet's nucleus.

The impact, which happened on July 4, 2005, instantly excavated a crater on Tempel 1's surface while the spacecraft collected data from the ejected material. The observations revealed that comets are porous and fluffy, with only about 20 percent of their volume taken up by dust, debris and ice—the rest is all empty space. The team also learned that comet surfaces are variable and dynamic, with much of their frozen water buried deep beneath the surface.

"The major surprise was the opacity of the plume the impactor created and the light it gave off," A'Hearn said just days after the impact. "That suggests the dust excavated from the comet's surface was extremely fine, more like talcum powder than beach sand. And the surface is definitely not what most people think of when they think of comets—an ice cube."

Now, more than a decade later, UMD's Deep Impact team looks back on the mission as a rare opportunity for high-risk, high-reward research.

"We had contingency plans, but it was not entirely clear that any of them would work. We didn't even know much about the comet's shape. We could have hit a crevasse or glanced off of the edge," said Jessica Sunshine, a UMD astronomy professor who served as a Deep Impact mission scientist. "We ran lots of simulations, but we couldn't control nature. Nobody had attempted anything on this scale before."

After Deep Impact's first encounter with Tempel 1, the team received NASA's approval to use the spacecraft to investigate three more comets: Hartley 2 (2010), Garradd (2012) and ISON (2013). The mission also inspired follow-up missions, including Stardust-NExT and Rosetta, the latter of which wrapped up in 2016.

"When we got to the other comets, we quickly learned that they are each completely distinct," said Lori Feaga, a UMD associate research scientist in astronomy who joined Deep Impact as a postdoc. "Comets have geological features such as layering, pits and flows. We could watch the comets evolve as surface processes and jets reshaped them. The idea of a dirty snowball was turned upside down."

Deep Impact illustration by NASA Jet Propulsion Laboratory/Pat Rawlings
Medal photo by Lovisa Engblom, ©® The Nobel Foundation

FEATURE

MY FEARLESS IDEA

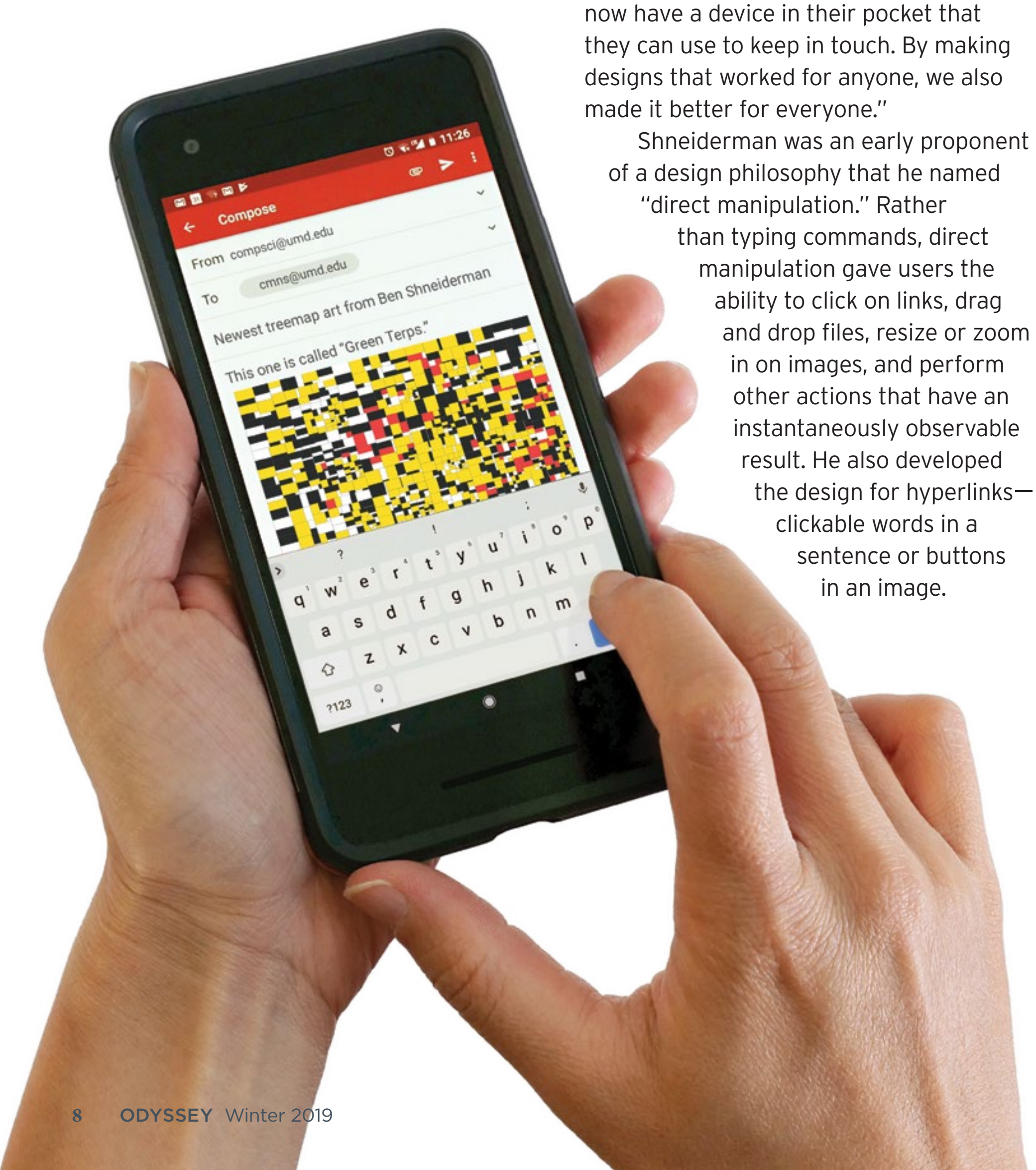
CREATED PRECISE TOUCH SCREENS

2000s: Ben Shneiderman

2002: Raymond Davis Jr., B.S. '37, M.S. '40, industrial chemistry, won the Nobel Prize in physics (see p. 15)

Today's personal computing devices are incredibly easy to use, featuring intuitive graphic user interfaces, widely accepted design standards and precise trackpads or touch screens. Given this, it can be hard to imagine just how challenging the earliest home computers were to use.

To run programs and perform operations, a user needed to type code on a command line. A working knowledge of at least one computer language was a must. In the early 1980s, while companies like Apple and IBM raced to market powerful new models at more affordable prices, personal computers remained an expensive indulgence for tech-savvy consumers.



Recognizing an unmet need, Ben Shneiderman, currently a Distinguished University Professor of Computer Science, began working to make computers more accessible to a wider variety of people. He is credited as a founder of the discipline known as human-computer interaction, which borrows lessons from cognitive psychology to better understand how humans interact with technology.

"As a research field, human-computer interaction was seen as edgy. It took some work to make it stick with computer scientists," Shneiderman said. "Even today, it's still a bit controversial. But the great success of this field is that 6 billion people now have a device in their pocket that they can use to keep in touch. By making designs that worked for anyone, we also made it better for everyone."

Shneiderman was an early proponent of a design philosophy that he named "direct manipulation." Rather than typing commands, direct manipulation gave users the ability to click on links, drag and drop files, resize or zoom in on images, and perform other actions that have an instantaneously observable result. He also developed the design for hyperlinks—clickable words in a sentence or buttons in an image.

"Early web interfaces relied on numbered menus. To access a new piece of information, a user would need to consult the menu and type in the right number. I just knew this wasn't workable," Shneiderman said. "With direct manipulation designs, if you see a word you want to know more about, you just click on it. You can drag and drop items. Word processors represent a document as it would appear when you print it. These once-novel ideas have now become standard."

Beginning in the late 1980s, Shneiderman made key refinements to touch-screen interfaces. Prior to his work, touch screens required big buttons—at least an inch square—and still had trouble precisely tracking finger presses. Thanks to Shneiderman and his teams' innovations, smartphones are now equipped with miniature, highly precise touch screens that enable people to use their devices instantly and intuitively.

"My focus has been on providing power to the user," Shneiderman explained. "Give them the tools they need to do what they need to do. It's not about what the computers can do, it's about what people can do."

Phone photo by Faye Levine
Treemap art by Ben Shneiderman / treemapart.wordpress.com
Medal photo by Lovisa Engblom, ©® The Nobel Foundation

MY FEARLESS IDEA

ILLUMINATED CELL MEMBRANE REPAIR

2001: Norma Andrews

Wound healing makes life possible. While the healing process is well understood for many tissues and organs, biologists have only recently learned how individual cells repair wounds to their cell membranes.

Biologists long assumed that the fatty molecules that make up cell membranes passively spread out to fill in a wound. Beginning in the 1990s, researchers observed small fluid-filled sacs within cells, called vesicles, participating in the healing process. This suggested that cells have an active role in sealing breaks in their cell membrane. But the details of the repair process were still unknown.

Then, Norma Andrews, currently a UMD cell biology and molecular genetics professor, and her colleagues made a surprising discovery while studying *Trypanosoma cruzi*. This single-celled parasite causes Chagas disease, which infects more than 6 million people throughout Latin America. The researchers wanted to learn how *T. cruzi* invades the cells of its animal host without killing the cells in the process.

Andrews' team suspected a role for lysosomes—specialized vesicles that contain digestive enzymes that cells use to break down waste products. But, instead of seeing lysosomes gather around the parasite after it had entered the cell, as they had expected, Andrews and her colleagues noticed that lysosomes were instead gathering at the cell surface. There, the lysosomes were fusing with the membrane near other parasites that were wounding the cell from the outside.

"With this observation, we began to wonder if the mystery vesicles observed near cell membrane injury sites in the 1990s might actually have been lysosomes," Andrews said. "But this didn't make sense. Why would cells use a vesicle filled with dangerous enzymes for a repair process? Then we found that lysosomes were gathering at the cell surface in response to calcium entering the cell. That's when we started looking closer."

Cells work to keep a higher concentration of positively charged calcium ions outside their membranes. This forms a gradient that is the basis for important functions like the conduction of nerve impulses and the contraction of muscle cells.

"Whenever there's a puncture in the cell membrane, a rush of calcium inside the cell is a signal that something is wrong," Andrews explained. "We reasoned that, if lysosome fusion to the cell membrane is a calcium-dependent process, we should be able to make it happen without *T. cruzi* being involved. Our experiments showed that this was indeed the case."

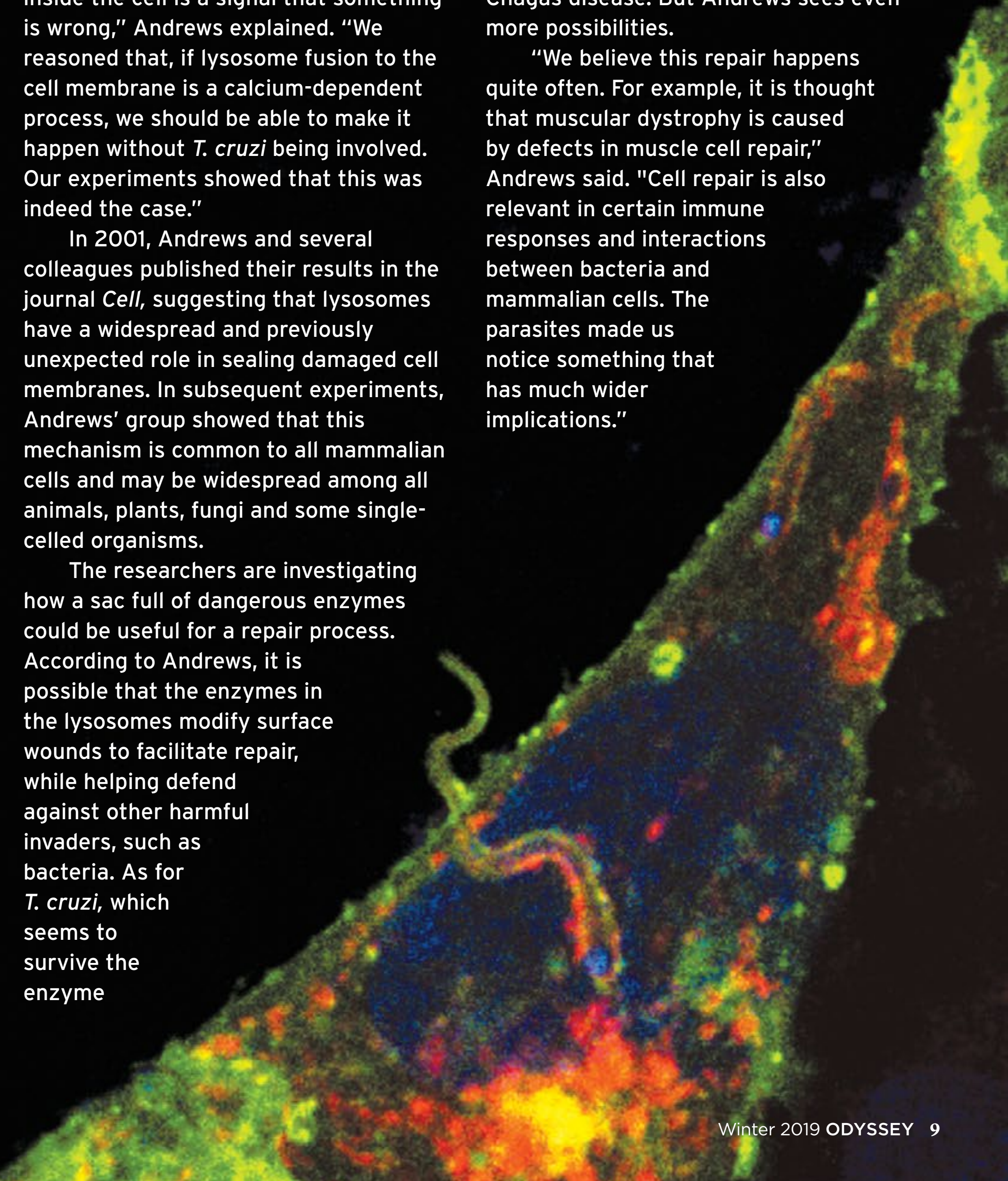
In 2001, Andrews and several colleagues published their results in the journal *Cell*, suggesting that lysosomes have a widespread and previously unexpected role in sealing damaged cell membranes. In subsequent experiments, Andrews' group showed that this mechanism is common to all mammalian cells and may be widespread among all animals, plants, fungi and some single-celled organisms.

The researchers are investigating how a sac full of dangerous enzymes could be useful for a repair process. According to Andrews, it is possible that the enzymes in the lysosomes modify surface wounds to facilitate repair, while helping defend against other harmful invaders, such as bacteria. As for *T. cruzi*, which seems to survive the enzyme attack with no issues, Andrews sees a Trojan horse-style strategy at work.

"The parasite is mimicking a cell repair mechanism to get into the host cell," Andrews said. "The parasite's initial contact with the membrane recruits the vesicles, and this response is what ends up bringing the parasite in. The cell has no way to distinguish between normal repair and a parasite invasion."

A better understanding of the process could one day help to treat deadly parasitic infections, such as Chagas disease. But Andrews sees even more possibilities.

"We believe this repair happens quite often. For example, it is thought that muscular dystrophy is caused by defects in muscle cell repair," Andrews said. "Cell repair is also relevant in certain immune responses and interactions between bacteria and mammalian cells. The parasites made us notice something that has much wider implications."



Microscopy by Norma Andrews

FEATURE

OUR FEARLESS IDEAS EXPLAINED EARTH'S ATMOSPHERE

2000: James Farquhar

1998: Alan Kaufman

More than 2.4 billion years ago, Earth was a harsh and unwelcoming place, with a hazy methane-rich atmosphere all but devoid of oxygen. Without oxygen, there was no protective ozone layer, permitting ultraviolet light to bombard the planet's surface. Early microbial life remained deep in the ocean, beyond the reach of this unchecked radiation.

Within a few hundred million years—the blink of an eye in geologic time—everything changed. The atmosphere filled with oxygen, the ozone layer formed and life came bursting toward the ocean's surface.

Why this happened is uncertain, but the process probably started around the time when blue-green bacteria—Earth's first organisms capable of photosynthesis—began producing oxygen. Several other lines of evidence provided clues to changes in early Earth's atmospheric composition as well. Still, geologists struggled to connect the dots until 2000, when UMD Geology Professor James Farquhar and his colleagues charted the rise of atmospheric oxygen in a paper published in the journal *Science*.

The researchers found a sharp change in the proportion of rare sulfur species that could only be explained by a rapid rise in atmospheric oxygen and, importantly, development of the ozone layer.

"When I first saw this sulfur signature, I wasn't really looking for it. I started out looking for evidence of the first appearance of sulfate-reducing bacteria," Farquhar said. "But the variation was 20 times larger than I had expected. At first I thought something had gone wrong with the experiment."

According to Farquhar, the shift from an oxygen-poor atmosphere to one with enough oxygen to develop the ozone layer was extraordinarily rapid.

"It would have been like someone flipped a switch," Farquhar said. "And this was like a wall switch, not a dimmer switch. There was no turning back."

This sudden shift in atmospheric chemistry, known as the "Great Oxygenation Event," had profound implications for life on Earth. Oxygen drove the evolution of cells with a nucleus—a drastic departure from the bacteria that ruled early Earth. The ozone layer blocked UV radiation, enabling life to occupy the upper reaches of the ocean for the first time in Earth's history.

But the rise of atmospheric oxygen also destroyed methane, which is roughly 25 times more efficient than carbon dioxide at capturing heat. This large-scale loss of methane—and thus heat—likely plunged the planet into a series of widespread ice ages.

One such series, which occurred more than a billion years after the Great Oxygenation Event, during the Neoproterozoic Era, may have resulted in "snowball Earths." During these times, glaciers and sea ice potentially blanketed the planet's surface from the poles to the equator for millions of years.

In 1998, UMD Geology Professor Alan Kaufman co-authored a paper on the snowball Earths in the journal *Science*. Based on evidence that pointed to profound changes in the global carbon cycle during the Neoproterozoic Era, Kaufman and his colleagues suggested that Earth underwent drastic and unprecedented swings in surface temperatures.

As the last of the great ice sheets melted, oxygen in the atmosphere began to accumulate rapidly again. Researchers named this second major shift the "Neoproterozoic Oxidation Event."

"The rise of oxygen during the Great Oxygenation Event might have taken us from insignificant amounts to about 1 or 2 percent oxygen in the atmosphere," Kaufman said. "But during the Neoproterozoic, we may have gone from 1 to 2 percent to the 20 percent we see today."

Photo of Dale's Gorge, showing banded iron formations that document the Great Oxygenation Event, by Alan Kaufman

OUR FEARLESS IDEA

CONTROLLED CHAOS

1990: Edward Ott, Celso Grebogi and James A. Yorke

1997: Professor William Phillips won the Nobel Prize in physics (see p. 15)

Can the flap of a butterfly's wings in Brazil set off a tornado in Texas? It may sound far-fetched, but according to chaos theory, not only are such connections possible—they're much more likely than we may realize.

Chaos theory is a field of mathematics that describes the behavior of complex, unpredictable systems. Mathematically speaking, a defining characteristic of a chaotic system is sensitivity to the system's initial conditions. Using the butterfly analogy, that first wing flap would create the initial conditions that define the entire chain of chaotic events to follow. Did the butterfly lead with one wing over the other? Was it a strong flap or a weak one? Did its wings have any scars or other blemishes that affected air flow?

Distinguished University Research Professor of Mathematics and Physics James A. Yorke, Ph.D. '66, mathematics, was the first to apply the term "chaos" in a mathematical context, in a paper he co-authored in 1975 in the journal *American Mathematical Monthly*. Since then, chaos theory has been applied in some form to nearly every discipline of science and has even found its way into popular culture—featured in films such as "Jurassic Park" and television shows such as "The Simpsons."

"I like to say that scientists were the last to learn about chaos. But other people are intrinsically aware of it," said Yorke, who illustrated his point with a story about a married couple who met purely by chance, when a woman hailed a taxi cab driven by her future husband. "This couple soon had a child, who eventually became a colleague of mine. Imagine if his mother had ridden in a different cab that day. Everyone knows, at some level, that chaos can produce huge impacts on their lives."

In 1979, Yorke met Edward Ott, then a new addition to UMD's faculty, who is now a Distinguished University Professor. An electrical engineer and a physicist by training, Ott had previously studied chaos in the behavior of highly ionized gases.

"People would always ask why I was interested in chaos. Isn't it something you always want to avoid in science? It's nasty and complicated," Ott said. "As soon as I started wondering whether there is a use for chaos, I started thinking about controlling chaos. Chaos has an interesting attribute, in that the effect of a small change grows exponentially and can have a huge effect on the total system. It was natural to ask if we could control a chaotic system with only a very tiny change."

In 1990, Yorke, Ott and Celso Grebogi, M.S. '75, Ph.D. '78, physics—then a UMD mathematics professor—answered that question for the scientific community with a resounding "Yes." The trio published a paper in the journal *Physical Review Letters* titled "Controlling Chaos," which, true to its name, described a method for stabilizing a chaotic system. By adjusting a carefully chosen parameter, the researchers showed that they could prod the system toward a desired outcome. The paper and method both are now better known by initials of the three authors' last names: OGY.

"First, we presented the general theory and then followed with numerical experiments," Ott said. "Almost immediately, others followed up with a large number of lab experiments and physical realizations. For the first time, if you understood chaos you could use it to your benefit. We showed that chaos isn't always an annoyance and a hindrance to gaining information."

The OGY method has since aided studies of turbulent fluids such as airplane jetwash and boat wakes, oscillating chemical reactions, the arrhythmic beating of cardiac tissues, and more.

Chaos visualization by James A. Yorke
Nobel medal photo by Lovisa Engblom, ©® The Nobel Foundation

FEATURE

MY FEARLESS IDEA

CONFIRMED STORMS SPREAD POLLUTION

1987: Russell Dickerson

1985: Herbert Hauptman, Ph.D. '55, mathematics, won the Nobel Prize in chemistry (see p. 15)

In the 1980s, severe pollution choked the skies above most major cities in the United States. But these pollution problems were widely accepted as local or regional issues. One could travel a few dozen miles outside of smog-stifled Los Angeles, for example, and reasonably expect to enjoy clear skies and a breath of fresh air.

Reality is a bit more complicated, however. In 1987, Russell Dickerson, currently a professor of atmospheric and oceanic science at UMD, led a study on air pollution published in the journal *Science*. The team was the first to demonstrate that large thunderstorms can launch pollution molecules nearly 9 miles above Earth's surface. At this altitude—above most clouds and all but the largest of storms—pollution survives for much longer and can travel miles away from its source.

"The bottom line is that storms can transform local pollution problems into regional—or even global—atmospheric chemistry and climate issues," Dickerson said. "The higher you go, the more stable the chemistry becomes. Because of this, pollutants stay around much longer, resulting in a bigger impact on radiative forcing and climate."

Prior to Dickerson's study, prevailing wisdom among atmospheric scientists held that thunderstorms could actually help clean up pollution. As raindrops fall to the ground, they attract and remove pollutant particles from the air. But this assumed a simpler model where pollutants remain less than a mile above the ground.

Then, some numerical models began to suggest that storms could launch pollutants into the upper reaches of the troposphere—the lowest 10 miles of the atmosphere where all weather takes place. Dickerson wanted to verify these predictions with observations. So his team set about doing this the only way possible: by flying three instrumented research planes very close to a giant thunderstorm.

"We did the work in Tornado Alley, in Oklahoma and Arkansas," Dickerson said. "But big storms happen nearly everywhere. Our group has since done lots of work in other places, such as Costa Rica, Guam, Canada and China."

Looking back, Dickerson is most proud of where his colleagues and students have taken the work since the 1987 study. Together, their body of research has contributed to a new understanding of how pollution is transported at the global scale.

"The 1987 paper lit a fire and opened up a whole new field of exploration into the interaction between chemistry and meteorology," Dickerson said. "We now know that pollution lofted from the U.S. can end up in Europe, and Europe's pollution ends up in Asia. And pollution from Asia—China especially—travels across the Pacific to North America."

Despite such widespread transport of pollutants, Dickerson noted that the air has become much cleaner in some key places over the course of his career.

"The wonderful story here is that air quality over North America and Europe has improved dramatically," Dickerson explained. "In places like Beijing and Mumbai, people often can't see across the street. People forget that New York City and Chicago used to look like this."

Storm photo by Ken Engquist/NOAA
Nobel medal photo by Lovisa Engblom, ©® The Nobel Foundation

MY FEARLESS IDEA HELPED PEOPLE QUIT SMOKING

1975: Paul Mazzocchi

Throughout the latter half of the 20th century, scientists were working to develop more effective pharmaceuticals to treat a wide range of ailments, including pain. Morphine—long a staple of wartime trauma centers and domestic surgical wards—had proven itself a highly effective painkiller, but with one major downside: a high potential for addiction.

In the 1970s, against this backdrop, Paul Mazzocchi, currently a UMD Chemistry and Biochemistry Professor Emeritus, joined the race to design a morphine like molecule, also known as a synthetic opioid. At the time, chemists believed that with a little engineering, they could develop an opioid that would offer all the pain-relieving benefits of morphine without snaring patients in a web of addiction.

"Back then, this was an ongoing research area funded by the National Institutes of Health. We thought we could generate a molecule that was like morphine but not addictive. This has since been recognized as nonsense," said Mazzocchi, acknowledging the well-documented problems with synthetic opioids like fentanyl and its derivatives.

Mazzocchi's efforts were not in vain, however. In a paper he co-authored in the *Journal of Medicinal Chemistry* in 1979, Mazzocchi described a molecule that lacked the painkilling powers of morphine, but was nonetheless able to bind to morphine receptors in the brain. Importantly, the molecule—a modified benzazepine—was later found to bind to another very similar group of receptors: those responsible for nicotine addiction.

A quarter-century later, researchers at Pfizer's research and development labs came across Mazzocchi's publication. With some modifications, the researchers transformed Mazzocchi's benzazepine molecule into a related compound called varenicline. Many former smokers may recognize varenicline by its brand name: the smoking cessation drug Chantix.

"I never knew our molecule would be useful for something else. We were only looking at the morphine receptor site," Mazzocchi said. "But there are now well-established links between the morphine receptor site and the nicotine receptor site. Pfizer was looking for a compound that had certain properties at the related nicotine site. That's how they found our paper, and that's how varenicline came about."

Chantix is now a highly profitable product—although not totally devoid of side effects. Because Mazzocchi published his findings on the modified benzazepine molecule in the public domain, as per the terms of his National Institutes of Health grant, his recognition came in the bibliography of Pfizer's original publication on varenicline. All the same, he is grateful that his efforts contributed to a positive outcome.

"The danger in any science is that you might make a discovery that's not beneficial but harmful," said Mazzocchi, referring to danger presented by other successful attempts to create synthetic opioids. "You can make the same comparison with nuclear science and the atom bomb. But as a scientist, you focus on your goal and hope that there aren't any alternative uses that are less than beneficial."

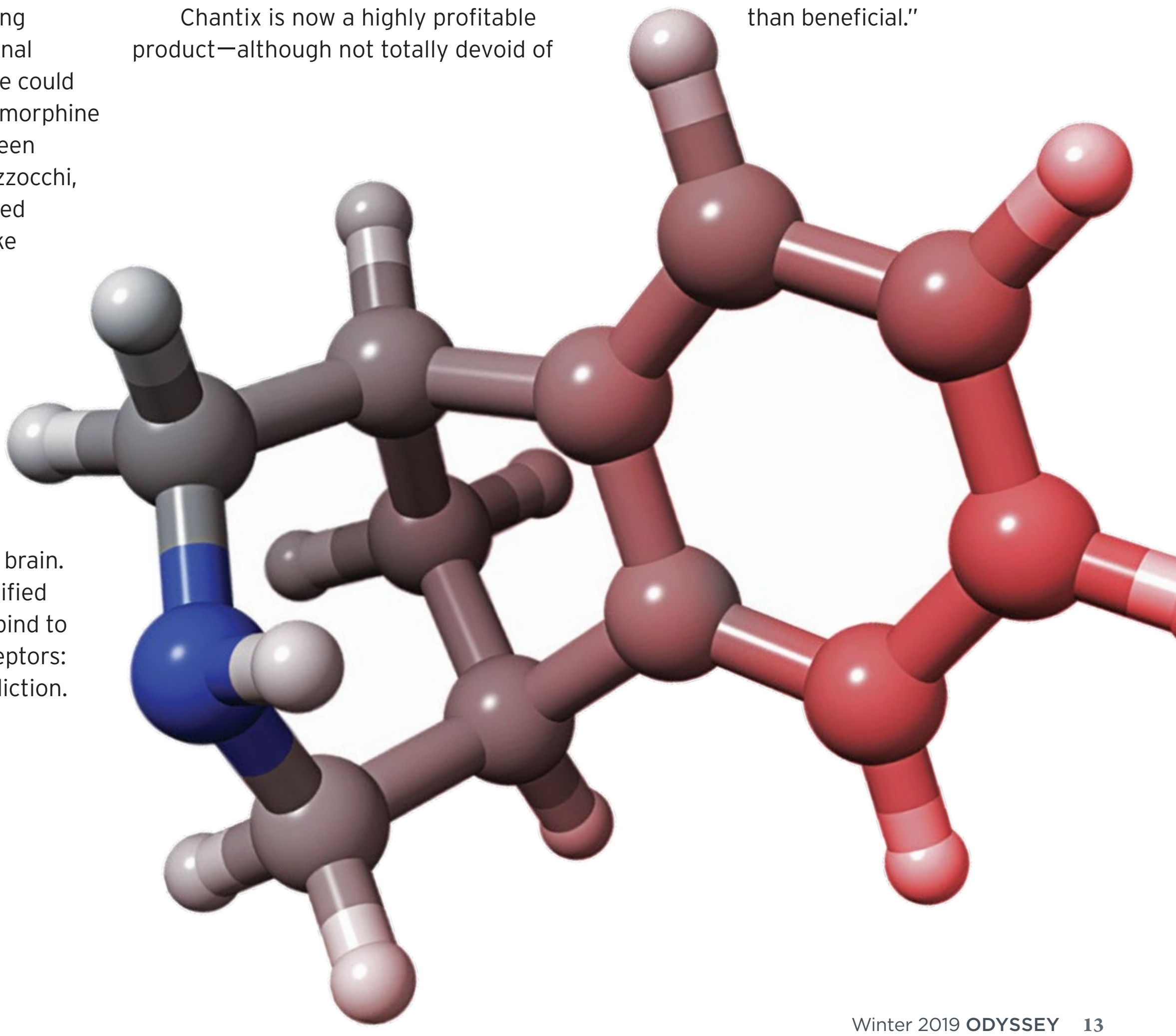


Illustration by Science Source

FEATURE

MY FEARLESS IDEA

GAVE "COLOR" TO QUARKS

1964: O.W. "Wally" Greenberg

In the 1950s and 1960s, particle physicists found themselves in the midst of a conundrum. They knew that atoms could be split into protons, neutrons and electrons. But the development of ever-more powerful atom-smashers revealed a veritable zoo of new particles never before observed by scientists. Where did these particles come from, and how did they fit into physicists' understanding of matter?

Today, we know that protons and neutrons can be further split into smaller particles called quarks. First proposed in 1964, quarks have unusual properties that initially made it hard for the scientific community to accept their existence. For example, protons contain three quarks—two with an identical electric charge and one with a different charge. This violates the exclusion principle, which forbids two quarks to be in the same quantum state. Only a property with three values could allow three quarks to coexist while satisfying this principle.

In 1964—the same year quarks were first proposed—UMD Physics Professor O.W. (Wally) Greenberg published a paper in the journal *Physical Review Letters*. He was the first to suggest that quarks exhibit a property called "color" which, despite the name, has nothing to do with the color we see with our eyes. Rather, it's a metaphor, rooted in the idea that the three primary colors—red, green and blue—combine to make white light.

Color provides three distinct quantum states in which a given quark can exist, while explaining the strong interactions that bind quarks together. Quarks and color were experimentally verified in 1973, and the "standard model" of particle physics was officially born. Finally, physicists had a basic understanding of what matter is and how it appears in the universe.

"With the discovery of quarks and color, our view of the fundamental particles of nature changed," Greenberg said. "Fifty years ago, we thought protons and neutrons were the most basic particles. Today, point-like quarks are the most fundamental particles ever seen even with the most advanced high-energy accelerators available."

Just as a mix of red, green and blue light yields white light, a combination of all three color charges yields a color-neutral proton or neutron. Quarks can change color when they exchange particles known as gluons with other quarks, but these changes balance each other out such that the proton or neutron remains color-neutral overall.

The force between color-charged particles, called the strong or nuclear force, is very strong indeed—more than 100 times stronger than the electrical force that holds atoms together. The nuclear force is largely responsible for the immense power of nuclear explosives, so it's a good thing that under normal circumstances, the nuclear force only acts at the scale of quark interactions.

"Basic science research led to the discovery of quarks and color," Greenberg said. "This type of research is extremely valuable, and continued basic research in particle physics will ultimately lead to a deeper understanding of the universe, and if history is our guide, also to practical applications."

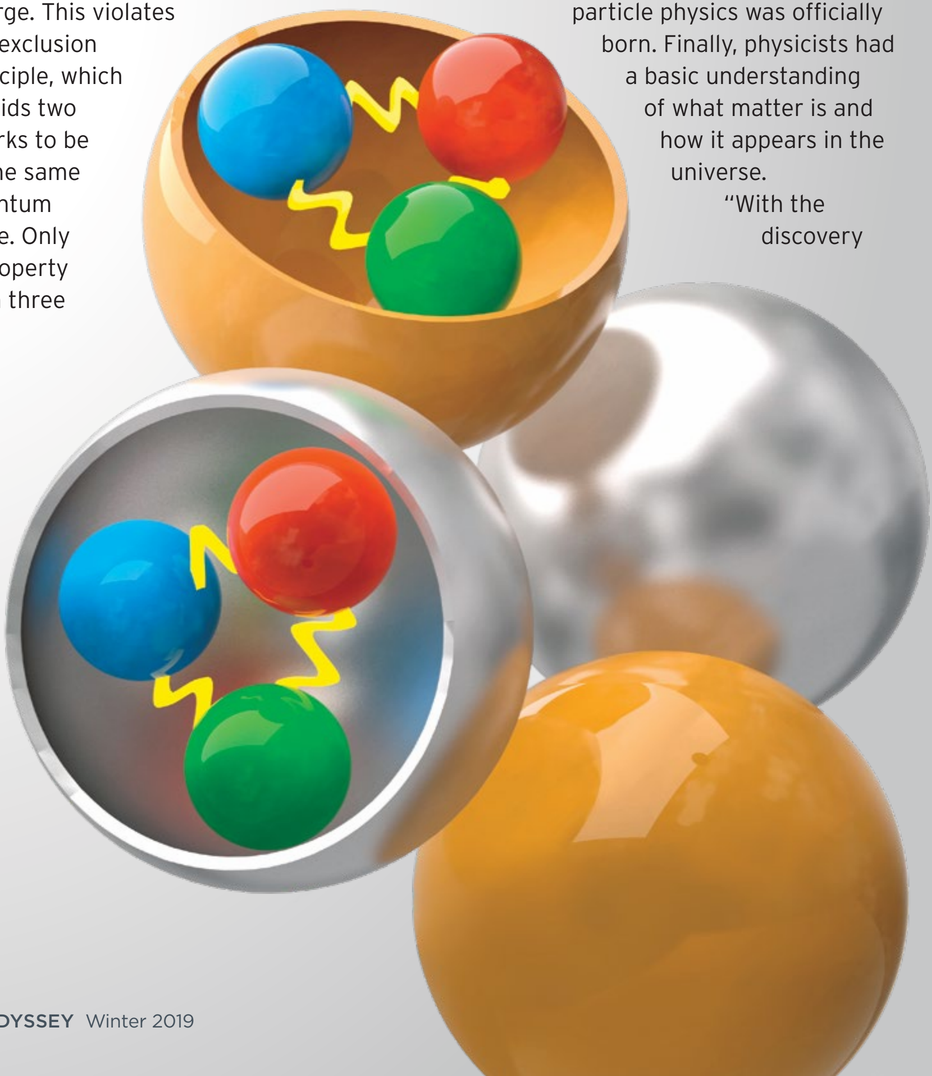


Illustration by Festa/Shutterstock

OUR FEARLESS IDEAS MADE US NOBEL LAUREATES

Alumni and faculty members who won the world-renowned scientific prize

John Mather
Nobel Prize in Physics, 2006

According to the Big Bang theory, cosmic microwave background radiation—an electromagnetic "glow" filling the universe—should have certain properties.

In 1974, John Mather led a team at NASA's Goddard Space Flight Center that analyzed this radiation. Their experimental results matched theoretical predictions, confirming the Big Bang theory.

Mather, who joined UMD as a College Park Professor of Physics in 1992, shared the Nobel Prize for the "discovery of the blackbody form and anisotropy of the cosmic microwave background radiation."

"I came to the University of Maryland because it's a great place to do science and it cooperates very well with NASA Goddard," said Mather, who continues to hold positions at NASA and UMD. "I have opportunities to collaborate with university professors on potential future space missions and new technology for ground-based observatories."

Mather earned a B.S. in physics from Swarthmore College in Pennsylvania and a Ph.D. in physics from the University of California, Berkeley.

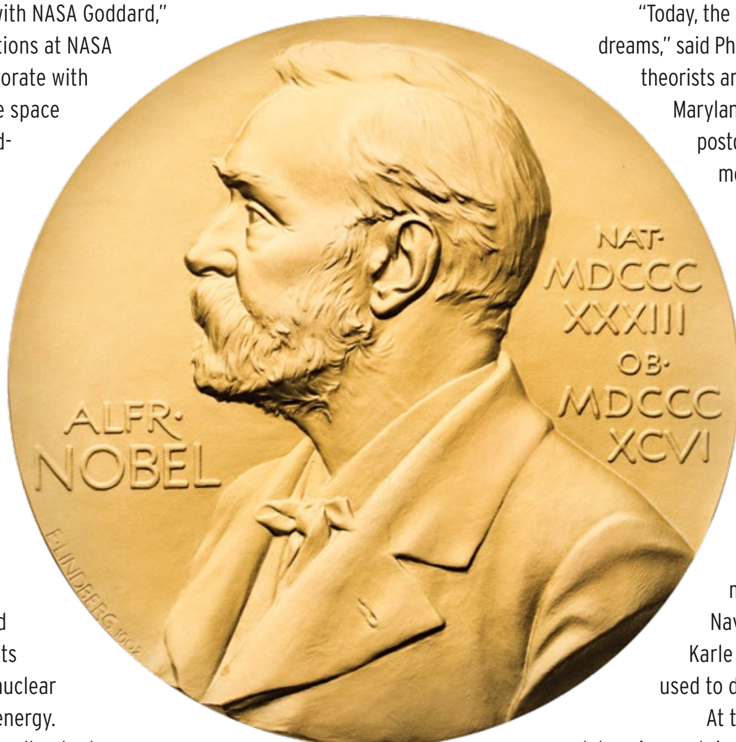
Raymond Davis Jr. (1914–2006)
Nobel Prize in Physics, 2002

Raymond Davis Jr., B.S. '37, M.S. '40, industrial chemistry, joined Brookhaven National Laboratory in 1948. There, he led a team that determined that the sun emits neutrinos—particles formed during the nuclear fusion reactions that produce the sun's energy.

Davis and his team built a 100,000-gallon tank 4,850 feet underground in the Homestake Mine in South Dakota to detect neutrinos. Starting in 1968, the Homestake Experiment began yielding results that eventually demonstrated the existence of solar neutrinos and confirmed that nuclear fusion occurs in the sun. Davis shared the Nobel Prize "for pioneering contributions to astrophysics, in particular for the detection of cosmic neutrinos."

The study of neutrinos continues to reveal new information about our universe. In 2018, UMD physicists helped find the first evidence that high-energy cosmic neutrinos and cosmic rays may come from supermassive black holes.

Davis earned a Ph.D. in physical chemistry from Yale University.



William Phillips
Nobel Prize in Physics, 1997

William Phillips joined what is now the National Institute of Standards and Technology (NIST) in 1978 to research laser cooling, which slows atoms for applications such as atomic clocks. There, he developed the Zeeman slower, an apparatus that captures and slows atoms. Phillips shared the Nobel Prize for the "development of methods to cool and trap atoms with laser light."

Phillips joined UMD in 1992 and was named a Distinguished University Professor and College Park Professor of Physics in 2001 and 2006, respectively. Phillips also helped launch the Joint Quantum Institute (JQI), a research partnership between the university and NIST that is headquartered on UMD's College Park campus.

"Today, the activity at the JQI exceeds my fondest dreams," said Phillips, who is also a JQI fellow. "JQI brings theorists and experimenters from the University of Maryland and NIST together with students and postdocs from all over the world in one of the most creative environments ever assembled for exploring the quantum mysteries of the universe."

Phillips earned a B.S. in physics from Juniata College in Pennsylvania and a Ph.D. in physics from the Massachusetts Institute of Technology.

Herbert Hauptman (1917-2011)
Nobel Prize in Chemistry, 1985

In 1947, Herbert Hauptman, Ph.D. '55, mathematics, began a collaboration with Naval Research Laboratory scientist Jerome Karle on X-ray crystallography, a technique used to determine the structure of molecules.

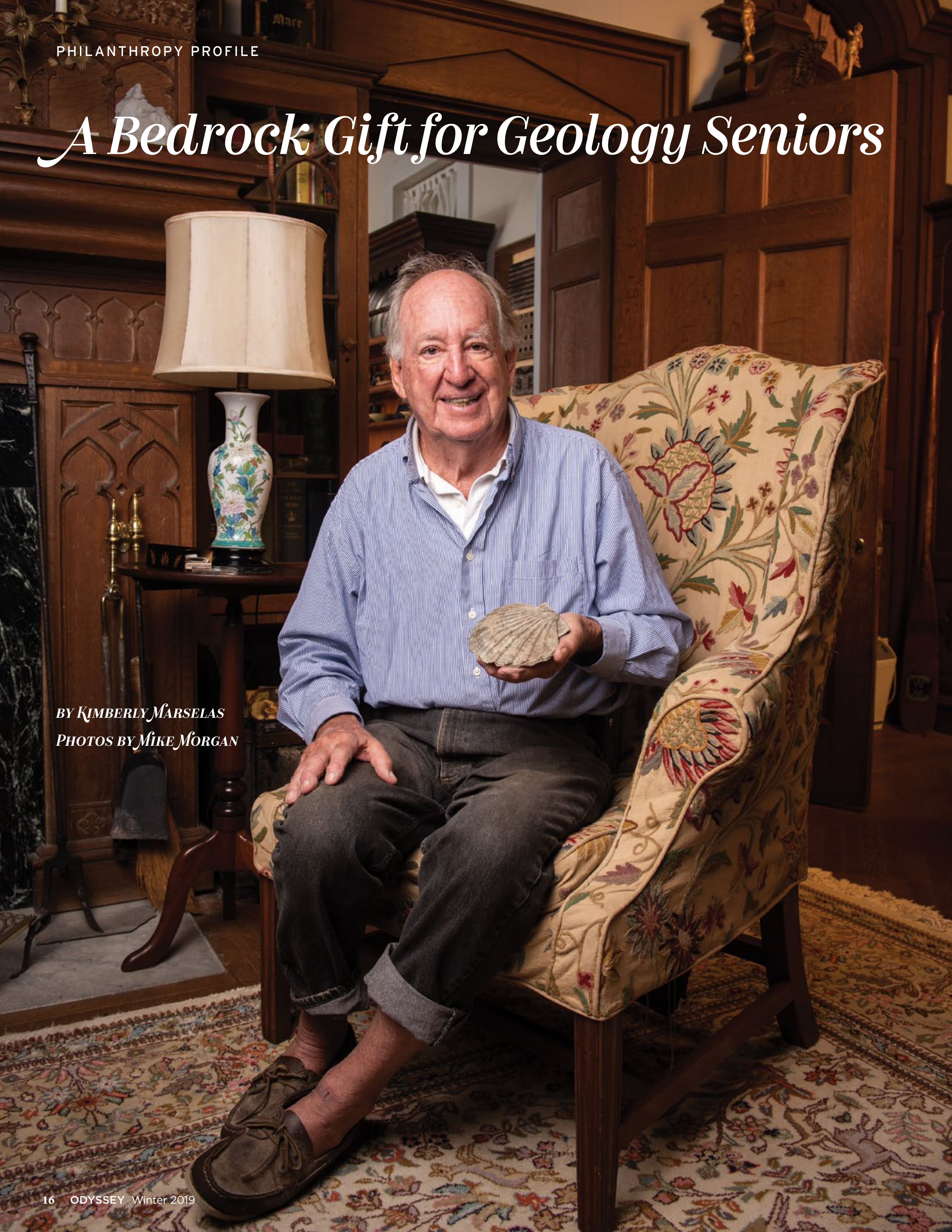
At the time, X-ray crystallography could only determine certain simple molecular structures. Hauptman and Karle developed equations that made it possible to directly determine the structure of larger molecules, such as proteins, using X-rays. This work enabled biological research and medical advances. Hauptman and Karle shared the Nobel Prize for "outstanding achievements in the development of direct methods for the determination of crystal structures."

Hauptman joined the Medical Foundation of Buffalo in 1970 and later became the organization's president. In 1994, the foundation was renamed the Hauptman-Woodward Medical Research Institute in honor of Hauptman as well as Helen Woodward Rivas, who helped establish the foundation.

Hauptman earned a B.S. in mathematics from the City College of New York and an M.A. in mathematics from Columbia University. ■ *–Z. IRENE YING*

Nobel medal photo by Lovisa Engblom, ©® The Nobel Foundation

A Bedrock Gift for Geology Seniors



By Kimberly Marselas
Photos by Mike Morgan

An outdoors enthusiast who grew up fishing and hunting in his native West Virginia, Peter Stifel never envisioned himself a teacher.

But his legacy to the University of Maryland's Department of Geology is 30 years of high-quality teaching. His teaching style emphasized hands-on experiences, written communication and plenty of fun to accompany his students' intellectual curiosity and hard work.

Stifel, an associate professor emeritus, created the department's undergraduate senior thesis program, which continues today more than 20 years after his retirement to Maryland's Eastern Shore. Now a dedicated environmentalist, Stifel pledged $250,000 to sustain UMD's geology senior thesis program in perpetuity—as a way to encourage student exploration and to better understand our world.

"Geologists are basically detectives," Stifel said. "They see evidence for things that happened in the past, and they have to figure out the circumstances that allowed this specific evidence to evolve."

Take Stifel's life, for example. His own career evolved unexpectedly. Stifel left West Virginia for prep school at the Hill School in Pennsylvania, which then led him to Cornell University where he majored in geology.

He was accepted to the University of Utah to pursue a master's degree. But having completed a voluntary thesis at Cornell, he was so well prepared that he received high marks and instead earned a doctorate in geology and zoology.

In 1966, Stifel arrived at UMD—one of the first three instructors in a geology program that was then housed in the agronomy department. Lab hours were limited because the building was locked up for the night, and Stifel recalls propping windows open so undergrads could sneak in after hours to conduct research.

As the university reorganized its departments and schools in 1973, geology faculty members saw an opportunity to create their own major. From the earliest days, Stifel insisted that undergraduates be required to design, complete and defend a research project.

"My main contribution was insisting that the course be as good for any one student as it was for another, whether that student was going to stock shelves at Safeway or going on to Harvard for graduate school," Stifel recalled. "A lot of times, character building was as important as the facts learned."

The thesis program quickly evolved from a one-credit class to its current format as a yearlong, six-credit program. In the first semester, students select a research question, determine what resources they need and test their data to prove the work is feasible. In the second semester, students complete the research, write a thesis and defend it in front of as many as 100 fellow students and faculty members.

Stifel still often attends the presentations, eager to see how students have focused their research lenses. Projects have taken the students to construction sites in Washington, D.C., rock outcrops in western Maryland, and as far away as Alaska and Africa.

One of the biggest challenges is managing student expectations.

"We can find out what was happening 400 million years ago by sampling and observation," Stifel said. "But you have to limit the students sometimes. They want to solve all the world's problems."

Stifel said what the students study is less important than learning how to collect and analyze data properly. The students also learn to troubleshoot, such as finding another streambed to sample when the original one remained icebound midway through the second semester.

Many students say their thesis projects became the foundation of successful careers, according to Philip Piccoli, a senior research scientist in the Department of Geology who oversees the thesis program today. While more departments at UMD are starting undergraduate thesis programs, many of those remain voluntary. That's also true of geology tracks at other universities—a fact that helps set Maryland apart.

"For many of our students, this is a transformative experience. They're taking what they've learned in the lab and applying it to research," Piccoli said. "These aren't pet projects our faculty have. The students take ownership in this."

Keeping students motivated with a mix of fun and rigor harkens back to Stifel's classroom philosophy.

In his teaching days, Stifel would conclude a unit on molluscan paleoecology with a classroom feast of cherrystone clams, mussels and oysters. He was famous for his Hope House stomps, inviting dozens of students and faculty members to his historic farm on the shore of Woodland Creek in Talbot County, Maryland. There, they could discuss their common bonds as geologists and admire the wildlife and scenery that made Stifel a devoted environmentalist.

"Pete was the first teacher in my life who knew about and loved fossils as much as I do," recalled Lawrence Thrasher, B.S. '75, geology, a Bureau of Land Management geologist.

Stifel advised Thrasher on his senior thesis that was built around a collection of fossils Thrasher found in northern Virginia as a child. The Paleozoic invertebrates—mostly corals and brachiopods—washed down to the D.C. area in streambeds from West Virginia and ended up as local gravel deposits.

"That was great preparation for my master's thesis several years later at the University of North Dakota on the invertebrate fossils—mostly brachiopods—and biostratigraphy [layers used to help date rocks] of the now-famous Bakken Formation," Thrasher said. "And that was all a great background for my current position as a federal geologist."

Thrasher still recalls cracking open chert, or sedimentary rock, with Stifel to reveal the seashells, and he especially remembers the inspiration both men found in that process.

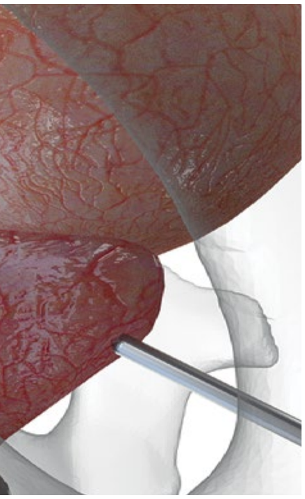
"Field work is the great equalizer," Piccoli said. "When you're at a site swinging a sledge hammer or trying to take notes in pouring rain and it's 35 degrees, you're all at the same level."

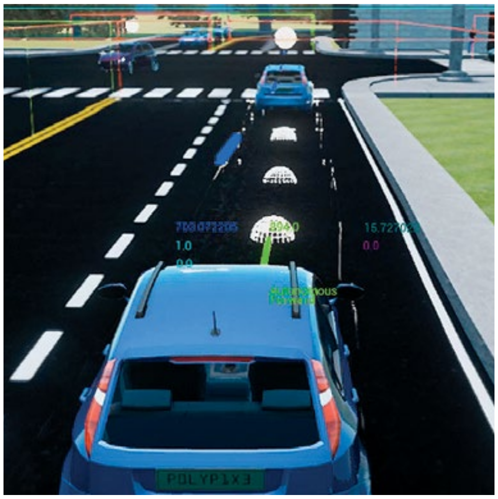
Some students work from laboratory slides or existing samples, if travel is prohibitively expensive. In the past, thesis expenses have been borne by the students themselves or by faculty advisors—even when the student's work didn't support the advisor's own line of research.

Stifel's gift will allow students to learn how to write grants, make travel to field sites more practical and enable more students to attend geology conferences. As a result, students will find themselves better positioned for graduate school or the job market.

"The inquiry-based learning that is fundamental to the senior thesis transcends traditional brick-and-mortar learning. This method allowed me to do science, which I found far more exciting than regurgitating science on exams," said Adam Simon, B.S. '95, Ph.D. '03, geology, an associate professor at the University of Michigan who researched copper in the Tuolumne Intrusive Suite for his senior thesis. "I would not be where I am today without my senior thesis experience."

STILL A STUDENT OF MOLLUSKS & ZOOLOGY
Life at Hope House keeps Peter Stifel busy. In addition to caring for his 200-year-old home, he grows crops, gardens, raises chickens and sheep, and harvests oysters from his boat dock. He can also be found making rounds in his antique car, a 1910 Thomas Flyer.





(CLOCKWISE FROM TOP LEFT) PROSTATE SURGERY SIMULATION; AUTONOMOUS VEHICLE NAVIGATION SIMULATION; AUTONOMOUS VEHICLE MOUNTED SENSOR RANGE AND EFFICIENCY SIMULATION; RECONSTRUCTION OF TRAFFIC FLOW IN SAN FRANCISCO USING GPS DATA FROM MOBILE DEVICES; TRADE SHOW CROWD INTERACTIVE SIMULATION; CROWD SIMULATION TO EVALUATE AND IMPROVE PEDESTRIAN FLOW IN NEW YORK CITY'S GRAND CENTRAL TERMINAL; SYSTEM TO ASSESS THE BEHAVIOR AND MOVEMENT OF VIRTUAL PEOPLE IN A SOCIAL VIRTUAL REALITY ENVIRONMENT.

A Real-life Boost for Virtual Research

BY ELLEN TERNES

> Ming Lin and Dinesh Manocha had a lot of good reasons to pull up stakes after 25 years at the University of North Carolina at Chapel Hill and come to College Park.

Lin was appointed as the new chair of the University of Maryland's Department of Computer Science and holder of the Elizabeth Stevinson Iribe Chair of Computer Science. Manocha joined her as the Paul Chrisman Iribe Professor in Computer Science.

The couple are looking forward to new possibilities for their virtual and augmented reality research in the university's highly ranked computer science program—one of the country's largest—and the new Brendan Iribe Center, slated to open this spring.

They're especially excited about UMD's potential to be at the center of the country's next major technology corridor.

"I expect a 'cyber valley of the future' will take shape right here in the D.C. metropolitan area, all the way to Baltimore," said Lin, who also has an appointment in the University of Maryland Institute for Advanced Computer Studies (UMIACS). "What university is best positioned to lead this development? It's going to be the University of Maryland, College Park."

When Silicon Valley was rocketing to its place as the undisputed leader of computer development, Lin and Manocha were at the University of California, Berkeley. Lin studied there from 1986 to 1993 for her B.S., M.S. and Ph.D. in electrical engineering and computer sciences and Manocha earned his Ph.D. in computer science there in 1992. They saw firsthand the impact their school and Stanford University had on the region's digital success.

Simulation images courtesy of Ming Lin and Dinesh Manocha

"In the economic development of a region, you assume a strong university plays a big role," said Manocha, who has joint appointments in UMD's Department of Computer Science, Department of Electrical and Computer Engineering, and UMIACS.

Lin believes the time is right for the next wave of cyber innovation. "Technology is changing fundamentally the way we live as humans and as a society," Lin said. Students pay for lunch with their phones. Self-driving cars are no longer science fiction. The influence of technology on elections and privacy promises to stay in the headlines.

"Technology is no longer a next phase of development, and research is no longer going to be stand-alone," Lin said. "There will be many interesting challenges and questions regarding policy and regulations. Examining how technology will affect society will be an integral part of our research."

MING LIN

The virtual and augmented reality research that Lin and Manocha do is valuable for the gaming and animation industries. A number of Lin and Manocha's students have graduated and gone on to jobs at places like Pixar, Disney and Oculus—the virtual reality company co-founded by UMD alumnus Brendan Iribe. But Manocha and Lin's research efforts also focus on looking at how these technologies can create virtual environments to help people on a larger scale.

"We have not just been looking at the pure 3D computer graphics representations and animations and simulations, but also at how they would live in a virtual world, using real data to predict how humans behave and move," Lin said. "We're constantly working on problems that have an impact on society as a whole, and that's critical because we're hoping through research that we can make a bit of difference."

For example, Manocha has been using virtual and augmented reality to study crowd safety and prevent disasters like the 2015 Mecca Hajj disaster in Mina, Saudi Arabia. That year an estimated 2,200 people were killed in a crush around the Kaaba, a building at the mosque's center, during the pilgrimage that brings 2 million people annually to Islam's holiest site.

"We wanted to see if we could simulate the movement of the pilgrims and improve their safety," Manocha said.

That meant accurately simulating the behavior of a crowd of millions, figuring out how people would move and change in reaction to the environment and stress, and understanding the culture of the crowd. Different cultures react differently to stress, according to Manocha.

Simulating human interactions also requires simulating human emotions, Lin explained.

"If you want to model any real world, you have to model everything, including human behavior," Lin said. "Modeling and simulating human behavior is an integral part of any virtual environment, and it's one of the most complex and challenging problems."

Lin's research has used virtual and augmented reality to better predict vehicle collisions and improve traffic control, an issue that promises new challenges as more autonomous vehicles take to the road. One of Lin's projects, the Road Network, is a library of methods for creating a 3D model of a large-scale road network that can be used for real-time traffic simulation, interactive visualization of a virtual world and autonomous vehicle navigation. This information can be used to make broader decisions about safety, policy and highway construction.

"Modeling and simulating human behavior is an integral part of any virtual environment, and it's one of the most complex and challenging problems."

> MING LIN

"The virtual environment has many advantages over testing that uses real people, which is expensive and difficult to do," Lin said. "If you want a larger-scale study, then you can use a virtual environment to test as many scenarios as possible for an autonomous car to interact with a human. And you can evaluate possible designs much quicker in a virtual environment."

Lin's research also employs virtual and augmented reality to improve health care. In 2016, one of Lin's research teams showed how using medical images could help to more accurately diagnose and treat prostate cancer in individual patients. By reconstructing 3D geometry from sets of multiple-view images and combining the findings with patient data, such as age and family history, the team determined a likely prognosis and a more timely diagnosis and treatment for cancer.

Photo by John T. Consoli

The virtual reality images can also be used for virtual surgery, which lets surgeons practice and experiment on 3D augmented reality objects without risk to a patient.

Several members of Lin and Manocha's UNC lab have joined them in College Park. Their research labs will be located in the new Brendan Iribe Center when it opens this spring, and the research team has begun to collaborate with other experts on campus in areas such as physics, math and engineering.

"We believe that the University of Maryland can become a leading university in virtual and augmented reality," Manocha said.

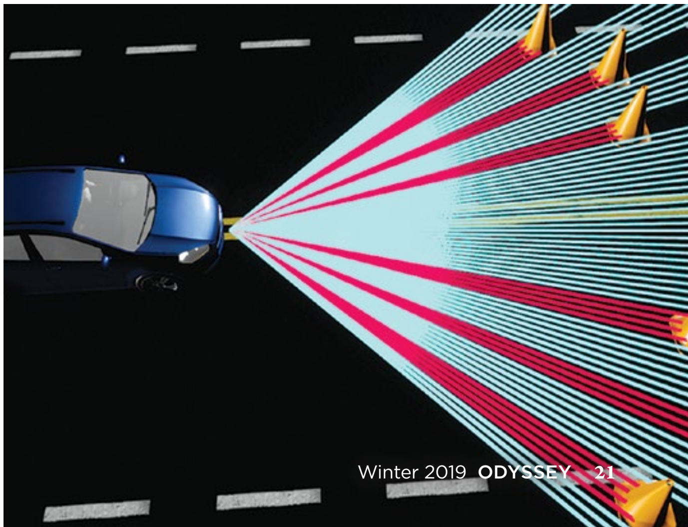
As computer science department chair, Lin also looks forward to additional challenges. Long active in efforts to increase the number of women in science, Lin wants to recruit more women and underrepresented minorities to the department, which may already have the country's highest number of women computer science undergraduates.

She also relishes the challenge of creating that next technology corridor, with the department and university at its center. It's a realistic goal, she said, partly because of what's already been set in motion by the university and its donors.

"We believe that the University of Maryland can become a leading university in virtual and augmented reality."
> DINESH MANOCHA

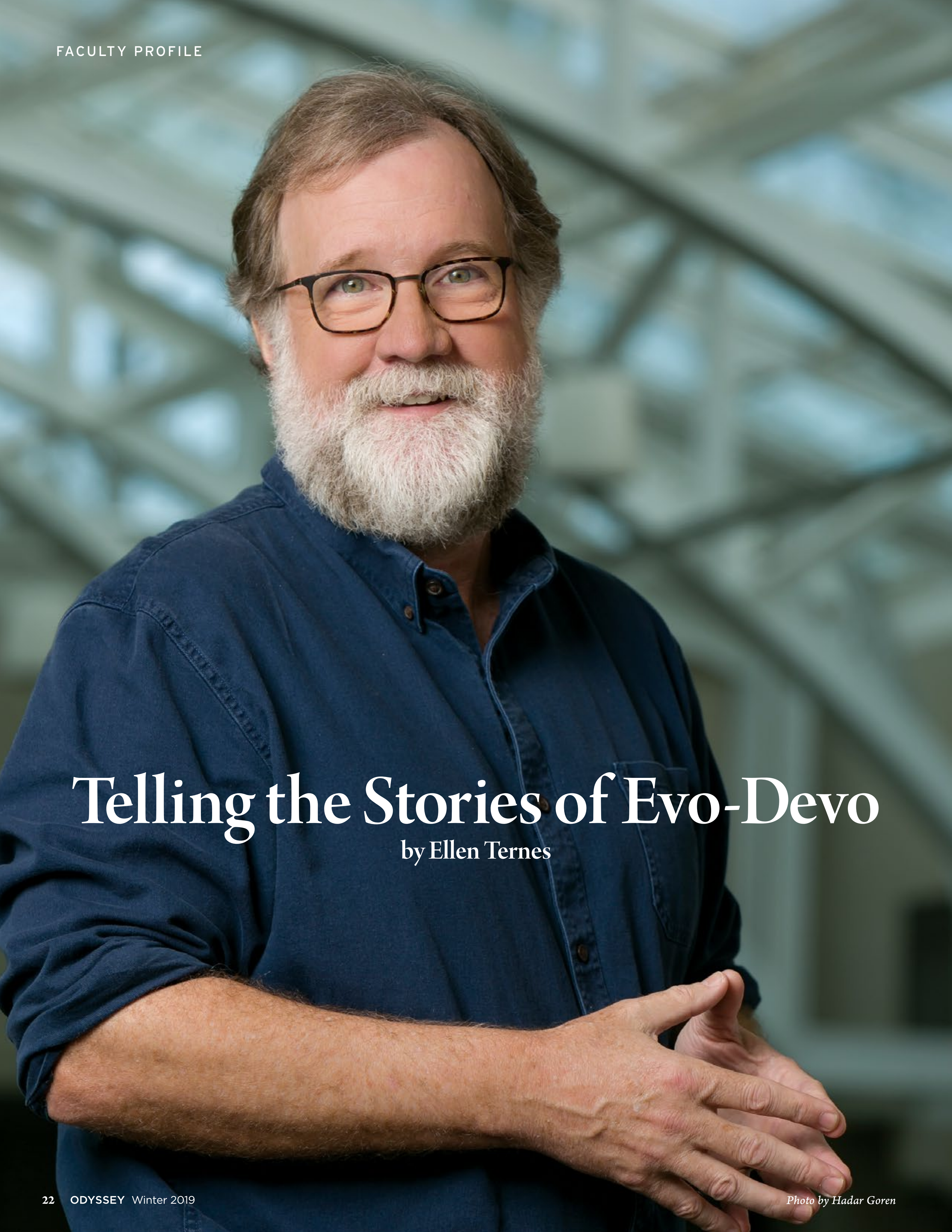
DINESH MANOCHA

"I want to thank the donors, especially the Iribe family, both Brendan and his mother, Elizabeth. If they didn't have their vision and desire to give back, none of this would have happened," Lin said. "Their support of a new building and endowed faculty positions has totally transformed the university and even the state. Funding for virtual and augmented reality research is even part of a state bill. That's just incredible. I think the biggest beneficiaries, however, are the students and the rest of us in the department." ■



AUTONOMOUS VEHICLE NAVIGATION SIMULATION OF COMPLEX TRAFFIC SCENARIOS, SUCH AS (TOP) HEAVY FOG OBSTRUCTING THE VIEW OF THE VEHICLE AND (BOTTOM) A VEHICLE WITH A LASER RANGEFINDER NAVIGATING AROUND TRAFFIC CONES.

Dinesh Manocha photo by Brandi Adams
Simulation images courtesy of Ming Lin and Dinesh Manocha



Telling the Stories of Evo-Devo

by Ellen Ternes

Photo by Hadar Goren

Sean Carroll boasts an impressive list of credentials. Internationally known biology researcher. Science educator. Published author. But at heart, he remains the 10-year-old boy who roamed the woods near his home in Toledo, Ohio.

"I went 'wow' on biology as a kid," Carroll said. "I was a log flipper. I would look under logs for salamanders and hunt snakes in fields and frogs in ponds. My bedroom had snakes and salamanders in cages. But it took a little education to figure out what to do with that fascination in biology."

Carroll and his lifelong fascination recently took up residence at the University of Maryland, thanks to his appointment as the inaugural holder of the Andrew and Mary Balo & Nicholas and Susan Simon Endowed Chair, which is the university's first endowed chair in the life sciences. Carroll is also the first Howard Hughes Medical Institute (HHMI) investigator to hold a faculty position at UMD.

Accompanying Carroll is his impressive catalog of research and even some of his team from the University of Wisconsin. A leader in the field of evolutionary developmental biology, fondly nicknamed "evo-devo," Carroll and his group study how changes in animal development shape the diversity of life.

"One of the big questions we're interested in is where do new things come from, how do novelties evolve?" said Carroll, who is a professor in UMD's Department of Biology. "One of the big, black-box mysteries of biology when I was a student was how does a fertilized egg become a complex animal? It's one of the most spectacular things that happens on the planet, and it is a real key to understanding the diversity of life."

Harkening back to his log-flipping days, Carroll continues to incorporate snakes into his research.

"We've studied the origins of anatomical novelties for a long time, but the goal of studying snakes, and venomous snakes in particular, is to understand biochemical novelties," Carroll said. "Venom is something animals have come up with multiple times—spiders, scorpions, jellyfish, snakes. Where does this come from? Is venom some normal enzyme that's been weaponized? We picked a group we thought would be good models: rattlesnakes."

While the study of venomous snakes might be frightening to some, there's no reason to be worried about live snakes getting loose in the lab. Carroll's team uses rattlesnake DNA and extracts from venom glands they get from a collaborator in Texas.

"One of the practical things we're going to try is using our new knowledge of venoms to design a more effective antidote," Carroll said.

Carroll will continue to serve as vice president of HHMI's Department of Science Education—based at the institute's Chevy Chase, Maryland, campus—as well as head of its film production unit.

"HHMI is the largest supporter of science education in the United States," he said. "We are present on hundreds of campuses, including the University of Maryland; in tens of thousands of classrooms; and now, through our public efforts, tens of millions of households."

"...storytelling is a way to lift the veil on science and let people in on the enterprise."

Helping students understand science and inspiring them to do science themselves are two of Carroll's passions. Through the seven books he has published, the "Remarkable Creatures" column he wrote for The New York Times for four years, and the HHMI films he has produced, Carroll uses storytelling to light the audience's passion for science.

"I think stories work because they can better reflect the actual process of science," Carroll said. "What inspires people to look at a question? How do they actually tackle that? What are the stumbling blocks? Where were the mistakes? Some discoveries are so profound, they shape our view of the world. You've got to know what they're made of."

For example, Carroll points to the story of the asteroid that put an end to dinosaurs and the Mesozoic Era. "It was a great detective story," said Carroll, who wrote about it in his book "Remarkable Creatures," and made a film on the topic for the Smithsonian Channel. The story later appeared in an HHMI film that tracked how scientists solved the mystery of the dinosaurs' demise.

"Not only was it the most important event on Earth in the last 100 million years, but it was the making of the modern world," he said. "It will occupy six sentences in a biology textbook, and that is malpractice. That is one hell of a story and we should know where our 'hell of a stories' are."

The big challenge in science education is giving students a feel for what real science is, Carroll added.

"That whole creative participatory process, we have trouble delivering at scale," Carroll said. "Students are studying it out of textbooks. No wonder people bail on it. If you told a music major, 'You can't touch an instrument for the first two years, you're going to study music as it is on paper,' music schools would be empty. Similarly, storytelling is a way to lift the veil on science and let people in on the enterprise."

Carroll has traveled around the world pursuing stories of discovery that intrigue him. His book "Brave Genius," about the friendship that formed between scientist Jacques Monod and writer Albert Camus after World War II, took him to the Paris police archives.

"I was following a hunch about how the gestapo got onto Monod during the German occupation," he recalled. "I was stitching together some pieces, very similar to the way you work on things in the lab. And there, on tissue-thin paper, was a whole detective's report of a search of Monod's apartment, of his lab, a blow-by-blow account that had never come to light before. And that feeling—I'd had that feeling at a microscope in a lab. That's the thrill of discovery."

Carroll and his team are getting settled in College Park, making themselves at home in their lab overlooking the football team's practice field.

"Maryland creates great opportunities," Carroll said. "The people in my lab are excited for a whole new group of colleagues and collaborators. I am looking forward to contributing to the mission of this great public university."

There will also still be time for log flipping.

"When I'm walking across the golf course and a snake or a turtle crosses, yeah, I stop and pick it up and move it out of the way," Carroll admitted. "It's a visceral thrill every time. That never goes away." ■

Photos by Brian Gratwicke

AMITABH VARSHNEY

Amitabh Varshney Named Dean of the College

Amitabh Varshney assumed his role as dean of the College of Computer, Mathematical, and Natural Sciences (CMNS) on March 1, 2018. A professor of computer science at UMD, Varshey also holds a joint appointment in the University of Maryland Institute for Advanced Computer Studies (UMIACS).

"My priorities for the college include supporting existing academic programs, creating new and meaningful academic offerings for our students, catalyzing new research partnerships, and enhancing our community-building efforts," Varshney said.

He is also strongly committed to developing long-term relationships with alumni, philanthropists, foundations, corporate and government partners, and peer institutions.

"Professor Varshney has the qualities of mind, temperament, leadership and character to be an outstanding dean," said UMD President Wallace D. Loh. "His record of commitment to excellence in learning and teaching, fundamental research and innovation, and multidisciplinary collaborations will serve CMNS well as it continues on its ascendant trajectory."

An expert in computer visualization, Varshney's research explores applications of high-performance computer graphics and visualization in science, engineering, medicine, and the arts. His research also involves virtual and augmented reality, an emerging field that could revolutionize education, health care, public safety, and the visual and performing arts.

One of the biggest strengths that Varshney brought to the job is his extensive experience forming multidisciplinary groups to address significant scientific and societal challenges.

Through MPowering the State—a strategic partnership between UMD and the University of Maryland, Baltimore—Varshney brought together scientists and clinicians to launch the Center for Health-related Informatics and Bioimaging and the Maryland Blended Reality Center. The latter is developing virtual and augmented reality tools that address critical-care patient diagnostics, human anatomy education, non-opioid pain management and implicit bias training.

Varshney came to UMD as an associate professor of computer science in 2000 and was named director of UMIACS in 2010. As director, he helped launch several initiatives, including the Maryland Cybersecurity Center, the Joint Center for Quantum Information and Computer Science, and the Corporate Partners in Computing program. Varshney also helped establish the Maryland Center for Women in Computing, which is committed to making computer science a field that includes people from all backgrounds.

"I have always been, and will continue to be, committed to boosting diversity in the sciences," Varshney said.

As a teacher and mentor, Varshney has advised nearly 100 students, taught UMD's first undergraduate course in virtual and augmented reality, and been co-leading a campuswide effort to launch an immersive media design major. He is also an IEEE fellow and has co-authored more than 80 articles in refereed journals and conference publications.

Photo by John T. Consoli

Quantum Simulators Wield Control Over More Than 50 Qubits, Setting New Record

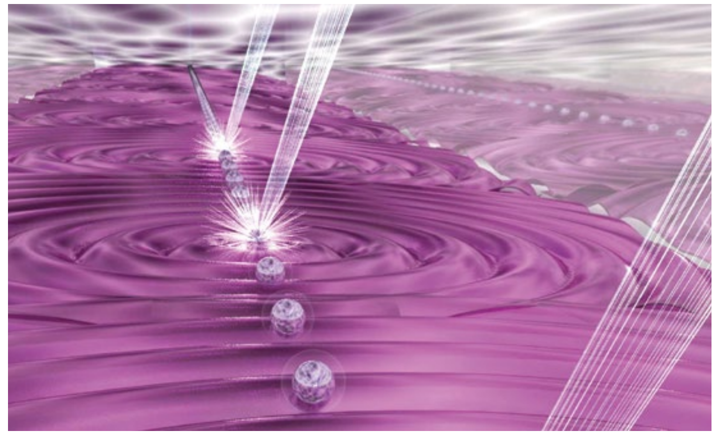
A team of scientists from the University of Maryland and the National Institute of Standards and Technology (NIST) used 53 interacting atomic ion quantum bits, known as qubits, to mimic interacting quantum matter—blowing past the complexity of previous demonstrations. Arranged in a device known as a quantum simulator, these 53 qubits have brought researchers to the cusp of physics explorations that are unreachable by even the fastest modern supercomputers. Adding even more qubits is just a matter of lassoing more atoms.

"Each ion qubit is a stable atomic clock that can be perfectly replicated," said UMD team lead Christopher Monroe, Distinguished University Professor and Bice Sechi-Zorn Professor in the Department of Physics. "They are effectively wired together with external laser beams. This means that the same device can be reprogrammed and reconfigured, from the outside, to adapt to any type of quantum simulation or future quantum computer application."

One of the early quantum computing pioneers, Monroe is also a fellow of the Joint Quantum Institute (JQI) and the Joint Center for Quantum Information and Computer Science (QuICS), as well as the co-founder and chief scientist at the quantum computing startup IonQ Inc. His UMD research group's quantum simulator is part of a blueprint for a general-purpose quantum computer.

While modern, transistor-driven computers are great for crunching their way through many problems, they can screech to a halt when simulating the behavior of interacting quantum matter made from about 20 qubits. Scientists need quantum machinery to deal with the added complexity that comes from quantum physics.

Monroe's quantum simulator is a restricted type of quantum computer suitable for probing magnetic matter and related problems that involve controlling dozens of qubits. Other kinds of calculations may need a more general quantum computer with programmable interactions and many more qubits.



ARTIST'S DEPICTION OF A QUANTUM SIMULATION

"Quantum simulations are widely believed to be one of the first useful applications of quantum computers," said collaborator Alexey Gorshkov, a NIST theoretical physicist who is also a JQI and QuICS fellow and an adjunct assistant professor in the UMD Department of Physics. "After perfecting these quantum simulators, we can then implement quantum circuits and eventually quantum-connect many such ion chains together to build a full-scale quantum computer with a much wider domain of applications."

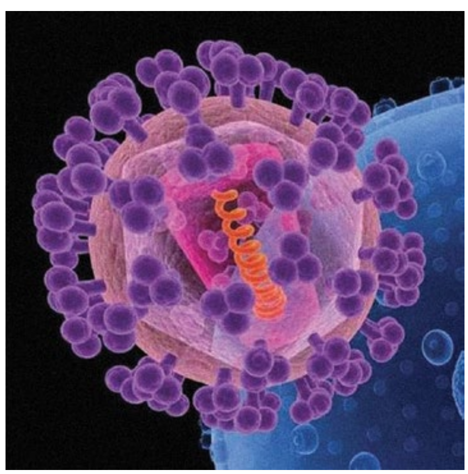
New Molecule Shows Promise in HIV Vaccine Design

Researchers at the University of Maryland and Duke University have designed a novel protein-sugar vaccine candidate that, in an animal model, stimulated an immune response against sugars that form a protective shield around HIV. The molecule could one day become part of a successful HIV vaccine.

"An obstacle to creating an effective HIV vaccine is the difficulty of getting the immune system to generate antibodies against the sugar shield of multiple HIV strains," said Lai-Xi Wang, a professor of chemistry and biochemistry at UMD. "Our method addresses this problem by designing a vaccine component that mimics a protein-sugar part of this shield."

Wang and collaborators designed a vaccine candidate using an HIV protein fragment linked to a sugar group. When injected into rabbits, the vaccine candidate stimulated antibody responses against the sugar shield in four different HIV strains.

The protein fragment of the vaccine candidate comes from gp120, a protein that covers HIV like a protective envelope. A sugar shield covers the gp120 envelope, bolstering HIV's defenses. The rare HIV-infected individuals who can keep the virus at bay without medication typically have antibodies that attack gp120.



ARTIST'S DEPICTION OF HIV. THE KNOBS (PURPLE) COVERING THE VIRUS ARE SUGAR-PROTEIN MOLECULES, INCLUDING GP120, WHICH SHIELD THE REST OF THE VIRUS (PINK)

Researchers have tried to create an HIV vaccine targeting gp120, but had little success for two reasons. First, the sugar shield on HIV resembles sugars found in the human body and therefore does not stimulate a strong immune response. Second, more than 60 strains of HIV exist and the virus mutates frequently. As a result, antibodies against gp120 from one HIV strain will not protect against other strains or a mutant strain.

To overcome these challenges, Wang and his collaborators focused on a small fragment of gp120 protein that is common among HIV strains. The researchers used a synthetic chemistry method they previously developed to combine the gp120 fragment with a sugar molecule, also shared among HIV strains, to mimic the sugar shield on the HIV envelope.

Next, the researchers injected the protein-sugar vaccine candidate into rabbits and found that the rabbits' immune systems produced antibodies that physically bound to gp120 found in four dominant strains of HIV in circulation today.

"This result was significant because producing antibodies that directly target the defensive sugar shield is an important step in developing immunity against the target and therefore the first step in developing a truly effective vaccine," Wang said.

Quantum simulation illustration by E. Edwards/JQI
HIV illustration by National Cancer Institute

Wilkinson Named Associate Dean for Faculty Affairs

Biology Professor Gerald "Jerry" Wilkinson was named associate dean for faculty affairs in the College of Computer, Mathematical, and Natural Sciences (CMNS) in April 2018.

In his new role, Wilkinson oversees the college's appointment, promotion and tenure (APT) process and the mentoring of tenured/tenure-track faculty members; the promotion process for professional-track faculty members; and the interview process for periodic faculty members.

Wilkinson joined the faculty at UMD in 1987 as an assistant professor of zoology and was promoted to professor of biology in 1998. He has served the department, college and campus in many capacities, including as interim dean of CMNS; director of the multidisciplinary graduate program in Behavior, Ecology, Evolution and Systematics; and chair of the Department of Biology. Wilkinson also sat on the Graduate Council and the campus APT Review Committee.

"Jerry's wealth of knowledge about our college and the university will be extremely valuable in his new position," said CMNS Dean Amitabh Varshney. "His vast experience will be a tremendous asset in enhancing faculty affairs and helping our entire college reach the next levels of growth and accomplishment."

Wilkinson has also served the larger scientific community in roles such as program director in the Division of Environmental Biology at the National Science Foundation, president of the Animal Behavior Society and a fellow at the Institute for Advanced Study in Berlin.

An award-winning scholar and teacher, Wilkinson has been recognized with the Searle Scholar Award from the Chicago Community Trust and the UMD Distinguished Scholar-Teacher Award. He has also received the College of Chemical and Life Sciences' Faculty Research Award and Faculty Service Award.


GERALD WILKINSON

"After learning a great deal about the exceptional and diverse faculty and programs in the college while interim dean, I believe I can provide useful guidance to help every CMNS unit become even stronger than it is today," Wilkinson said.

North American Waterways are Becoming Saltier & More Alkaline

Across North America, streams and rivers are becoming saltier, thanks to road de-icers, fertilizers and other salty compounds that humans indirectly release into waterways. At the same time, freshwater supplies are becoming more alkaline.

Salty, alkaline freshwater can create big problems for drinking water supplies, urban infrastructure and natural ecosystems. For example, when Flint, Michigan, switched its primary water source to the Flint River in 2014, the river's high salt load combined with chemical treatments to make the water more corrosive, causing lead to leach from water pipes and creating the city's well-documented water crisis.

A study led by University of Maryland researchers is the first to assess long-term changes in freshwater salinity and pH at the continental scale. Drawn from data recorded at 232 U.S. Geological Survey monitoring sites across the country over the past 50 years, the analysis shows significant increases in both salinization and alkalinization. The study results also suggest a close link between the two properties, with different salt compounds combining to do more damage than any one salt on its own.

"We created the name 'Freshwater Salinization Syndrome' because we realized it's a suite of effects on water quality, with many different salt ions linked together," said Sujay Kaushal, a professor of geology at UMD and lead author of the study. "Many people assume that when you apply salt to the landscape it just gets washed away and disappears. But salt accumulates in soils and groundwater and takes decades to get flushed out."

The researchers documented sharp chemical changes in many of the country's major rivers, including the Mississippi, Hudson, Potomac, Neuse, Canadian and Chattahoochee Rivers. Many of these rivers supply drinking water for nearby cities and towns, including some of the most densely populated urban centers along the Eastern Seaboard.

According to Kaushal, most freshwater salinization research has focused on sodium chloride, better known as table salt, which is also the dominant chemical in road de-icers. But in terms of chemistry, salt has a much broader definition, encompassing any combination of positively and negatively charged ions that dissociate in water. Some of the most common

Gerald Wilkinson photo by John T. Consoli
Snow plow photo by tamaw/iStock

FERNANDO MIRALLES-WILHELM

positive ions found in salts—including sodium, calcium, magnesium and potassium—can have damaging effects on freshwater at higher concentrations.

"These 'cocktails' of salts can be more toxic than just one salt, as some ions can displace and release other ions from soils and rocks, compounding the problem," said Kaushal, who also has an appointment in UMD's Earth System Science Interdisciplinary Center. "Ecotoxicologists are just now beginning to understand this."

The recent study is the first to simultaneously account for multiple salt ions in freshwater across the U.S. and southern Canada. The results suggest that salt ions are driving up the pH of freshwater as well, making it more alkaline. Over the period covered by the study, the researchers concluded that 37 percent of the drainage area of the contiguous U.S. experienced a significant increase in salinity. Alkalinization, which is influenced by a number of different factors in addition to salinity, increased by 90 percent.

New Atmospheric & Oceanic Science Chair: Fernando Miralles-Wilhelm

Fernando Miralles-Wilhelm became chair of the Department of Atmospheric and Oceanic Science (AOSC) on July 1, 2018. He is a professor in the department, as well as interim director of the Earth System Science Interdisciplinary Center (ESSIC) and executive director of the Cooperative Institute for Climate and Satellites (CICS).

"Fernando is the ideal person to lead AOSC at this important time," said Amitabh Varshney, dean of the UMD College of Computer, Mathematical, and Natural Sciences. "His strong leadership of CICS since 2013 and ESSIC since 2016, as well as his exemplary academic accomplishments, gives me great confidence that he will be a transformative, dynamic and visionary leader for the department."

Since arriving at UMD in 2013, Miralles-Wilhelm led efforts to secure a five-year, $64.8 million cooperative agreement with NASA's Goddard Space Flight Center for ESSIC in 2017 and a five-year, $93 million cooperative agreement with the National Oceanic and Atmospheric Administration for CICS in 2014. He currently serves as principal investigator for both programs.

"AOSC is at the intellectual forefront of many problems that affect human beings, ecosystems, the environment and society at large," Miralles-Wilhelm said. "I am excited about building on the remarkable accomplishments of the world-class group of scholars at AOSC and leading the department to new achievements and increased involvement in research and teaching across such important problems."

A hydrologist and water resources engineer, Miralles-Wilhelm conducts research on water, sustainability and climate. He has worked on problems related to surface water and groundwater; physical, chemical and biological processes in aquatic ecosystems; climate-hydrology-vegetation interactions in ecosystems; water resources management in urban and agricultural watersheds; stormwater management; and water quality control.

During his career, Miralles-Wilhelm has consulted on topics related to the environment, urbanization and adaptation to climate change for several international organizations, including the U.S. Agency for International Development, the World Bank and the Inter-American Development Bank.

He also served on the National Academy of Sciences' Committee on Independent Scientific Review of Everglades Restoration Progress, on the Consortium of Universities for the Advancement of Hydrologic Science, on several science diplomacy missions for the U.S. Department of State and as an advisor on climate change to the Organization of American States. Miralles-Wilhelm is also a contributing author to the Intergovernmental Panel on Climate Change.

He is a fellow of the American Society of Civil Engineers, board certified by the American Academy of Environmental Engineering and a diplomate of the American Academy of Water Resources Engineers.

Fernando Miralles-Wilhelm photo by John T. Consoli

Falling into Entrepreneurship

Senior biological sciences major Maria Chen admits she chose to attend the University of Maryland for its sports teams.

"I couldn't even bring myself to apply to any colleges that were Maryland's rivals in sports," said Chen, who grew up in nearby Germantown and followed UMD athletics during high school.

To her joy, Chen not only gained acceptance into UMD's Integrated Life Sciences program in the Honors College, but also received the Clay Siegall Scholarship. The four-year full scholarship for a life science major was created by Siegall, B.S. '82, zoology, the founder and CEO of Seattle Genetics.

After she graduates from UMD in May, Chen plans to attend medical school. Although she was afraid of blood as a child, volunteering at hospitals during high school changed Chen's mind about pursuing a career in medicine.

"I saw that even though the doctors had completed their medical training, they were still working hard to learn every day," Chen said. "I thought, this is the kind of thing I want to do."

This decision thrilled Chen's grandmother, who was one of the only women in her medical school class in China.

"My grandma never pushed me toward becoming a doctor, and she made it clear how difficult that path would be," Chen said. "But she was the first person I told when I decided to study medicine."

To gain clinical experience, Chen began working at Washington Adventist Hospital in Takoma Park, Maryland, in 2016. As a scribe in the emergency room, Chen created charts for doctors while they treated patients.

"What I loved about working in the ER is that you get to help everyone in need, not just those who choose to come to you," Chen explained. "I felt that we helped people of all demographics, increasing our impact on the community."

In 2017, Chen's interest in medicine led her to join electrical and computer engineering major Erich Meissner and computer science major Kyle Liu in the Do Good Challenge, a campus initiative that encourages students to develop solutions for social problems.

Meissner's grandmother had recently suffered a fall and lost consciousness. This motivated Meissner, Chen and Liu to start a company, Symbiont Health, to develop a device that automatically detects when a person falls down. Symbiont won both the 2018 Pitch Dingman Competition—UMD's annual student-only business competition—and the 2018 Do Good Challenge. Chen and her teammates also received the Social Entrepreneur of the Year award at the Robert H. Smith School of Business' 2018 Rudy Awards.

"I had no business experience and felt intimidated at first," Chen said. "But I was passionate about Symbiont because our device sends alerts even if the person who fell is unconscious. I love that we can reach patients who don't realize that they need help."

As Symbiont's chief medical officer, Chen surveyed medical communities and used their feedback to improve patient satisfaction, such as pivoting from a wearable device to a home-based system. Chen now works with caregivers to learn how Symbiont can help reduce their stress and provide better care to patients.

Last summer, Chen learned from another successful entrepreneur when she interned with Siegall at his company, Seattle Genetics, which develops antibody-based treatments for cancer.

"In the ER, I often saw people dying of cancer and suffering from the side effects of their treatments," said Chen, whose aunt was diagnosed with ovarian cancer a few years ago. "Seattle Genetics is interesting to me because the company is creating therapies that will fight cancer cells and leave healthy cells alone, reducing side effects and providing patients with a better quality of life during a very scary moment in their lives."

Back on campus last fall, Chen continued to work at Symbiont. She also returned to Washington Adventist Hospital, this time as chief scribe in the emergency room. And she still makes time for her first love: Maryland athletics.

"If we win, I'm in a great mood, but I get really down if we lose," Chen said. "My roommates are not into sports, but they still check the scores—to see if they have to avoid me!" ■ *–Z. IRENE YING*

Photo by Faye Levine

IN MEMORIAM

EDWARD ABENDROTH, B.S. '11, finance; B.S. '16, computer science, died Aug. 10, 2017. He was a computer scientist at the Naval Surface Warfare Center Dahlgren Division.

GEORGE ANASTOS, zoology, died Dec. 11, 2017. He taught at UMD from 1951 to 1981, retiring as professor emeritus.

JAMES ROBERT "BOB" ANDERSON, physics, died March 25, 2018. He joined UMD in 1964 and retired in 2014.

BRENDA BLOOMGARDEN, B.S. '65, physical sciences; M.Ed. '86, curriculum and instruction, died Sept. 8, 2017. She was professor emeritus of mathematics at Chesapeake College, where she taught for 30 years.

ROBERT DE ZAFRA, Ph.D. '58, physics, died Oct. 10, 2017. He helped confirm that the chemicals in some aerosols and refrigerants were responsible for the expanding ozone hole over Antarctica. He taught at Stony Brook University for 38 years.

RAYMOND DOETSCH, Ph.D '48, bacteriology, died Dec. 29, 2017. He joined UMD in 1948 and retired in 1985 as a professor emeritus of cell biology and molecular genetics.

RICHARD ELLIS, physics, died May 6, 2018. He served as assistant and associate dean of the College of Computer, Mathematical, and Physical Sciences and as associate chair for graduate education in physics.

CHARLES "CHUCK" GOODRICH, astronomy, died March 22, 2018. He joined UMD in 1980 and retired in 2013.

ADAM KLEPPNER, mathematics, died Jan. 25, 2018. He joined UMD in 1961 and retired in 1998.

JOHN LAYMAN, physics, died Dec. 30, 2017. He joined UMD in 1970 and retired in 1998.

JIM OWINGS, mathematics, died Jan. 12, 2018. He joined UMD in 1966 and retired in 1997.

PHILIP PROVOST, M.S. '59, Ph.D. '61, microbiology, died April 17, 2018. His research at Merck & Co. helped lead to the development of the hepatitis A vaccine.

FRANK VASINGTON, Ph.D. '55, biochemistry, died June 26, 2018. He taught at the University of Connecticut, where he was also associate vice president for academic affairs and dean of the College of Liberal Arts and Sciences.

C. ROBERT WARNER, mathematics, died Aug. 7, 2017. He was at UMD from 1965 until 2012.

SUSAN WILLIAMS, Ph.D. '81, botany, died April 24, 2018. She was a distinguished professor of evolution and ecology at the University of California, Davis.

ALUMNI HIGHLIGHTS

Five alumni received 2018 National Science Foundation Graduate Research Fellowships.

- **TOMAS BREACH**, B.S. '15, mathematics; B.A. '15, economics
- **JUSTUS JOBE**, B.S. '17, biological sciences
- **ORION MCCARTHY**, B.S. '15, biological sciences
- **LUKE SKALA**, B.S. '15, chemistry
- **PRAYAAG VENKAT**, B.S. '17, computer science; B.S. '17, mathematics

RICARDO AREVALO, Ph.D '10, geology, joined UMD as an associate professor of geology.

BRIAN ARKELL, B.S. '78, geology, joined Argonaut Gold as vice president of exploration.

CHARLES BENNETT, B.S '78, physics and astronomy, received the 2018 Breakthrough Prize in Fundamental Physics. He is the Bloomberg Distinguished Professor in Physics and Astronomy at Johns Hopkins University.

RYAN BLAUSTEIN, B.S. '11, biological sciences, M.S. '14, environmental science and technology, received a TL1 fellowship from the National Institutes of Health. He is a postdoctoral research fellow at Northwestern University.

JENNIFER BUSS, Ph.D. '12, biochemistry, became president of the Potomac Institute for Policy Studies.

CHRISTOPHER DANFORTH, M.S. '04, Ph.D. '06, applied mathematics & statistics, and scientific computation, published the 17th most discussed scientific study of 2017 as ranked by Altmetric. He is the Flint Professor of Mathematical, Natural, and Technical Sciences at the University of Vermont.

BRYAN DICKINSON, B.S. '05, biochemistry, received a Faculty Early Career Development (CAREER) award from the National Science Foundation. He is an assistant professor of chemistry at the University of Chicago.

BERNARD DILLARD, M.S. '04, applied mathematics & statistics, and scientific computation, authored a new textbook, Moneymatics: Where Money and Mathematics Meet. He is a professor of science and math at the Fashion Institute of Technology.

CAROLINE FORTUNATO, Ph.D. '12, marine-estuarine environmental sciences, joined Wilkes University as an assistant professor of biology.

CHESTER GOOD, B.S. '79, biochemistry, was named senior medical director for the Center for Value-Based Pharmacy Initiatives at the University of Pittsburgh Medical Center.

MATTHEW HOUSE, B.S. '00, computer science; B.S. '00, physics, was appointed vice president of homeland security and national security at eGlobalTech.

RICHARD ISAACSON, Ph.D. '67, physics, was honored by the American Physical Society, which named a new award for him. Before retiring, Isaacson was program director of gravitational physics at the National Science Foundation.

MARK JOHNSTON, B.S. '91, physical sciences, became chief commercial officer of Promethera Biosciences group in Belgium and managing director of Promethera Biosciences LLC in the U.S.

GARRETT KATZ, Ph.D. '17, computer science, assumed the role of an assistant professor of computer science at Syracuse University.

SAMIR KAUL, M.S. '97, biochemistry, was named as a 2018 Rock Venture Capital Partner by Harvard Business School's Arthur Rock Center for Entrepreneurship.

GEORGETTE KISER, B.S. '89, mathematics, joined the board of directors at Adtalem Global Education. She is managing director and chief information officer at the Carlyle Group, an investment firm.

RAVI KUCHIMANCHI, M.S. '91, Ph.D. '95, physics, received the 2018 Andrei Sakharov Prize from the American Physical Society. He founded the Association for India's Development.

ROBERT LAURINE JR., B.S. '80, geology, joined the federal advisory board at QTS Realty Trust. He is vice chancellor and chief information officer at the University System of Georgia.

FRANK LEVIN, Ph.D. '61, physics, authored a new textbook, "Surfing the Quantum World." He is a professor emeritus of physics at Brown University.

HARRISON LISABETH, Ph.D. '16, geology, received the American Geophysical Union's 2017 Mineral and Rock Physics Graduate Research Award. He is a postdoctoral research fellow at Lawrence Berkeley National Laboratory.

TOBIN MARKS, B.S. '66, chemistry, received the 2017 Harvey Prize from Technion in Israel and was elected to the Italian Academy of Sciences. He is a professor of chemistry, materials science and engineering, and catalytic chemistry at Northwestern University.

WILLIE MAY, Ph.D. '77, chemistry, was appointed vice president of research and economic development at Morgan State University.

JASON MEYENBURG, B.S. '04, biochemistry, was appointed chief commercial officer of Orchard Therapeutics.

PARTHO MISHRA, M.S. '91, Ph.D. '93, computer science, joined Cumulus Networks as vice president of engineering.

RUSSELL MOY, B.S. '75, zoology, was appointed as the Harford County, Md. health officer.

NALINI MURDTER, Ph.D. '85, biochemistry, was appointed president and CEO of life science company MBL International.

MARTIN O'NEILL, B.S. '83, computer science, joined ClearEdge IT Solutions as its chief operating officer.

NEIL OTTENSTEIN, M.S. '86, Ph.D. '90, physics, received a 2017 Robert H. Goddard Award from NASA. He is a systems engineer at a.i. solutions.

BARRY RABNER, B.S. '75, zoology, joined Rider University's board of trustees. He is founder and CEO of Penn Medicine Princeton Health.

WILLIAM REGLI III, M.S. '94, Ph.D. '95, computer science, became director of UMD's Institute for Systems Research.

DANIEL ROGERS, Ph.D. '08, chemical physics, received a 2018 Tech 10 award from the *Baltimore Business Journal.* He is co-founder and CEO of information security company Terbium Labs.

PAUL SEKHRI, B.S. '81, zoology, was appointed as a director and chairman of the board of the drug company Compugen.

KIMBERLY SELLERS, B.S. '94, M.A. '98, mathematics, was a 2018 Honoree of the Network of Minorities in Mathematical Sciences. She is an associate professor of mathematics and statistics at Georgetown University.

SOPHIA TONG, M.S. '98, computer science, won the *Washington Business Journal*'s 2018 Minority Business Leader Award. She is founder and CEO of T and T Consulting Services.

DEBORAH TRANOWSKI, B.S. '82, computer science, became vice president of program management and operations at Amphivena Therapeutics Inc.

EMILY WORSHAM, Ph.D. '16, geology, won the 2018 Pellas-Ryder Award from the Meteoritical Society and the Geological Society of America. She is a professor of experimental and analytical planetology at the University of Münster in Germany.

FACULTY & STAFF HIGHLIGHTS

Five received National Science Foundation Faculty Early Career Development (CAREER) awards.

- **MAISSAM BARKESHLI**, physics
- **JORDAN BOYD-GRABER**, computer science
- **MARINE CARPUAT**, computer science
- **OSVALDO GUTIERREZ**, chemistry and biochemistry
- **PETER NEMES**, chemistry and biochemistry

Barkeshli also received a 2018 Sloan Research Fellowship.

Four made Clarivate Analytics' 2017 list of Highly Cited Researchers.

- **SANKAR DAS SARMA**, physics
- **IAN SPIELMAN**, physics
- **JACOB TAYLOR**, physics
- **DENNIS VANENGELSDORP**, entomology

Six were elected fellows of the American Physical Society.

- **ALESSANDRA BUONANNO**, physics
- **MICHELLE GIRVAN**, physics
- **WOLFGANG LOSERT**, physics
- **JOHNPIERRE PAGLIONE**, physics
- **A. SURJALAL SHARMA**, astronomy
- **EDO WAKS**, physics

ALESSANDRA BUONANNO, physics, received the Gottfried Wilhelm Leibniz Prize from the German Research Foundation.

CATHERINE CARR, biology, was elected fellow of the International Society for Neuroethology.

HAIHONG CHE, astronomy, won the inaugural René Pellat Memorial Festival Prize for her work in plasma physics developed during the Festival de Théorie in Aix-en-Provence, France.

WEN-AN CHIOU, Institute for Research in Electronics and Applied Physics, was elected fellow of the Microscopy Society of America.

RANCE CLEAVELAND, computer science, was named director of the National Science Foundation's Division of Computing and Communication Foundations.

RITA COLWELL, University of Maryland Institute for Advanced Computer Studies, received the Lee Kuan Yew Water Prize, the International Prize for Biology and was awarded the rank of Chevalier (Knight) in the French Legion of Honor.

KELLY HAMBY, entomology, received the Early Career Professional Extension Award from the Entomological Society of America.

GEORGE HELZ, geology, was elected fellow of the Geochemical Society.

FACULTY & STAFF HIGHLIGHTS

BENJAMIN KEDEM, mathematics, won the 2018 *Canadian Journal of Statistics* Award from the Statistical Society of Canada.

DAVE LEVIN, computer science, received the IEEE Cybersecurity Award for Innovation. He also won a distinguished paper award at the 2017 USENIX Security Symposium.

VLADIMIR MANUCHARYAN, physics, received a 2017 Young Faculty Award from the Defense Advanced Research Projects Agency.

ATIF MEMON, computer science, was awarded the 2017 Most Influential Paper Award at the 32nd IEEE/Association for Computing Machinery's International Conference on Automated Software Engineering.

LAURENT MONTÉSI, geology, was named an outstanding reviewer by the journal *Geochemistry, Geophysics, Geosystems.*

MARGARET PALMER, entomology, received the Ruth Patrick Award from the Association for the Sciences of Limnology and Oceanography.

SCOTT RUDLOSKY, Earth System Science Interdisciplinary Center, received the National Oceanic and Atmospheric Administration's David Johnson Award from the National Space Club and Foundation.

PAULA SHREWSBURY, entomology, won the 2018 Eastern Branch Distinguished Achievement Award in Extension from the Entomological Society of America.

ELEONORA TROJA, astronomy, received the Italian Bilateral Scientific Cooperation Award.

JENNY ZAMBRANO, biology, was awarded the 2017 John L Harper Early Career Researcher Award by the British Ecological Society.

STUDENT HIGHLIGHTS

Two undergraduates received 2018 Churchill Scholarships and National Science Foundation Graduate Research Fellowships.

- **CHRISTOPHER BAMBIC**, physics and astronomy major
- **YOUSUF KHAN**, biological sciences major

Three undergraduates were named 2018 Goldwater Scholars.

- **PAUL NEVES**, physics major
- **LILLIAN SUN**, biological sciences and economics major
- **TANAY WAKHARE**, mathematics and computer science major

Three graduate students received 2018 National Science Foundation Graduate Research Fellowships.

- **ZACKERY BENSON**, physics
- **JACQUELINE NELLIGAN**, computer science and linguistics
- **PATRICIA RAZAFINDRAMBININA**, chemistry

Three graduate students received 2018 NASA Earth and Space Science Fellowships.

- **CHENG DA**, atmospheric and oceanic science
- **PRADIP GATKINE**, astronomy
- **ANGELA MARUSIAK**, geology

Two graduate students were named 2018 Achievement Rewards for College Scientists scholars.

- **ZACHARY ELDREDGE**, physics
- **MATTHEW THUM**, chemistry

Two undergraduates were named 2018 Kleiner Perkins Caufield and Byers Engineering Fellows.

- **ZACK KHAN**, computer science major
- **SANNA MADAN**, computer science major

MADELINE BEAUDRY, a biological sciences and geographical sciences major, received a 2018 National Oceanic and Atmospheric Administration Hollings Scholarship.

Physics major **JACOB BRINGEWATT** received a Department of Energy Computational Science Fellowship.

KRISTEN CONFROY, a biological sciences major, was awarded a 2018 Big Ten Postgraduate Scholarship and a 2018 Big Ten Medal of Honor.

Geology graduate student **ERIN CUNNINGHAM** received a 2017 Graduate Student Research Grant from the Geological Society of America.

STEPHANIE GNEWUCH, a chemistry graduate student, won the Margaret C. Etter Student Lecture Award in Neutron Scattering at the 2018 American Crystallographic Association annual meeting.

KATHERINE HESS, an environmental science & policy and geographical sciences major, received a NASA internship to study ecological forecasting.

Computer science graduate student **DOOWON KIM** won the National Security Agency's Fifth Annual Best Scientific Cybersecurity Paper Competition.

TONGYANG LI, a computer science graduate student, received a 2018 IBM Ph.D. Fellowship Award.

Entomology graduate student **BRIAN LOVETT** won a student presentation award at the European Congress of Entomology and the Society for Invertebrate Pathology meeting.

GUSSIE MACCRACKEN, an entomology graduate student, received a 2018 Big Ten Academic Alliance Smithsonian Institution Fellowship.

Entomology graduate student **SAMUEL RAMSEY** won both the Judge's First Place and People's Choice awards at the 2017 International Three Minute Thesis competition.

YOGARSHI VYAS, a computer science graduate student, received the Adam Kilgarriff Best Paper Award at *SEM 2017: The Sixth Joint Conference on Lexical and Computational Semantics.

Computer science graduate student **XIAO WANG** received an appointment as assistant professor of computer science at Northwestern University.

Computer science graduate student **ZUXUAN WU** was named a member of Snap Inc.'s first class of research fellows.

ALUMNI NOTES ARE WELCOME.

Please send them to Odyssey, CMNS Dean's Office, University of Maryland, 2300 Symons Hall, College Park, MD 20742. Email information to abbyr@umd.edu.

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OPENING SPRING 2019

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