flux

a publication of the
national high magnetic field laboratory

Table of Contents

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Mag Lab Director
Greg Boebinger

Associate Director for Management and Administration
Brian Fairhurst

Director of Public Affairs
Susan Ray

***Flux* Editor**
Amy Mast

Webmaster & Writer
Kristen Coyne

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Savoy Brown

The National High Magnetic Field Laboratory, or Magnet Lab, is a national user laboratory that provides state-of-the-art facilities for magnet-related research in all areas of science and engineering, including biology, medicine, chemistry, geochemistry, bioengineering, materials science, and physics. It is one of the nine laboratories of its kind in the world. The Magnet Lab is supported by the National Science Foundation and the State of Florida. It is operated by Florida State University, the University of Florida, and Los Alamos National Laboratory, with unique facilities at all three campuses. Users come from universities, private industry, and government laboratories worldwide.

This document is available in alternate formats upon request. Contact Amy Mast for assistance. If you would like to be added to our mailing list, please write us at the address shown below, call 850-644-1933, or email winters@magnet.fsu.edu.

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In an unstable time for basic research, a flash of promise

In a weak economy, U.S. research funding tends to become more heavily weighted toward applied rather than basic research. Scientists at the Mag Lab – a basic research facility – refer to basic research as "fundamental" or "curiosity-based" research. Its motivation is knowledge of still unanswered questions – of which there are so many!

Fundamental knowledge lays the foundation for the applied research that often follows. For example, without Michael Faraday's basic research (during the 1820s!) into the relationship between electricity and magnetism, we would have almost none of today's electrical devices – including the generators that create our electrical power. These are all among the applied fruits of Faraday's principle of electromagnetic induction. A more recent example is Magnetic Resonance Imaging (MRI), which originated in basic research that started in the early 1900s.

Virtually all of the high-tech conveniences of everyday life – computers, high-speed Internet, cell phones – are the result of basic research. Remember huge cell phones? Monitors as large as the desk upon which they rested? Dial-up Internet? Without basic materials-science research, we'd still be using rotary phones and carrying around huge boom boxes instead of iPods.

Of course, scientists and researchers are not alone in struggling with tight budgets. Families, small business, students… everyone is feeling the pinch. Scientists who've been around a while have been through a number of the peaks and valleys of research funding. Sometimes, it's tempting to give into the pessimism.

But one day in February reminds those of us who work at the Magnet Lab that enthusiasm for science and curiosity about the unknown is alive and well.

More than 4,600 people of all ages flocked to the Mag Lab's Open House on Feb. 23, shattering the previous attendance record. They came to see flying potatoes, shrinking quarters, levitating tops and lightning in a bucket. They came to ask questions, to see scientists at work, and to be reminded how fascinating – and fun – science can be.

Visitors lined up before the doors opened at 10 a.m., some of them arriving as much as half an hour early to be the first ones in, and they stayed until well after the 3 p.m. closing time. Among the hundred demonstrations at the Magnet Lab, people waited in very long lines in particular to see cryogenics experiments – demonstrations of strange things that happen only at ultra-cold temperatures. When a guide reminded those in line that there were lots of other things to see, they opted to wait – they had heard how cool (literally!) the demonstrations were and wanted to see for themselves.

Kids observe the launching power of the lab's potato cannon.

People waiting in line for science? How great is that?

This year marked the debut of a series of basic talks about the Magnet Lab and the kinds of research conducted here by researchers from all over the country and world. The room was packed, and speakers answered questions until well after the 30 minutes of allotted time had passed. Students who'd just showed up for the extra credit could be found all over the lab after the talks ended, asking scientists questions and getting their hands dirty.

The crowds at our Open House, and the creativity and passion displayed by the scientists interacting with them, both show us that enthusiasm for American science is alive and well. You'll see that enthusiasm reflected in the pages of *Flux*.

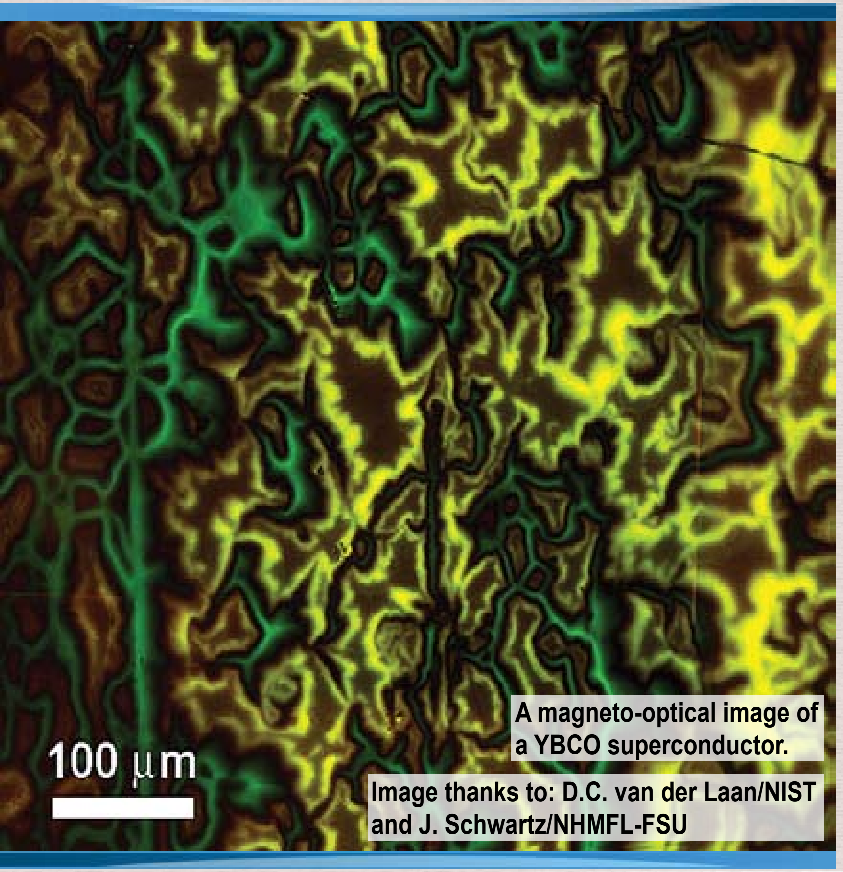
High-temperature superconductivity combines mystery and possibility

By Susan Ray

Although superconductivity was discovered in 1911, in many ways the history of superconductors is only just beginning, and research at the National High Magnetic Field Laboratory is shaping that history.

The man who discovered superconductivity – Dutch physicist Heike Kammerlingh Onnes – showed that certain materials (in his case, mercury) conduct electricity with no resistance when cooled to 4.2 Kelvin. That's about -451.84 degrees Fahrenheit!

Electricity comes from electrons traveling through wire conductors. Those electrons bumping into each other generate friction, which in turn generates an enormous amount of heat. With superconductors, however, there is no friction – that's what "no resistance" means.



A magneto-optical image of a YBCO superconductor.

Image thanks to: D.C. van der Laan/NIST and J. Schwartz/NHMFL-FSU

It wasn't until 1956 – 45 years later – that scientists developed a solid theory of why superconductors behave as they do. That theory, called the BCS Theory after its creators, John Bardeen, Leon Cooper and Robert Schrieffer, as well as Onnes' discovery years earlier, were Nobel-honored landmarks in the world of physics.

Since the earliest days of the discovery of superconductivity, scientists have been working to raise the temperature at which materials become superconducting, recognizing the potential commercial applications of superconductors. The cost of the liquid helium required to cool the materials to extremely low temperatures, as well as difficulty fabricating the superconductors into a usable form, limited the usefulness of superconductors.

By the mid-1980s things were heating up … literally. In 1986, IBM researchers Karl Muller and Johannes Bednorz discovered a material that becomes superconducting at 36 Kelvin, or -394.6 degrees Fahrenheit. That discovery, which also netted a Nobel Prize, kicked off a frenzy of research into similar materials that continues to this day.

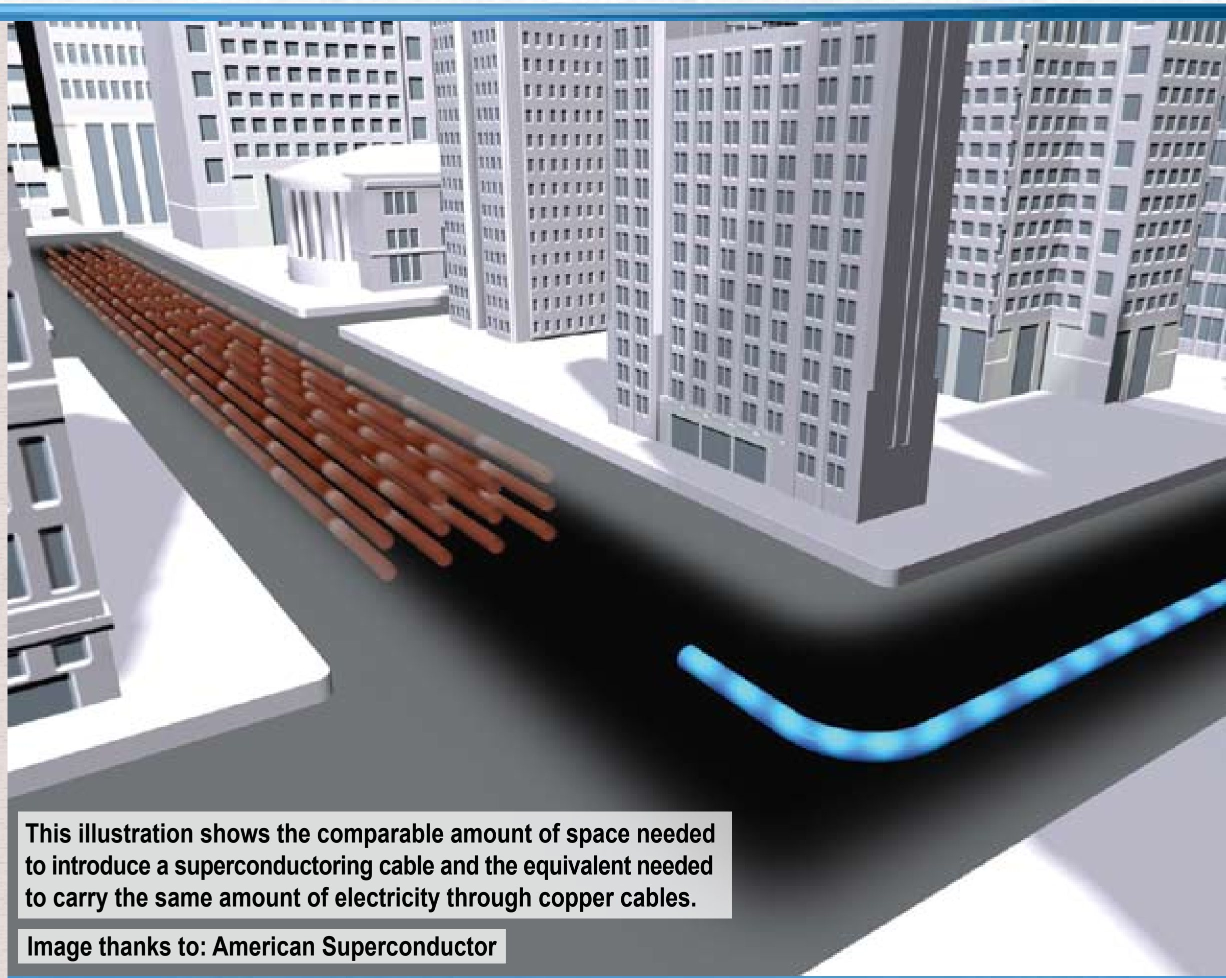
A compound called yttrium barium copper oxide – or YBCO – was found in 1987 to achieve superconductivity above the boiling point of liquid nitrogen – a still frigid -320.5 degrees Fahrenheit. Materials that become superconducting above that point are called high-temperature superconductors (HTS), and they are so significant because they can be cooled with liquid nitrogen, which is relatively inexpensive and easily handled.

"The discovery of high-temperature superconductors made the idea of using superconducting materials for power transmission feasible," said Magnet Lab Director Greg Boebinger, whose research interests include high-temperature superconductors.

Materials research done at the Magnet Lab and its world famous Applied Superconductivity Center promises to lead to new discoveries in this field, and collaborations with industry help pave the way for emerging technologies.

Mag Lab scientists and engineers have worked with companies such as American Superconductor, an energy technologies firm based in Massachusetts that is developing superconducting cables for utility applications.

"Basic research is very important to American Superconductor, particularly in developing our HTS wire processes," said Alexis Malozemoff, Ph.D., the company's executive vice president and chief technical officer. "We have worked closely in this area with U.S. national labs and universities that have made important contributions."



This illustration shows the comparable amount of space needed to introduce a superconductoring cable and the equivalent needed to carry the same amount of electricity through copper cables.

Image thanks to: American Superconductor

Industry is moving ahead with applications of high-temperature superconductors, but scientists still don't have a solid theoretical understanding of high-temperature superconductivity; it remains one of the most important unsolved riddles in physics. And scientists worldwide are still seeking the Holy Grail of physics: room-temperature superconductors, which would eliminate the need for liquid nitrogen, making superconducting materials more inexpensive and practical.

Back at the Mag Lab…

So what do high magnetic fields have to do with the study of superconductors? Plenty. Electricity and magnetism are forever intertwined. Magnetic fields can be used to probe the nature of these materials. At lower fields, superconductors repel magnetic fields (this is called the Meissner effect, a phenomenon often demonstrated at science fairs by a small magnet floating magically above a superconducting material). But in their research, scientists found that higher magnetic fields start to penetrate the superconductor, and it eventually loses its superconductivity. This presents all kinds of interesting scenarios for scientists to study.

"Because scientists know high magnetic fields kill superconductivity, they can study promising materials in high magnetic fields to learn how to make the materials more robust," said Boebinger. "If the materials can resist high magnetic fields, they also can resist destructive high temperatures. The superconductors of the future must be able to operate at high temperatures at high fields while carrying high currents."

According to Boebinger, 56 percent of the energy generated by power plants can't be utilized. About half of that is off limits for fundamental science reasons, he said. The rest can be conserved or used – but only if we have new technologies.

"Superconductors could be the biggest breakthrough in this area," said Boebinger. "Superconductors conduct electricity without friction. That's important because friction on standard conductors is what generates heat, and energy is lost in the process."

The technology is already moving in that direction. Currently, two superconducting power line projects are underway in New York, the Albany High-Temperature Superconducting Cable Project and Project Hydra (see sidebar), and superconductors could have great impact elsewhere.

"We see superconducting cables based on HTS wires having broad impact in addressing capacity constraints in dense urban areas, and longer term, providing a backbone of the electric power grid around the country," said Malozemoff. "HTS wires also underlie many other applications opportunities – motors, generators, transformers, fault current limiters, etc. Other markets closer to the consumer could include coils for Maglev trains and MRI systems."

Outside of consumer applications, high-temperature superconductors can be used to make high-field magnets that are less costly to operate. The Magnet Lab regularly tests HTS materials to for its next-generation magnets.

SEE HOW IT WORKS

Watch animations depicting how secure super grid systems can protect electrical grids at: http://www.amsc.com/products/hydra.cfm

SUPERCONDUCTIVITY IN ACTION

Superconductor technology has attracted great interest from utility companies and the Federal government. According to industry advocates, electric power transmission cables crafted from high-temperature superconductor material can carry between seven and 10 times more current than conventional cables. This reduces power grid congestion as well as installation and operating costs, all with a low environmental impact. Several projects are underway; two are profiled here:

Albany High-Temperature Superconducting Cable Project: On July 20, 2006, the world's first in-grid superconducting power cable, developed by SuperPower Inc., was energized in Albany, N.Y. In the project's second phase, completed in February of this year, a superconducting power cable made of a more cost-efficient and high-performance second-generation wire replaced 30 meters (90 feet) of the cable. The 350-meter (1148-feet) HTS cable runs between the Riverside and Menands substations. The $27 million dollar project is funded by the U.S. Department of Energy and the New York State Energy Research and Development Authority.

Project HYDRA: This project focuses on the development and deployment of superconducting technology developed by American Superconductor in the Con Edison-operated power delivery network in lower Manhattan. The "Secure Super Grids" technology utilizes HTS power cables and ancillary controls to deliver power through the grid while at the same time suppressing power surges – or fault currents – that can disrupt service. A 50-meter (164-feet) prototype cable is expected to be in place by year's end, and the full-scale, 300-meter (984-feet) power cable system is scheduled to be operational in 2010. The Department of Homeland Security is providing $25 million for the $39 million project.

Liquid nitrogen, the coolant required to maintain superconductor cables at their operating temperature, flows through a cable that can transmit many times more power than copper cables of the same diameter.

Image thanks to: American Superconductor

What is this?

The newest of the Magnet Lab's three helium recovery bags. The bags are one step in the process of re-cooling "used" liquid helium from the magnets for later use.

Helium is moved around the building in these giant metal containers, called dewars.

This helium liquefier is one of three used at the Magnet Lab.

We've all held onto a helium balloon and felt helium's differences from the air around us – both its lightness and the speed at which it dissipates, invisible, if a balloon is popped or opened.

Take that same helium and cool it all the way down past 4.2 Kelvin. That's -451.44 degrees Fahrenheit – about twice as cold as spending the night on the moon without a spacesuit, and three and a half times colder than the coldest recorded naturally occurring temperature on Earth.

Eventually the helium is cooled all the way down to around 2 Kelvin, the temperature needed to operate the lab's cold-hungry magnets. At this supercool temperature, helium becomes a liquid with no viscosity – meaning that theoretically, it can flow forever without stopping.

Without liquid helium, the most powerful superconducting magnets here at the lab would work about as well as your body without blood. Helium keeps superconducting and hybrid magnets cool enough to handle high magnetic fields, helping energy to move through the magnet without resistance or outside electricity. Without this simple ingredient, running these powerful research magnets simply wouldn't be possible.

Buying and storing this resource doesn't come cheap; the lab's annual bill for liquid helium alone can reach $1 million. That's why the lab has adapted a system to recycle as much of the helium as possible, a move that's both eco-friendly and cost-effective, and that's where the giant balloon pictured comes in.

That giant balloon is one of the lab's three helium recovery bags (and yes, they're all that big). The bags are basically high-tech recycling bins for helium ready to be re-cooled. Each one of these bags holds about 2,700 cubic feet of helium in gas form. From that huge space, the lab squeezes the gas into about a hundred liters of liquid helium – only enough to fill around 26 one-gallon milk jugs.

DIG DEEPER

Want to know more about liquid helium?
Visit: http://www.magnet.fsu.edu/education/tutorials/magnetacademy/cryogenics/index.html

Clean, keen, machining team

Scientists and craftsmen collaborate to create powerful tools

By Kristen Coyne

"Machine shop."

Let your mind construct a mental image of those words, and within seconds you've probably got a scene involving dirty overalls, metal shavings flying pell-mell through the air, a blaring radio and fingernails encrusted in grease. Throw in a half-eaten box of day-old donuts set atop a lathe somewhere.

Now erase that image. It has little in common with the Magnet Lab's machine shop – except for the classic rock. OK, and the occasional box of Krispy Kremes brought by a happy customer.

This 4,000 square feet of orderly, tidy space is the Ritz of machine shops. In fact, one might almost be tempted to call it a machine *boutique*.

Although the six seasoned machinists who work there would likely blanch at the characterization, it is in some ways fitting: These guys don't manufacture run-of-the-mill auto parts; they do extremely high-end, custom work, often using expensive or exotic materials such as gold or beryllium copper. They collaborate with some of the most accomplished scientists in the world. They use sophisticated design and engineering software, and operate a wide range of machinery from the conventional drill press to the state-of-the-art, computer-controlled lathe. Their craftsmanship requires the exactness of a watchmaker, the patience of a parent, and the depth of experience that only a staff with a combined 170 years in the field can offer.

The staff works on hundreds of projects a year. Many of them are repairs or modifications to existing equipment. Most involve the creation of prototypes – unique parts made for the first time.

Scott Hannahs, chief of User Research Instrumentation with the lab's DC Field Facility, says the lab's unique magnet instruments, capable of measurements done nowhere else in the world, are made possible by the machine shop's tools and talents.

"These are machinists who can design and build the bizarre parts that we imagine," said Hannahs. "They can work with us as collaborators and help us refine our ideas into actual, real, physical instruments to make our measurements."

In the machine shop you'll find a very neat mix of ingenuity and skill, high-end problem solving and good-natured wise-cracking. Put on a pair of safety glasses and come see for yourself.

High-end tools and experienced hands

Scientists and engineers who use our magnets, whether from the in-house staff or visiting from another institution, often need a special piece of equipment for their experiments. It might be a **probe** – a long, tube-like device containing the researcher's sample that is inserted into the bore of a magnet. Or it might be a **pressure cell**; scientists sometimes put their sample in one of these small containers in order to observe how it responds to the combination of high fields *and* high pressure. Or it might be a specialized **rotator**, a small cage affixed to the probe that allows the sample inside it to turn during the experiment.

Just about everything made in the machine shop starts with a concept. Scientists might draw the device or part they need by hand or with a computer, but their design abilities typically end there.

That's where Vaughan Williams, the machine shop's group leader, steps into the picture.

"We understand what it takes to make parts in a prototype setting," he said.

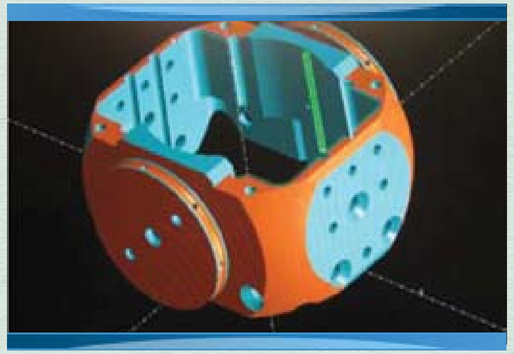
Collaborating closely with the scientists, Williams takes the drawing to the next phase, creating a virtual model of the needed part with special design software. That model is then uploaded into a **computer-aided manufacturing** (CAM) program that spells out which tools are best suited to fashion the part's various features. Thanks to the software, the staff can test out maching operations virtually, catching errors while they're still cheap and easy to fix.

A machinist may then fashion the object manually, using the shop's traditional milling machines, drill presses, lathes and grinders. But for projects requiring multiple copies of the part, or for especially complex designs, machinists will opt for one of several **Computer Numerical Control** (CNC) machines, which will execute orders it receives from computer code generated by the CAM software. For the most complex projects, machinists may have to fashion specialized drills or boring bars before beginning the actual part that those tools will create.

In addition to exercising their craft, the machinists teach it. Everyone benefits when scientists know more about the design and manufacturing process. That's why machinist John Farrell holds several classes a year for students and post-docs at the lab, instructing them on what to keep in mind when dreaming up tools for their research (for example: avoid small, square holes).

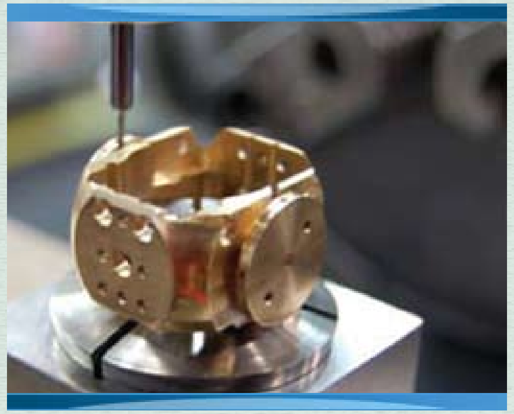
Collaboration is key

To illustrate how scientists and machinists work together at the lab, let's follow the creation of one particular part designed and built in 2008.



1. VIRTUAL MODEL OF A NEEDED ROTATOR.

2. DRAWINGS.



3. NEARLY COMPLETED, ROTATOR SITS ON A MILLING MACHINE.

4. THE FINISHED ROTATOR IS MOUNTED IN THE SAMPLE CHAMBER AT THE END OF A 10-FOOT MAGNET PROBE.

Ju-Hyun Park, a postdoctoral associate who studies how superconductors behave at extremely low temperatures, needed a special rotator for an experiment involving CeCoIn5, a superconducting material made up of cerium, cobalt and indium. Most rotators, as they turn, can sometimes brush up against wires inside the probe – of no consequence for most experiments, but something that could interfere with the results of the experiment Park had designed. Depending on the angle at which his sample was positioned, Park hoped to observe different properties in CeCoIn5 as he examined the superconducting vortex of the material's structure.

"For this particular experiment, I needed something smooth that doesn't hit anything," he said.

Park, who has some design experience, produced his own virtual model of the rotator he envisioned. But his skills could only take him so far. "I draw things unreal sometimes," he said. "In my head, it's OK."

But in actual science, it's not OK, which is why Park relied on the expertise in engineering, materials and design found in the machine shop.

"They know more features than we do," said Park, who has worked on several projects with the machine shop team, including a specialized probe. "They can suggest, 'What if you do this? What if you do that?' I don't really have knowledge of engineering."

The machine shop is just across the hall from the Millikelvin Facility where Park works, so he and the machinists can confer easily and quickly when questions arise. As a result, not only are parts produced much more quickly than if they were ordered outside the lab, they are also of higher quality – just what the scientist ordered. And because good communication means fewer mix-ups, costly misunderstandings are avoided.

"Throughout, interaction is key," Park said. "That's the only way you can get a good part."

Park collaborated closely with machinist Danny McIntosh on the rotator project. Because of its complex design, both CNC and manually operated machines were used to turn and shape blocks of beryllium copper into a unique science tool fit for an art museum. The shop's most high-tech apparatus, a six-axis wire electrical disccharge machine (EDM), was used to nail the tricky geometry of the center of the ¾ inch-wide part. Then McIntosh manned the milling machine to craft the holes and grooves that completed the project. Some 30 hours later, Park had a one-of-a-kind rotator for his experiment.

"It's the first time we ever made a rotator like that," said McIntosh, who, like his shop mates, will relent with a serious answer only after two or three jocular ones. Continuing in a serious tone, the 33-year machining veteran added that the challenge of creating something for the first time, combined with the chance to work with some of the best tools and scientists around, make his a pretty awesome job.

That, he quipped, plus the donuts.

"Throughout, interaction is key," Park said. "That's the only way you can get a good part."


Machinist Danny McIntosh at work.

Francis Bitter and the invention of the Bitter plate

"There appears to be more and more to see, the deeper we look."

-Francis Bitter
1902-1967

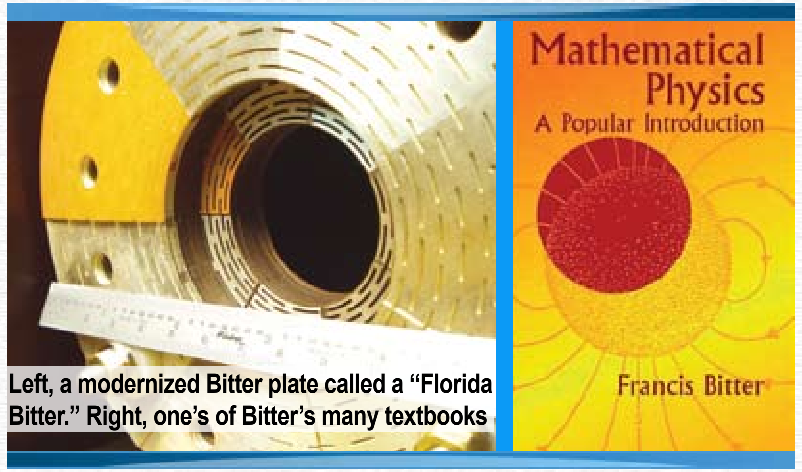
Would the Magnet Lab exist without the work of Francis Bitter? Maybe, but certainly not in the same way. The academic and inventor pioneered some of the most important magnet technology used at the lab, and his influence still resonates as technology catches up with his ideas.

Bitter, who grew up in Weehawken Township, New Jersey, was already a scientific standout when he became interested in magnetism as a Ph.D. student. That spark of interest would come to revolutionize the construction of experimental magnets.

After getting his undergraduate degree at Columbia University, Bitter elected to stay and continue graduate studies there. In 1930, his doctorate complete, he worked for Westinghouse, and remained a consultant there after the pull of research drew him to the Massachusetts Institute of Technology in 1934.

Bitter invented a technology during his early years at MIT that solved a long-standing problem: the energy needed to make a high magnetic field gives off heat, and high temperatures can ruin both the magnetic field and the magnet itself. To solve the problem, he created an electromagnet using stacked copper plates with strategically placed holes through which cooled water could flow. This allowed for the creation of higher fields than ever before.

More sophisticated versions of the same technology are still used today, at magnetic field strengths Bitter could have only dreamed of in the 1930s. In fact, Magnet Lab engineers took the "Bitter" plate design and re-engineered the shape of the holes (creating the "Florida Bitter" plate), leading to a series of world records for strength of magnetic field.



Left, a modernized Bitter plate called a "Florida Bitter." Right, one's of Bitter's many textbooks

With the advent of World War II, Bitter halted his experiments to work with the Naval Bureau of Ordnance to find ways to demagnetize German-built mines placed in the English Channel. He also pioneered some the Allied force's surveillance equipment, and after the war, he remained a reserve officer for many years.

Bitter finished out his career at MIT, eventually becoming the associate dean of the school of science and a founding member of the group that designed and acquired funding for the original National Magnet Laboratory in Cambridge, Mass., renamed the Francis Bitter National Magnet Laboratory in 1967 upon his death.

DID YOU KNOW?

- It took Bitter six years to finish his undergraduate degree. During college, he got a job on a cattle boat and sailed to Europe.
- Bitter's father, Karl Bitter, was an accomplished New York City sculptor who was hit by a car and killed at the height of his career.
- The many complex patterns found in the study of basic research reinforced Bitter's belief in a higher power, and he wrote on the subject several times.
- Bitter's first wife was then a well-known singer, Alice Coomara, who went by the stage name of Ratan Devi.
- While at MIT, Bitter authored several often-used physics textbooks.
- While consulting for Westinghouse, Bitter helped to improve the design of the fluorescent light.

Beyond X-ray vision

Seeing without seeing: An MRI for an unborn penguin

By Amy Mast

A Sea World, king penguin eggs are marked and tracked.

The Phillips Three-Tesla Whole Body System at the University of Florida's Advanced Magnetic Resonance Imaging and Spectroscopy (AMRIS) facility is just the right shape to slide a person through. This time, however, the MRI patient in question is small enough to hold in your hand, temperature-controlled, and as well-guarded as a bar of gold.

"This is exploratory I guess, but I hope we see something beautiful," said UF Biochemistry and Molecular Biology Professor Art Edison as the patient was readied for imaging.

An MRI works by using a magnetic field to discern soft tissues of different densities, creating a picture with that information. Without harming the person or animal, the magnetic field, along with radio waves, interacts with hydrogen atoms inside the body, and the way those atoms react informs the image's content. MRI gives scientists and medical personnel information that can help them to more intimately learn the structure and function of something as small as a mouse brain or as everyday as an athlete's injured ligament.


The egg was placed inside an MRI machine and imaged.

Today's patient is a perhaps fertilized king penguin egg, carefully removed from a temperature-controlled cooler called a "Brooder." King penguins, the second-largest of all penguin species and a 250-strong fixture colony at Sea World's Orlando location, don't give up their secrets easily. Their eggs are far thicker than the chicken egg you're used to buying at the grocery, both to insulate them from cold and to help them endure the rough-and-tumble life of being sat on by two 30-pound parents. A single king penguin egg typically weighs up to two-thirds of a pound.

This sturdiness serves king penguins well in their sub-Antarctic natural habitat, but it's a frustrating roadblock to caretakers who want to learn more about the animals' development. Typically, to gauge whether a chicken egg is fertilized, you "candle" the egg, or hold a light behind it. Because the shells are translucent, people who raise chickens and other fowl have developed visual clues to identify each stage of development.

For Sea World staff, the same process that's so clearly revealed in a chicken and even in some other penguin species is shrouded in mystery. Caretakers can see only the faintest shadows inside such thick eggs, and must treat many infertile eggs with the same time, care and attention as those 10 or 20 each year that turn into penguins.

"When we candle other eggs, we can see the whole process–the veins starting to develop, the chick movement," explained Sea World staff member and penguin specialist Jill Lewis. "If this imaging process ends up working out, it would be a nice to learn a little bit more about the stages of development, especially with the king penguin's eggs."

Lewis and others number and date each egg so that the gestation period can be tracked. It typically takes a little under two months from the day the egg is laid until the brown, downy chick hatches.

After the egg is secured in the MRI, the imaging process begins and a ghostly image of the egg appears. Inside, it's shadowy, mostly black. A lone, clearly delineated white curve appears, and the technicians and staff assembled in the room begin to whisper to each other. Is it a spinal column? It's probably not, but that single, knobby curved line is the only sign of life – of structure – to look at.

The penguin egg was also imaged in UF's 4.7 Tesla magnet, which is more powerful than an MRI found in any hospital and can produce a more detailed image than the first machine. The more powerful field requires a smaller space for specimens, so it's is used for animal-only imaging. But even with more power, the results are the same – an egg with nothing but shadows inside.

As it happens, penguins don't care about the scientists as much as the scientists care about the penguins. This time around, each of the eggs imaged was infertile or not viable.

With the kings' secrets preserved, staff at Sea World will for now do as they've always done - treat each egg in the temperature-controlled colony as precious and as fertilized, incubating the ones the birds abandon in the hopes of producing a chick until the regular gestation period has passed.

Next time, the team may, through educated guess and luck of the draw, produce a fertilized egg for imaging. When this happens, they'll use the same MRI machine again. This sophisticated piece of equipment has been used to image everything from human beings to, well, just about everything else.

"We've done a lot of strange imaging before," Edison explained. "We've looked at termite mound formation, large boa constrictors, golden eagles with broken wings. We've looked at manatee parts. We image mostly mice and rats for medical research, but it's nice to get some variety. Actually, we've done a Florida panther in there. I got to touch its paw."


The 4.7 Tesla magnet.

Though the team didn't get the result they were after, both the scientists and the Sea World staff got a reminder that sometimes nature's fickleness can outwit trained experts and the technology they employ. Maybe next time more than that thin white line, curved like the tiniest moon, will be waiting to meet all the curious people eager to see something no eye has ever seen before.


UF Magnet Lab and Sea World staff await imaging results.

THREE LOCATIONS, ONE LAB

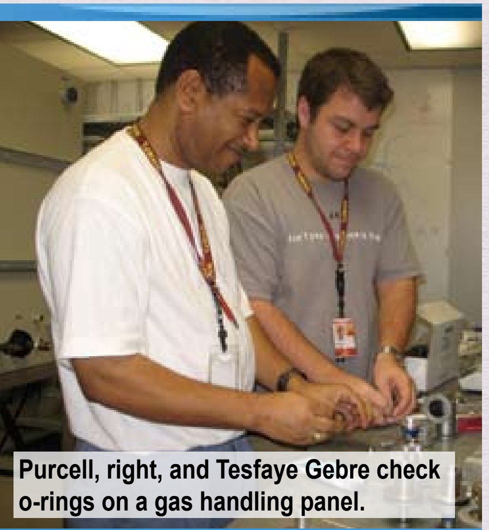
The University of Florida's Magnet Lab facility, located in Gainesville, FL, is one of three facilities bearing the Magnet Lab name (the other two are the main location in Tallahassee and the pulsed-field facility in Los Alamos, New Mexico). The **AMRIS Facility** described in this article focuses on ultra-sophisticated imaging, from whole animals all the way down to individual cells, and nuclear magnetic resonance.

The University of Florida's Magnet Lab group also includes the **High B/T Facility**- a research group studying the behavior of matter in high magnetic fields with super-low temperatures. This group works with three interconnected, superconducting magnets and experimental temperatures are so low that even noise is controlled to minimize interference that could raise temperature.

The University of Florida and Florida State are traditionally rivals, but the Magnet Lab partnership has been fruitful for researchers on both sides. "It really is one thing that UF and FSU really work together closely on," said Edison. "We are lucky to have a great relationship, although football season is always exciting."

Ken Purcell turns a summer into a degree

By Amy Mast



Purcell, right, and Tesfaye Gebre check o-rings on a gas handling panel.

Ken Purcell always knew he liked science. He'd been playing "school" with his sister since he was too young to go himself, and after a high-school experience with an inspired teacher, he decided that he wanted to inspire others as well.

During his sophomore year at Western Kentucky University, two of his professors encouraged him to enroll in the Magnet Lab's Research Experiences for Undergraduates (REU) program at the place they called "the greatest school in the world"—Florida State University. Though it wasn't lost on Purcell that both of these suggestions came from FSU alumni, he applied and was accepted.

"I really learned a lot that summer about condensed matter physics," said Purcell.

Purcell expected to learn a bit more about physics, meet some established scientists, and narrow the focus of his work. Having been assigned to work with a team under then Magnet Lab Director Jack Crow, he got a little more than he bargained for.

"I really learned a lot that summer about condensed matter physics," said Purcell, now 28.

Purcell came back again the following year and with the second experience under his belt, he added FSU to his list of prospective graduate schools.

"I was on the fence about that I wanted to do," he said. "I started undergrad with the intention of becoming a high school physics teacher. But once I came down here, it was like, no, I've got to do research, and I'll be able to teach, too."

With a 2004 master's degree under his belt and his Ph.D. to be completed this year, he's convinced he made the right choice.

"I truly can't think of a better place to be a graduate student," said Purcell. "Out of all my friends I've talked to at other schools, all the visiting scientists I've met – there is no other place I would have rather done it.

"You can walk a matter of minutes in this place and talk to some of the world's greatest theorists in several topics," he continued. "You can talk to people who do the thing you're trying to learn on an everyday basis.

An important goal of Purcell's mentor Crow was combining great research with community and educational outreach.

"Outreach is an integral part of the mission of the lab. As an undergrad, it was amazing to be that age and have access to these kinds of people willing to help you – it's neat to be this age even and have it," said Purcell. "There's not any other lab of this caliber where you can bring a grade-school class and walk them around during the middle of the day. That's who we are."

Purcell said the most important lessons he'll take from his time here are the importance of being able to discuss his work in layman's terms; and the necessity of working across cultures and research interests to find the most exciting work possible with your research team. Wherever his career takes him next, he thinks he chose a great time to study at the Mag Lab.

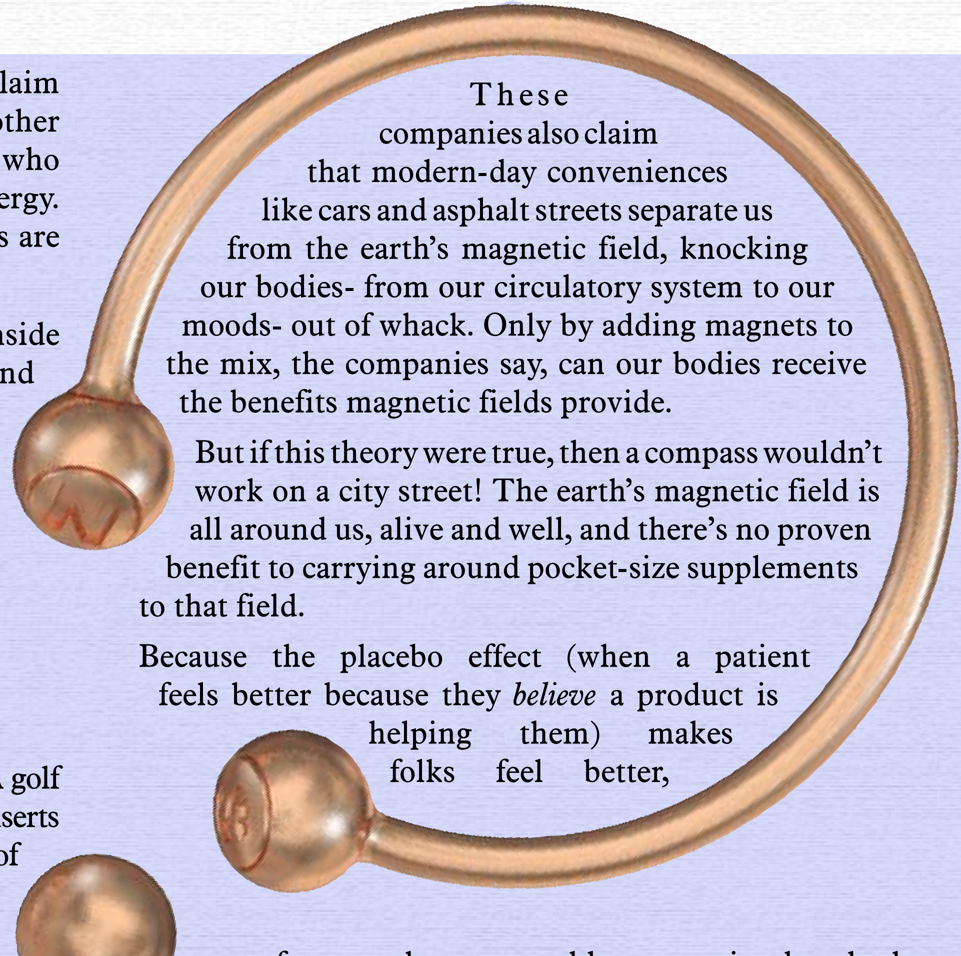
"We had a new REU recently whose adviser had told him: 'Florida State. You need to go to Florida State. They're the diamond in the rough right now, and you can still get into school there. You can get in, and then do better work than at Berkeley.' It's difficult to get into a lot of the traditionally difficult high-end research schools. We've already got the muscle and the brand is still building. It's a great time to be here."

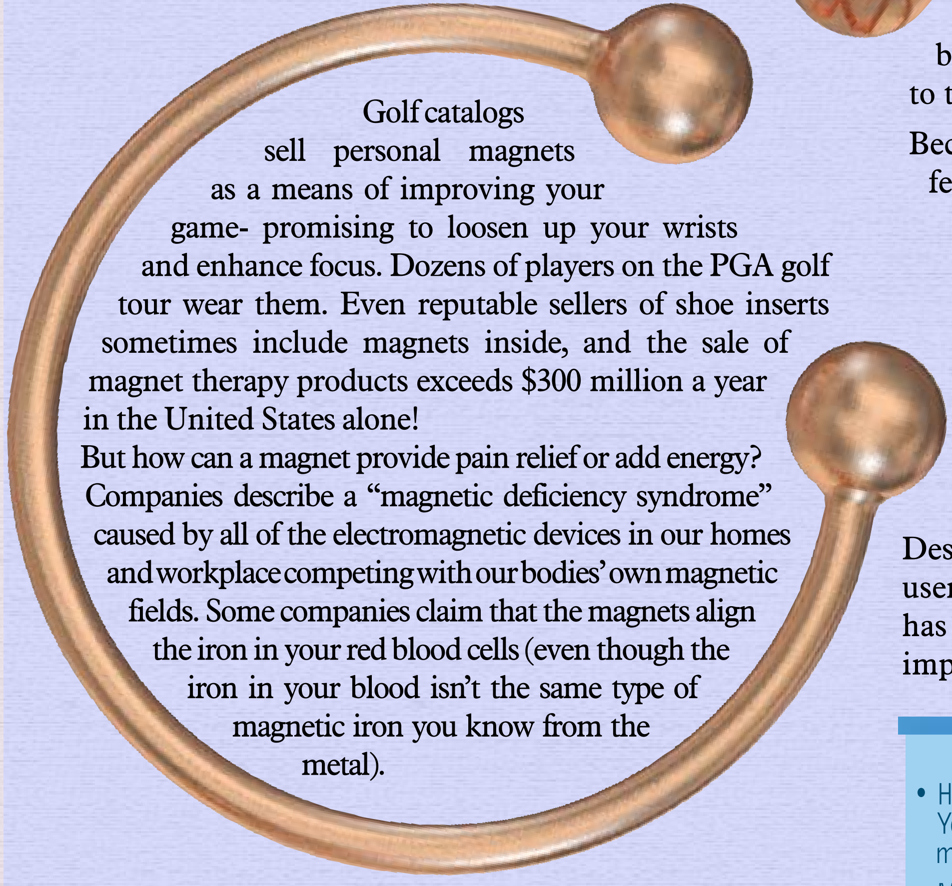
Do health magnets really work?

By Amy Mast

Companies that manufacture "health" magnets claim the devices provide relief from arthritis and many other chronic aches and pains- and many say that sufferers who wear the magnets also receive an extra boost of energy. Allergies, thyroid problems, and even sleep disorders are treatable with magnets, claim their manufacturers.

You'll often see these magnets for sale implanted inside bracelets and necklaces or even inside pillowcases, and texts about the healing power of magnets go back thousands of years.





Golf catalogs sell personal magnets as a means of improving your game- promising to loosen up your wrists and enhance focus. Dozens of players on the PGA golf tour wear them. Even reputable sellers of shoe inserts sometimes include magnets inside, and the sale of magnet therapy products exceeds $300 million a year in the United States alone!

But how can a magnet provide pain relief or add energy? Companies describe a "magnetic deficiency syndrome" caused by all of the electromagnetic devices in our homes and workplace competing with our bodies' own magnetic fields. Some companies claim that the magnets align the iron in your red blood cells (even though the iron in your blood isn't the same type of magnetic iron you know from the metal).

Can a bracelet make you feel better?

These companies also claim that modern-day conveniences like cars and asphalt streets separate us from the earth's magnetic field, knocking our bodies- from our circulatory system to our moods- out of whack. Only by adding magnets to the mix, the companies say, can our bodies receive the benefits magnetic fields provide.

But if this theory were true, then a compass wouldn't work on a city street! The earth's magnetic field is all around us, alive and well, and there's no proven benefit to carrying around pocket-size supplements to that field.

Because the placebo effect (when a patient feels better because they *believe* a product is helping them) makes folks feel better, manufacturers have no problem amassing hundreds of user testimonials, and the products keep selling.

Despite the testimonials, no double-blind study- in which users don't know if they have a health magnet or a placebo- has ever proved that wearers experience real pain relief or improved circulation.

DID YOU KNOW?

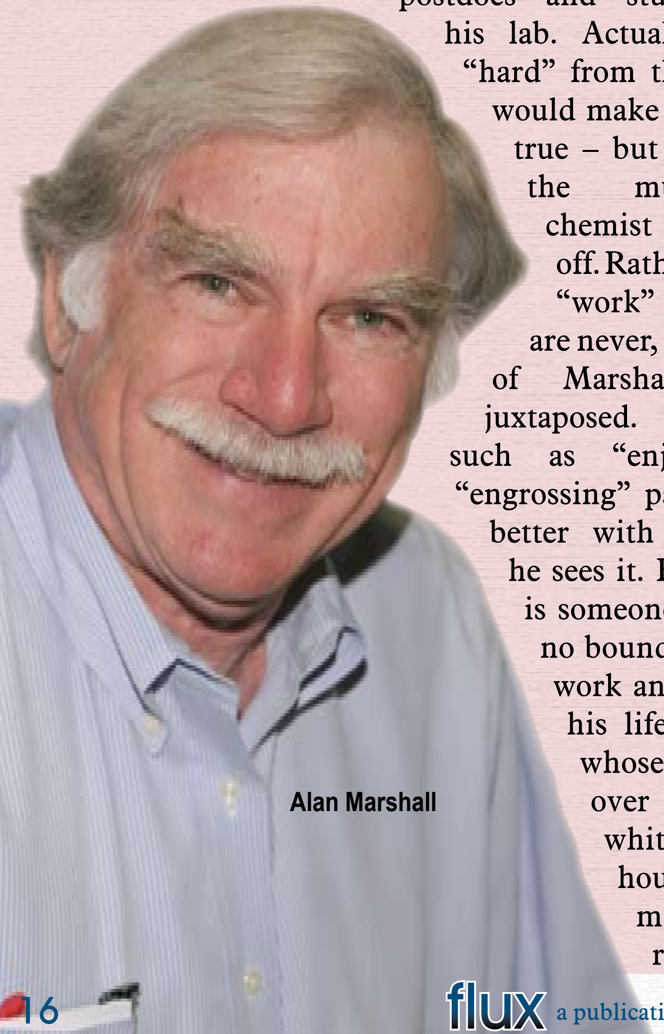
- Health magnet manufacturers make products for you and your pet. Your dog can wear a magnetic health collar and sleep on a magnetic pad.
- Magnetic therapy is a form of alternative medicine that has been practiced in the East for centuries.

Alan Marshall: A Scientist and a Gentleman

By Kristen Eliza Coyne

Alan Marshall, Kasha Professor of Chemistry at Florida State University and director of the Ion Cyclotron Resonance Program at the Magnet Lab, is ensconced in his favorite armchair. Smiling, he absent-mindedly twirls a white tuft of sideburn with one hand and cradles a yellow coozy in the other, appearing as chilled-out as the drink inside.

Meet one of the greatest innovators in the history of mass spectrometry, hard at work.



Alan Marshall

Marshall, though in his gracious North Tallahassee home, the pool and a well-stocked cooler just outside the door, truly is hard at work, surrounded by a score of scientists, postdocs and students from his lab. Actually, deleting "hard" from that sentence would make it ring more true – but not because the much-honored chemist is slacking off. Rather, the words "work" and "hard" are never, in the syntax of Marshall's career, juxtaposed. Adjectives such as "enjoyable" or "engrossing" partner much better with "work," as he sees it. For Marshall is someone who draws no boundary between work and the rest of his life, a scientist whose lab spills over into his white brick house a dozen miles away, a renaissance man of many interests, but none of which compete with his life's greatest passion: Fourier transform ion cyclotron resonance (FT-ICR).

His passion is a key ingredient in his success, which began early in his career when he co-invented FT-ICR, a type of mass spectrometry that relies on powerful magnets. It has proven an extremely productive tool for scientists trying to figure out the composition of complex molecules such as proteins and petrochemicals. The technique has been a boon to oil companies, the pharmaceutical industry, counterterrorism efforts, medical research and biotechnology, among other areas, and scientists are constantly finding new applications. It's the type of high-impact achievement for which Nobel Prizes are handed out.

At the forefront of the innovation is Marshall's program at Magnet Lab headquarters in Tallahassee, Florida. The lab boasts some of the most powerful ICR equipment available; the gem of this collection is a spectrometer featuring a superconducting ICR magnet with a field of 14.5 tesla – the highest field in the world for such an instrument. (Tesla is the unit of measure of magnetic field strength). Scientists come from all over the world to use these machines and benefit from the unparalleled expertise found in Marshall's team.

These visitors know Marshall from his reputation before they actually meet him: The insight that fueled an invention, the dedication that has produced more than 450 refereed journal articles, the passion that brings him into the office every single day, except Christmas and business trips. But many are surprised to discover that kindness is part of the package. In connection with this top scientist, one hears a word not often invoked these days, in the sciences or any other field, a way of being that has fallen out of fashion: Gentleman.

"It's rare to have somebody be that brilliant and that nice," said Chris Hendrickson, Director of instrumentation for the lab's ICR program. "It's really rare."

From red wagons to Stanford

Alan George Marshall was born in Northwest Ohio in 1944, the only child of Herbert Marshall and Cecile Marshall (later Cecile Rosser), a farmer and a school nurse. Even as a lad he helped out on the farm by ferrying crops from the field to the packing shed in his little red wagon.

He was 7 when the family moved to San Diego, Calif., where his dad took an engineering job. Because young Alan skipped second grade and his growth spurt was late in coming, he was smaller than most of his classmates and an easy target for bullies. But as the boy began to distinguish himself – in seventh grade, he was the proud winner of the junior high school spelling bee and set a school record for the standing broad jump the following year – he gained confidence and recognition. His interests were broad: Though his greatest love was science, he also played the clarinet and was on the track and cross country teams. He learned that focusing too much on one thing can work against you: He beat out his closest rival to be named outstanding male scholar of his graduating class because he'd earned better grades in gym. When Marshall left for Illinois' Northwestern University in 1961 for a six-year medical program, scholarship money paved the way.

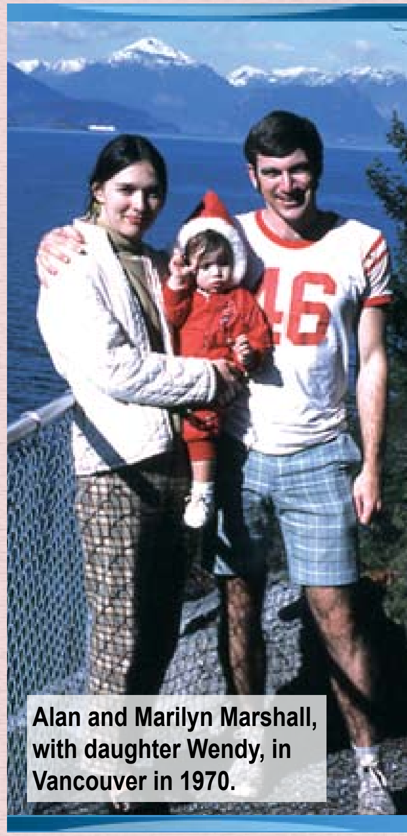
It did not take long for Marshall to realize that he chose medicine for the wrong reasons.

"I still like medicine, but I hated medical school," he recalled. "It was all memorization."

He switched to chemistry and never looked back. Lesson learned: to achieve success and happiness, you must love what you do.

While in college Marshall took another critical step toward securing future success and happiness when he set his sights on English and political science major Marilyn Gard. The two met in November 1964 and were engaged by Christmas.

"He had a wonderful sense of humor," said Marilyn Marshall. "And of course I thought he was very handsome."



Alan and Marilyn Marshall, with daughter Wendy, in Vancouver in 1970.

The newlyweds moved to California the following year, where Marilyn finished her undergraduate degree at Stanford University and Alan worked toward his Ph.D there. Marshall continued to cultivate other interests, both scientific and otherwise, reading broadly about a wide range of topics. In an echo of his choice to quit medical school, he dropped his initial thesis topic, in which he used nuclear magnetic resonance (NMR) to study how drugs bind to receptors. The topic failed to inspire him, so he cut his losses and switched to calculating shapes of ICR spectra. His unconventional decision to do two thesis topics – one in NMR, one in ICR – would have huge implications for both his future and the future of analytical chemistry. He will be forever grateful that his thesis advisor, John Baldeschwieler, allowed Marshall to follow his curiosity.

"I spent a lot of time working on topics other than the assignment he gave me," Marshall recalled.

Another event that would greatly shape the young scientist's career was his friendship with Mel Comisarow, a Stanford postdoc. Both men shared an interest in science and electronics, and paired up to build color TVs with Heathkits. When Marshall moved his family to Vancouver to launch his teaching career at the University of British Columbia in 1969, he encouraged Comisarow to join him. Two years later, he did.

It was during long campus strolls and late nights at the lab that the duo hatched and developed an idea that other chemists would have dismissed as either impossible or inconsequential: combining Fourier Transform with Ion Cyclotron Resonance.

History in the Making

When Marshall initially mentioned the idea to Comisarow, Marshall recalled, even Comisarow was skeptical, listing all the reasons it couldn't be done. But Marshall convinced him it could.

The key ingredients for a novel scientific breakthrough were at hand.

"A lot of people think that science occurs by brilliant intuition coming out of blue sky," said Marshall. "Really what is much more the case is that somebody knows something in one area and transfers it to another."

With such a challenge, two heads were far better than one. Comisarow brought to the partnership expertise in ICR, a tool first developed in the 1930s, while Marshall offered expertise in NMR along with his strong ICR background. Marshall's knowledge of NMR was important in part because Fourier Transform (a centuries-old mathematical algorithm that converts signals detected over time into a spectrum of usable data) had recently been combined with NMR; in fact, Swiss researcher Richard Ernst went on to win the Nobel Prize in Chemistry for developing this tool.

"It wasn't accidental that it took two people," Marshall said of FT-ICR.

What helped set this effort apart was Marshall's unique conflux of qualities: an ability to approach a problem with a broad command of science, a confidence in his abilities, a gift for teamwork, and the diligence to put in long hours, do the tedious calculations and write up the results.

Naresh Dalal, professor of chemistry at FSU and a researcher with the Mag Lab's Electron Magnetic Resonance program, remembers the night in December 1973 when Marshall and Comisarow first hit pay dirt with the help of a 2-tesla magnet that Comisarow had configured into the world's first FT-ICR spectrometer. Dalal, a UBC postdoc at the time, was working late in his second floor lab when an exuberant Marshall came in waving a piece of graph paper at him.

"We just created a new technique," Marshall, a few months shy of his 30th birthday, told Dalal. "This is the world's best mass spectrum."

It looked like just a bumpy line on a scrap of paper. But Marshall recognized it for an achievement of exceptional promise.

"The peak was very narrow, and that's what was better," said Marshall.

The peak represented the mass spectrum of a methane gas sample the men had tested using the new technique.


Marshall entertaining colleagues at home.

Determining the mass spectrum of a simple, well-known substance was of no particular note. But, as Marshall then boasted to his friend Dalal, the resolution they had achieved was so high that if they were to examine a sample containing 50 different compounds, they would get 50 distinct peaks. While it was possible at the time to identify that many molecules within one sample by using existing ICR techniques, the resolution was not nearly as high as with this new approach. And while existing techniques required an hour for such results, Marshall and Comisarow had achieved theirs in seconds. Their instrument allowed them to measure all the molecules at once, rather than one type at a time, as instruments did at the time.

It was, in fact, the beginning of a revolution in analytical chemistry. But nobody told that to the editors of the prestigious *International Journal of Mass Spectrometry and Ion Processes*, who rejected Marshall and Comisarow's paper reporting the news. Fortunately for science, *Chemical Physics Letters* did accept it. While the paper created a stir, it hardly changed the field overnight.

> "Marshall leaves the type of mark that shapes a life. 'Alan' has become a popular name for the sons of people who work with him."

"I felt like it had to work," said Marshall. "It took a while to convince everybody else."

While conducting most of his research on NMR, Marshall continued to develop the new invention while waiting for technology, equipment and the mindset of scientists to catch up. More than anyone, Marshall saw the potential in the invention, and devoted his intellect, hard work and passion to developing it.

"Smart isn't enough," observed his wife. "He's also diligent. He works more hours than anyone else in his lab and everyone knows it."

Michael Bowers, a chemistry professor at the University of California at Santa Barbara who has known Marshall for some 35 years, said Marshall is king of the field. "He's innovative in that he's continually trying to develop new methods to improve FT-ICR," said Bowers. "There have been a lot of good people working there, but he stands above the rest in developing the method."

A career takes wing

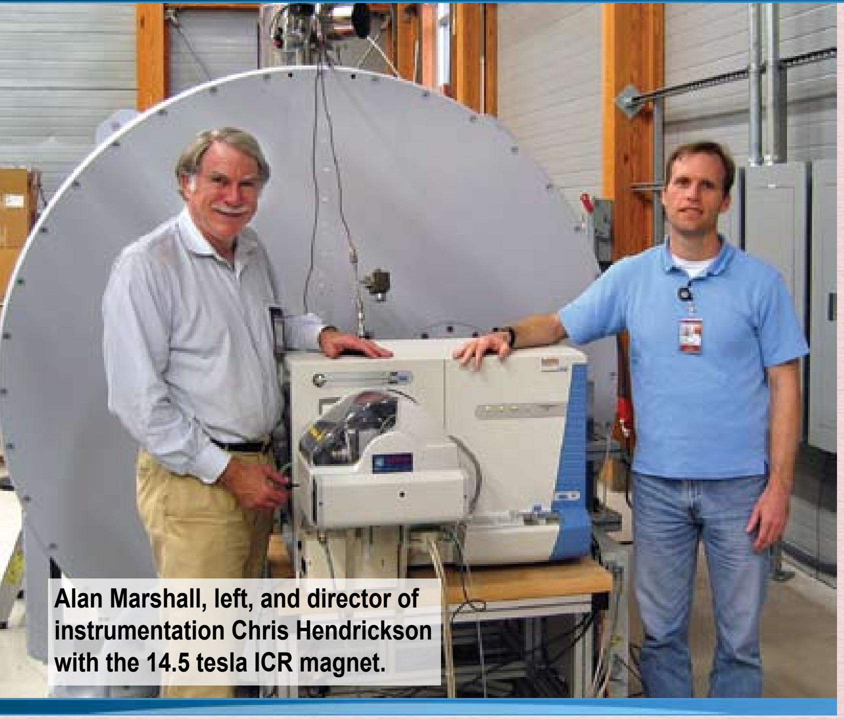
Recognizing a rising star, The Ohio State University hired Marshall in 1980 as professor of analytical chemistry and biochemistry and director of the new Chemical Instrumentation Center for NMR and Mass Spectrometry. OSU lured Marshall with the promise of new tools, and in 1983 the National Institutes of Health delivered with a 3-tesla FT-ICR instrument. State of the art for its time, the tool finally allowed Marshall to show the world the great potential of the technique. He devoted his attention to developing new instrumentation, new applications and new theories. It was during this period that Marshall came up with a method for exciting and detecting ions in a sample called stored waveform inverse Fourier transform (SWIFT) that has found widespread use in the field. Although he could not bring grant money from Canada, he began attracting more and more funding to his new university.

Down in Tallahassee, Florida, Jack Crow took note.

Crow was the founding director of the Magnet Lab, which had been relocated by the National Science Foundation from the Massachusetts Institute of Technology in 1990 due in large part to Crow's efforts. He courted Marshall aggressively. Marshall would not be wooed, and his wife didn't want to leave her successful legal career. But in 1993, lured in part by a half-million dollar grant from the state of Florida to build a 9.4 tesla FT-ICR instrument (the biggest in the world at the time), Marshall agreed.

"I decided that if I didn't come here, I would have to compete with the person who did come," he said.

Since then Marshall has built a world-renowned program. He is directly responsible for attracting more than $20 million



Alan Marshall, left, and director of instrumentation Chris Hendrickson with the 14.5 tesla ICR magnet.

in outside funding to the lab and has been instrumental in securing an additional $10 million in grants for other FSU scientists. (With his most recent grant – $1.3 million from the National Institutes of Health – Marshall is researching the structural mapping of protein complexes.) He and his team have racked up records for mass resolving power, mass resolution and mass accuracy. The scientific establishment has noticed, bestowing a heap of prestigious awards on Marshall.

Marshall relentlessly pushes the envelope, in the process taking on some of the most challenging problems in the field, such as analyzing crude oil – the most complicated chemical mixture known to scientists.

“It was viewed as virtually impossible because of the huge number of components that make up crude oil, and how to unravel that,” said chemist Bowers.

But thanks to the work of Marshall, his team and their collaborators, the field of petroleomics has grown extensively, helping to locate, drill for and refine oil. Oil companies contributed half a million dollars to build his lab’s world-record 14.5 tesla ICR magnet, commissioned in 2004. Petroleomics is the subject of one of the three books he has written in recent years.

Marshall is nothing less than a missionary when spreading the word about this technique, its application, and its continued promise.

Over the course of his career he has presented more than 1,400 talks and conference posters worldwide, both within and outside his field, to scientists as well as general audiences, explaining FT-ICR and inviting researchers to send their samples to the Mag Lab. He is always seeking new ground to cover, new territory to conquer, new applications for his instruments. It’s not unusual for a scientist to come to the lab, learn about the instruments and techniques, get exciting results with them, and return to his or her home institution to acquire his or her own spectrometer and continue probing.

“We basically build the field as part of the mission,” explained Marshall.

Nice guys finish first

Those who work with Marshall are in awe of his encyclopedic intellect. Despite the quantity and breadth of his work, he fields questions about it quickly, pulling details from the prodigious file cabinet of his brain.

“You could go and ask him about any of his hundreds of papers and he’ll know exactly the equations in there, the details in the experiments. He just has it all in his head,” said Kristina Håkansson, a former postdoc in his lab who is now an assistant professor of chemistry at the University of Michigan. “Some people who have been working in the field as long as he has, you ask them about a paper they published in 1975, they won’t remember. He will.”

Marshall has made the most of his gifts not just by working a lot, but by working effectively. Those who have worked with and for him praise his ability to manage a team, to get the most out of people by encouraging and supporting them, to accord his staff the freedom to flourish. One fact underscoring how easy he is to work with: about a quarter of his refereed papers are results of collaborations.

Along with this is an ethic of service. By attending meetings, writing letters and making phone calls, he does more than his share to support the work of the chemistry department, the mission of the Mag Lab, and the future of his staff members. Dozens of hours every month are devoted to writing hundreds of letters recommending someone for a job, an award or grant. Common are the stories of his benign intervention in others’ lives. Håkansson was headed in another direction when Marshall recognized her talents and recruited her. When it was time to move on, she hadn’t even considered a job in the U.S. until Marshall convinced her she could land a plum post and helped pave the way.

FSU chemist Dalal has felt that guiding hand more than once himself. He was a grad student at UBC when he first met Marshall, heading toward a career in photoelectron spectroscopy. But after taking Marshall’s class in magnetic resonance Dalal changed course to focus in that area. (The choice was propitious: In 2007, Dalal was honored with the 2007 Southern Chemist Award based on his three decades of research in magnetic resonance.) Marshall again intervened in his career by recruiting Dalal to leave West Virginia State University and join FSU’s Department of Chemistry and Biochemistry in 1996.

“To me he’s a teacher, friend, mentor,” said Dalal, a highly respected and accomplished chemist himself who chaired his department for eight years. “I wish I could be like him. It’s a feeling of awe.”

Marshall leaves the type of mark that shapes a life. “Alan” has become a popular name for the sons of people who work with him.

Marshall knows how much it meant to him when mentors encouraged him: He still remembers his eighth grade science teacher as well as the freshman physics professor to whom he dedicated his thesis. He appreciates the people along the way who took a chance on him. UBC hired him even though he didn’t have a postdoc. OSU hired him even though he had little funding and had never run a facility. The Mag Lab’s Crow hired him even though his funding was up for competitive renewal.

Certainly all of those people have been pleased with their investment. The ripple effect of FT-ICR on analytical chemistry has been enormous over the decades, and continues as more and more instruments go online and more applications are discovered.

According to UC chemist Bowers, the invention is, “certainly in the top quarter of all things ever done in science, and probably in the top 10 to 15 percent.”

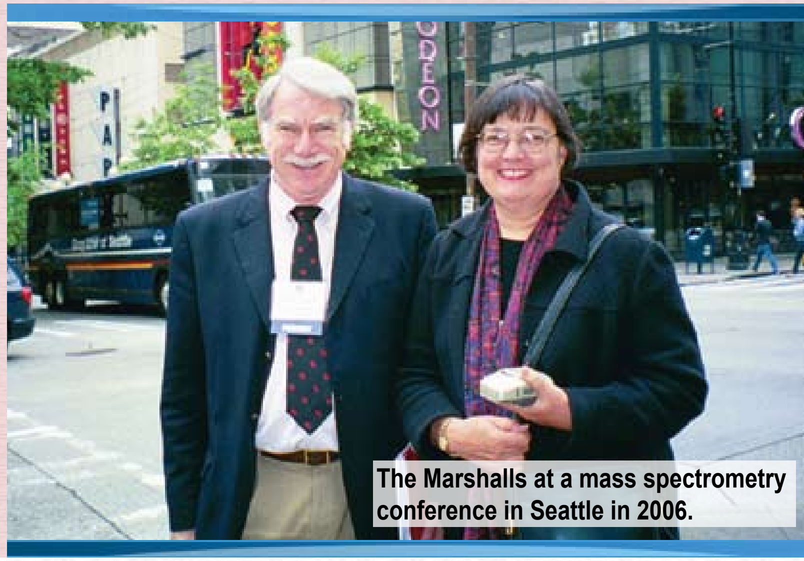
But, Bowers quickly added, “His best stuff may be ahead of him.”

Dalal agrees. “This is just the tip of the iceberg,” he said. “Better electronics and bigger magnets will only improve the technique.”

Marshall hopes to get one of those bigger magnets soon. The Mag Lab has designed a 21 tesla FT-ICR magnet for which they are currently seeking funding.

With it added to his impressive arsenal, Marshall will forge ahead with research technique development. In the lab’s future he foresees progress in identifying biological biomarkers for diseases such as Alzheimer’s and kidney disease, which could tell scientists more about the diseases and help doctors identify them sooner.

And at the end of the day, Marshall will leave his office, don his bush hat, climb into his red sports car (license plate: FT-ICR) and head home, where he will be sure, as he does every night, to toast his wife’s good cooking and, after their meal, clear the dishes.



The Marshalls at a mass spectrometry conference in Seattle in 2006.

Follow the Needle: Making a Compass

Every magnet you'll see has a north-seeking and south-seeking pole, just like the Earth, which is basically a giant magnet. If two magnets are brought together, the north pole of one will attract the south pole of the other. This is why compasses work on the Earth. The Earth's magnetic field is strong enough to make the north pole of a very light compass needle align with the magnetic south pole of the planet. If you're confused (don't compasses point north???), you may not realize that the Earth's geographic North Pole is the opposite of its magnetic north pole! In other words, the planet's geographic North Pole is its magnetic south pole, and vice versa.

In this activity, you will make a magnet and see it respond to the bigger magnet that is our planet. We show you two ways to do this. Either way, it's important that there be no friction on the needle, so that it can respond to the slight tug of the Earth magnet.

What you need

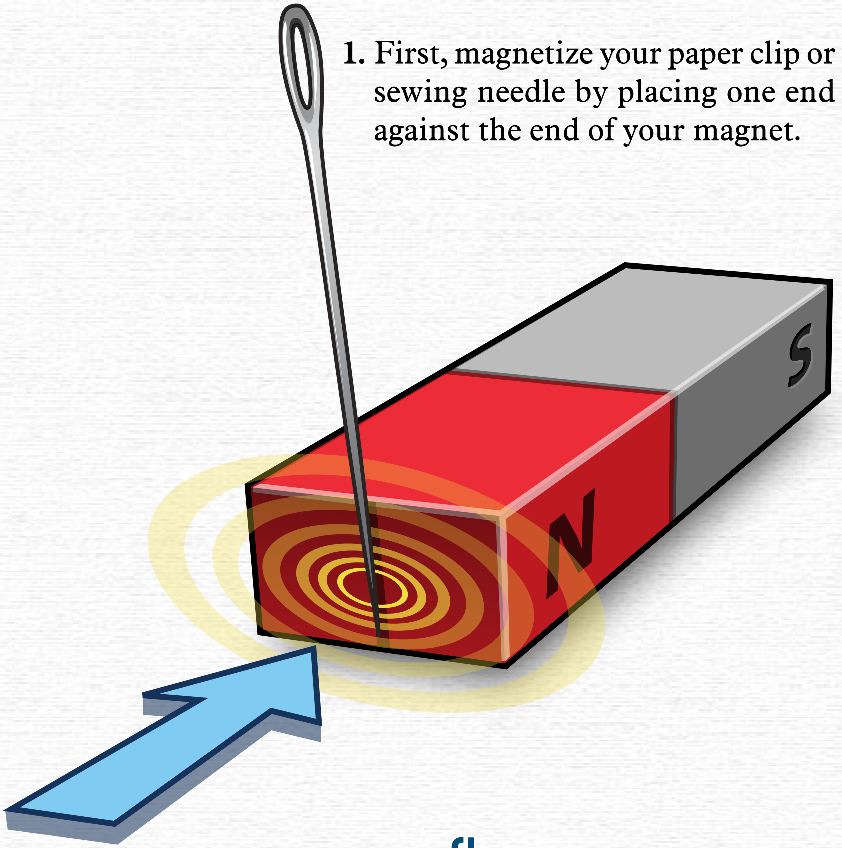
A bowl of water

A paper clip or sewing needle

A magnet

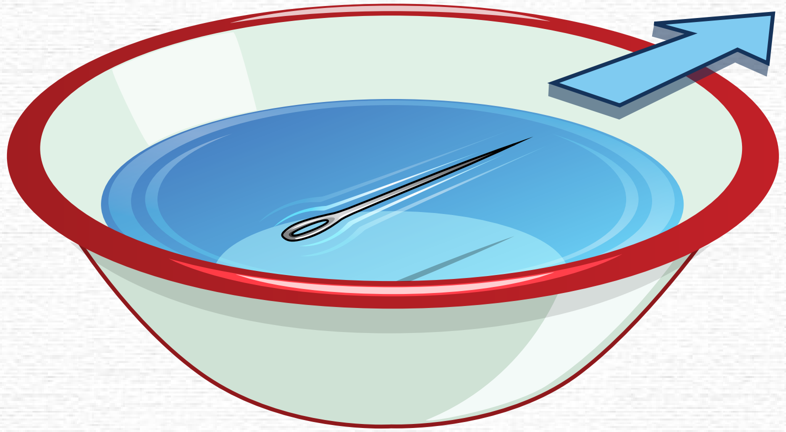
What you'll do

1. First, magnetize your paper clip or sewing needle by placing one end against the end of your magnet.



2. Float the magnetized needle very carefully on the surface of the water. The end that you magnetized will point north or south, depending on how you magnetized it.

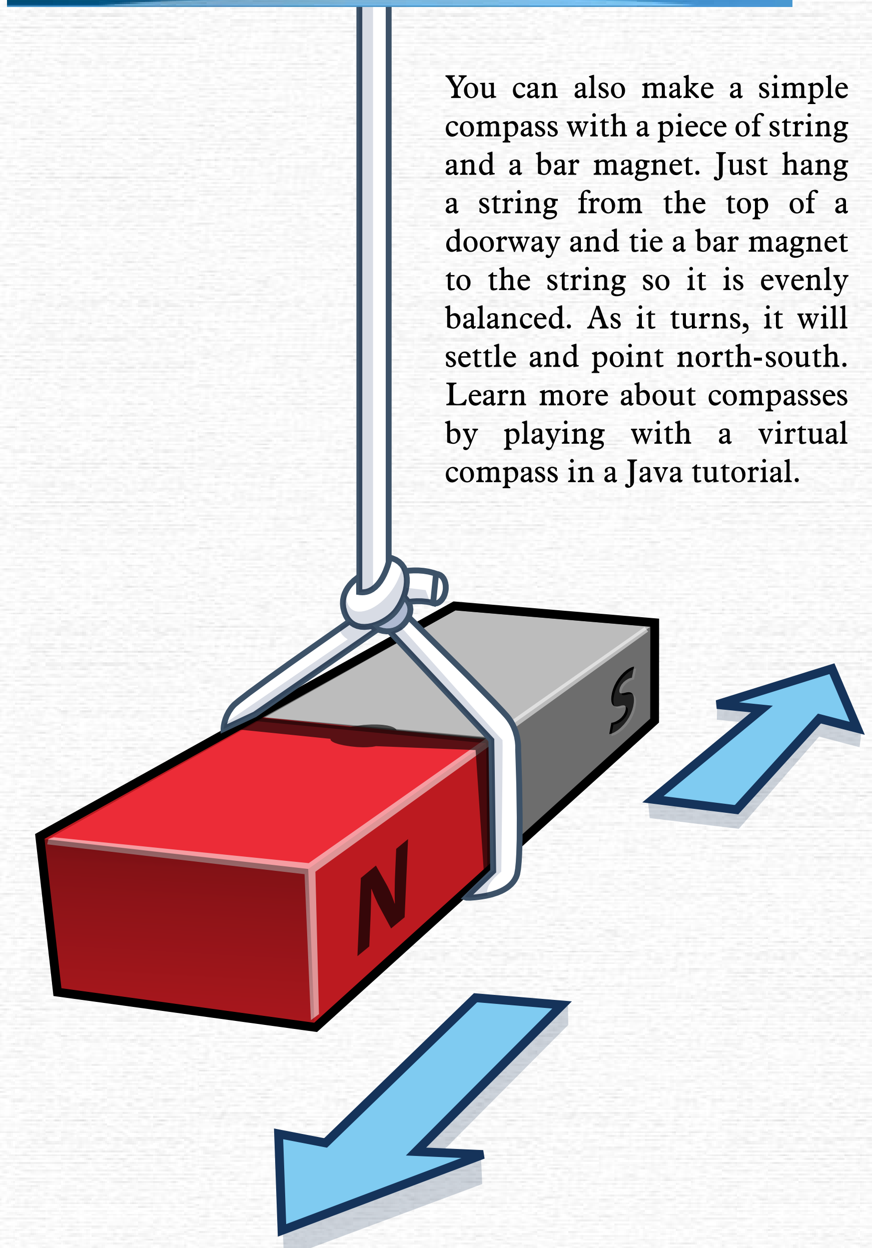
If you are having a hard time doing this, try placing the needle inside of a drinking straw, on a piece of cork, or on anything that will help it float.



DID YOU KNOW?

- A compass responds to the Earth's magnetic field. Scientists believe that field is generated by the churning of very hot liquid iron at the planet's core.
- The Earth's magnetic field does not run exactly from the North Pole to the South Pole, but is a little skewed. That's called the declination, and its effects, which vary depending on where you are on the planet, can be seen on compasses.

You can also make a simple compass with a piece of string and a bar magnet. Just hang a string from the top of a doorway and tie a bar magnet to the string so it is evenly balanced. As it turns, it will settle and point north-south. Learn more about compasses by playing with a virtual compass in a Java tutorial.



FACTS ABOUT THE COMPASS

Compasses have been used for 1000 years! Though people in China were using a compass-like device as early as 1088, and pre-Columbian peoples perhaps even before then, the compass as we know it was created by Europeans in the late 1100s.

Use of the compass spread, like many other customs, along trade routes.

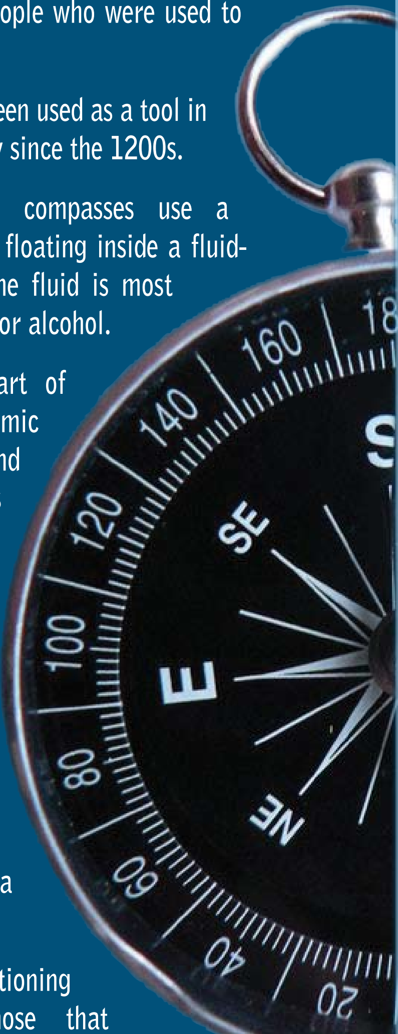
People in cloudy climates, where navigation by the stars wasn't possible, began using the compass earlier than the people who were used to clear skies.

The compass has been used as a tool in the mining industry since the 1200s.

Most modern-day compasses use a magnetized needle floating inside a fluid-filled container. The fluid is most often kerosene, oil or alcohol.

Compasses are part of both Jewish and Islamic prayer tradition, and religious compasses are manufactured which show markings toward Jerusalem and Mecca so that worshippers may face in that direction. In Islam, the prayer compass is called a Qibla.

A Global Positioning System- like those that many people have in their cars- is actually an electronic compass.



Mag Lab Photo Board

Open House 2008

Lab Director Greg Boebinger talks to the media at the annual Magnet Lab Open House, which attracted a record-breaking 4600 visitors.

Andy Powell demonstrates a Tesla coil for a rapt audience.

The Museum of Florida History brought along some toothsome displays.

Hands-on interaction was encouraged at almost every display the Open House offered.

A young visitor helps a scientist out with an interactive demonstration.

Geochemist Munir Humayun builds a "comet" on the spot for visitors.

Need a hand? Scientists at the Open House were more than happy to help you get your experiment just right.

Electromagnetic Resonance scientist Hans Von Tol conducts a demonstration.

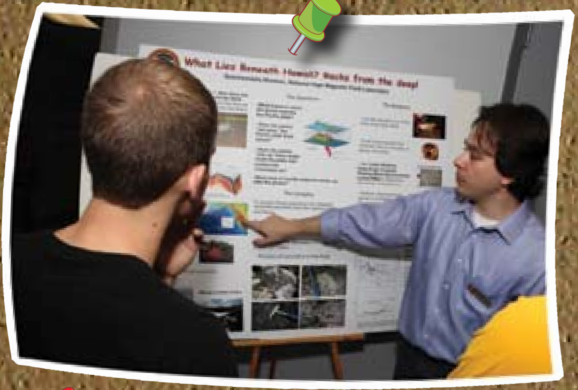
Representatives from FSU's Sea to See program give kids hands-on access to marine life.

The Challenger Learning Center provided a (literally) hair raising experience for some visitors.

Open House 2008

John Farrell offers visitors a peak inside the working of the Magnet Lab's machine shop.

James O' Reilly uses a model to demonstrate electron alignment inside a magnetic field.



At Open House, scientists and staff were happy to walk through the scientific principles behind each demonstration.

Nuclear Magnetic Resonance Director Tim Cross speaks to Open House guests in the atrium overlooking the lab's star 900 MhZ magnet.

Vaughan Williams takes a crowd of fascinated boys (and some of their dads) through the workings of the machine shop.

Lab Director Greg Boebinger guides a visitor through an Open House demonstration.

The future of the Magnet Lab is so bright...

Kids aren't the only Open House guests; there's lots for grown-ups to learn, too.

Got a question? Scientists, grad students and volunteers were on hand to answer.

Open House scientists and volunteers are always thinking of innovative ways to connect kids with science.

Uses substances trapped in balloons and instantly supercooled, cryogenics demonstrations showed different freezing points of various materials.

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