Spotlight

On Alumnus George Shaw (Ph.D., '90)

By: Karrie Sue Hawbaker, editor

Recently, I had the opportunity to catch up with Dr. George Shaw (Ph.D., '90), who was kind enough to share with me how his career, seeded in a chilhood fascination with the space program, brought him from physics research to medical research and that, oh yeah, he's an ER doc, too.

On the afternoon of July 20, 1969, George Shaw, age five, went missing. His mother, after anxiously searching their Texas apartment and neighborhood, finally found him in the apartment above theirs. The medical students that shared that apartment, unlike the Shaw family, had a television set – something very important to George on this particular day as he sat with his eyes transfixed on the set, watching Neil Armstrong take his very first steps on the moon.

While his memory of this specific event comes mostly from the story his mother has told him, he clearly remembers the excitement of the Apollo missions of the time, especially Apollo 11, and he credits that space program with his interest in physics.

A few years later, the Shaw family moved to Fairfax Country, Virginia, where George lived until he went off to the University of Virginia – as a physics major. He earned his bachelor's degree from UVA in 1985 and then came to Maryland to pursue his Ph.D. He says the Maryland program attracted him not only because it was reasonably close to home, but also because he was unsure of exactly what area of physics he wanted to study and Maryland was definitely big enough and diverse enough in its research areas. As it turns out, he ended up focusing his research on condensed matter physics, studying with Professor Satindar (Sam) Bhagat.

Shaw raves about Bhagat, even though "writing a paper with him was torturous!" Shaw says this with a little laugh and tells me that Bhagat was not only rigorous about the research (he wanted to know what you were doing, why you were doing it, how you were thinking about and analyzing the project), but also about communicating the research and communicating it using correct grammar. Shaw says, "Any paper writing skills I have now I owe to him."

After graduation, he took a job as a post-doctoral associate at the nearby Naval Research Lab. He had a very positive experience there, working under Dr. Geoffrey Summers (who is also the chair of the Applied Physics department at the University of Maryland Baltimore County), looking at the effects of radiation on GaAs materials.

After two years, he was feeling bored with being held up in the lab so much and, even though the work was very interesting, he felt like it didn't have much "real world" benefit. So, he took a career turn. He went to medical school, and received his M.D.

Spotlight

Meet Professor Kara Hoffman, Looking To the Heavens For Neutrinos

Kara Hoffman knows about speeding particles. After all, she has worked on CDF, a giant microscope used to analyze the debris from protons colliding with their antimatter analog, the antiproton, at the Tevatron, currently the world's high energy "atom-smasher". She also lived in Switzerland for a few years while she collaborated with scientists working on the Large Electron Positron Collider (LEP), which hurtled electrons at it's antimatter partner, the positron, at energies infinitesimally close to the speed of light. She even tried her hand at designing the machines which accelerate subatomic particles to such mind-boggling speeds: as a member of the Muon Collaboration, she worked on designing fanciful machines which might one day accelerate muons, a much heavier cousin of the electron, to such a clip. Such an accelerator is made even more intriguing because muons are short lived, and decay to a beam of neutrinos, ephemeral particles so lightweight that they have been only recently discovered to have any mass at all. So why has Professor Hoffman now turned her attention to the heavens?

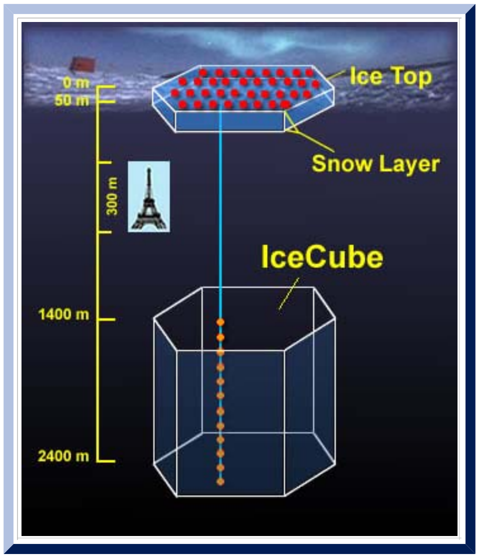
"There are objects out there in space that can accelerate subatomic particles to energies much greater than any man made accelerator here on earth," she explains. "Scientists have been aware of this for decades, but no one can explain where they're coming from...and instances have been recorded of particles reaching earth at billions of times the energies achieved at even the Tevatron."

The search for the origins of these so-called "cosmic rays" has previously focused on messengers such as photons (light), and more recently protons. These particles are launched on their journey through space by violent collisions and nuclear reactions that take place within stars and galaxies, for example. Professor Hoffman explains that modern day astrophysicists can use radiation detectors to "see" these particles radiating from various points in the sky.

"This is not so different from the methods of famous astronomers of antiquity," she says. "Galileo, in fact, used his eyes as radiation detectors to sense photons -light, that is- emanating from points in the sky. Your eye is a radiation detector, of sorts, but it's sensitivity is limited to radiation of a particular type and frequency- visible light. You can supplement this information by looking at other types of radiation."

Protons, like photons, are also relatively easy to detect. That's because protons have a mass and electrical charge and therefore make a mark when they collide with a radiation detector. The energy from the impact allows the detector to sense their presence. Therein lies the problem, explains Professor Hoffman: "if a particle can deposit enough energy in your detector for you to see it, how do you know it hasn't been depositing energy and slowing down as it travels through space to reach us? That means the information we receive from photons and protons may be somewhat misleading. For example, if they ricochet in a collision, they may appear to be coming from somewhere they're not."

The solution to this ambiguity may lie in those ghostly neutrinos mentioned earlier. Neutrinos often travel clean through the earth without slowing down or deviating from their original path. It is hypothesized that neutrinos might be copiously produced by these enigmatic cosmic accelerators in much the same way that Professor Hoffman and her former colleagues proposed to make a neutrino beam here on earth. The problem is, if neutrinos rarely leave any trace, then how do you build a telescope study them?



Professor Hoffman and her new colleagues on the IceCube collaboration, which also includes Professors Sullivan and Goodman, are banking on a new idea--building a telescope that instead of looking up into the sky, looks down into the earth. The earth is not much of an obstacle to a neutrino, but it will screen out other, more easily detected types of radiation. Otherwise, looking for neutrinos would be like stargazing on a sunny day. "Although most neutrinos travel through the earth undisturbed, there is a chance, a tiny chance, that they will interact with the material in the earth or your detector. When they do, they produce a particle such as a muon or an electron that we CAN detect. Muons leave a faint blue glow, called Cerenkov radiation, when traveling through water, so your telescope is essentially a huge tank." The trouble is, with such small odds, how do you catch enough of them to form an image of what's going on out there? "You build a VERY big telescope", says Professor Hoffman.

The IceCube telescope will be very big indeed. It will be shaped like a cube that is 1 km (2/3 of a mile) on each side. Luckily, nature has provided the huge tank of water needed-- in the form of ice. The South Pole is covered with a solid block of ice several miles thick and largely unpolluted by human activity.

All scientists from the IceCube collaboration need to do is embed instruments called phototubes into the ice to detect the faint blue glow that results from neutrino interactions. Phototubes are essentially a light bulb, but in reverse. Instead of converting electricity into light, they convert light into electricity, which is then used by a computer at the South Pole to gather information about the sky--over the Northern hemisphere!
"It's a simple idea, in principle, just add phototubes and--viola!"

The experiment, however, is complicated by the fact that IceCube scientists are working in perhaps the most hostile environment on earth. Will the ghostly neutrinos finally bring our extreme universe into focus? "It's quite a challenging project", says Professor Hoffman, "but one we hope will pay off with some very exciting discoveries. If we 'see' something, I'll make sure that readers of The Photon will be among the first to know!"

Well, in that case, I guess we here at The Photon should wish her luck...

****Editor's Note:** On January 27, 2005 (after this article was completed), the IceCube team successfully deployed its first string of 60 phototubes into the ice of the South Pole. Many congratulations to Professor Hoffman and the many hard-working scientists involved with the project.

Professor Hoffman is an assistant professor working in the field of particle astrophysics here at the University of Maryland. If you have any questions about her research, she can be reached at kara@icecube.umd.edu.

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from Georgetown University in 1997. He then completed a residency in Emergency Medicine at the University of Cincinnati in 2001.

Now Shaw is an emergency room doctor, an educator in a residency program, and a researcher in Biomedical Engineering at the University of Cincinnati . His hospital is a level one trauma center, so he and his residents see anything and everything from people of all ages. It's fast-paced, intellectually demanding work that requires a very broad knowledge base, since he has to be able to take care of anything for at least two hours. After that, a patient might go to surgery or require the care of a specialist, but for the first two hours, Shaw is responsible for that patient. It may sound burdensome to some, but he likes it and says it definitely has its rewards. After all, even though it's not quite like the television show, Shaw tells me that “every two or three shifts I save somebody's life.”

Shaw is also now back in the lab – this time with research with a very real impact on the lives of many people. He is working to improve the treatment of acute ischemic stroke, an increasingly common problem that he often sees in the ER. These strokes account for about 80% of all strokes, and are caused by a clot in one of the major arteries of the brain. Deprived of blood and oxygen, the portion of the brain dependent on the artery is immediately injured. This can result in permanent brain damage after a short period of time. Currently, the only FDA (Food and Drug Administration) approved therapy to treat such strokes is a drug called tissue plasminogen activator, or “tPA.” This drug can break up the clot, and restore blood flow to the affected part of the brain. However, the success rates of the therapy are not wonderful and it has dangerous side effects, like bleeding in the brain that can cause additional brain damage or death.

That's why Shaw's group, an interdisciplinary team of scientists from the field of biology, medicine, biomedical engineering, biochemistry and physics, are working on a new therapy called ultrasound enhanced thrombolysis . Scientists already know that this therapy, combining ultrasound and tPA treatment of the clot yields better results. Shaw's group is trying to find out why and then how that “why” can help them even further improve the therapy. Shaw's lab is actually the first to visualize the clot at the microscopic level and watch it break up using the tPA and ultrasound combination.

Shaw says that it's amazing (and a little scary) how little we know about how the human body works, especially the brain. For instance, we still don't know why we need sleep or what is the physical basis of memory, both of which are seemingly basic questions. So, studying ischemic strokes can be a bit daunting.

While it might not seem that way at first glance, Shaw says his physics background has been invaluable. The way that physicists are trained to think is rather unique and it allows him to “parachute right into the middle of a problem.” In fact, he has a postdoc who is a physicist who he praises for his contributions in the lab.

Shaw is hesitant to recommend his career path to anyone, since it involved many years in school and requires many long and intense hours a day. However, he does say, “If you're crazy enough to do it, you can certainly make a career out of it.” He says the field of medical research is in need of more people, like physicists, who are trained in the quantitative sciences. Physicists are trained to go back to first principles to figure out a complicated problem. They bring a world viewpoint, which is very useful to this type of research. Biomedical engineering programs are more than willing to talk to physicists. And the market is good for a biomedical engineer with a physics background. Many career opportunities exist in academia and even more in industry.

Despite his warning of the many years in school and the long hours he works, Shaw appears happy – at home as well as at work. He and his great wife of nearly 20 years are now expecting their eighth child. And it is clear that he is excited and impassioned by his work.

"I don't regret doing it. It's a lot of fun," Shaw says. "But it's kind of insane."

If you have questions or comments for Dr. Shaw, please contact the editor. She will be happy to pass along the message.

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