# Fermi's First Results and the April Meeting of the American Physical Society

Scott Vaughn Burger

May 29, 2009

## Coming to the APS

When I first planned on coming to the April meeting of the American Physical Society, I had no idea what to expect, since I had never been to a convention centered on the world of academia. For the first time I would be a journalist on my own in the streets of Denver, surrounded by the brightest minds in the world of physics.

Almost within minutes of my arrival into this new world of science journalism, I was bombarded with physicists antsy to talk to journalists. Having a press badge at a conference like this was a lightning rod for attracting scientists. I had never talked to an academic outside of my own Department of Physics and Astronomy at Western Washington University, and now here I was, neck-deep in a conversation about fusion with someone who had gotten their doctorate under Werner Heisenberg, one of the most famous physicists in history.

The April APS meeting was being run alongside the Sherwood Fusion Theory Conference, so there was much talk at this meeting about huge experiments in the fusion world like that being done at the National Institute of Fusion and the International Thermonuclear Experimental Reactor, or ITER. Of all the meetings of physicists to choose from, I chose this one because the April meeting is more focused on particle and high energy physics, like that at the Large Hadron Collider (LHC) at CERN, the European Center for Nuclear Research. This is where my main interests lie. Specifically, this meeting would highlight the first results from the Fermi telescope that was recently launched into space by NASA. One aspect of Fermi was to hunt for byproducts of the elusive substance deemed “dark matter.” Dark matter makes up about 25% of the universe, whereas normal matter makes up only about 5%. A whopping 70% or so of the rest of the universe is the even more mysterious dark energy.

Before my flight I had arranged to interview a number of people involved in dark matter research which was being presented at the meeting. Being a conference neophyte, I was completely aloof to all of the talks going on at the meeting and my schedule was therefore reasonably open for me to wander around and explore. I had missed my first interview due to a typo on where the talk was supposed to be, so I thumbed through the 250-page booklet that detailed all the talks and presentations that were going on. My knees almost buckled when I read that there was a Nobel Prize session going on, so I quickly ran off to investigate.

## A Nobel Interview

The April APS meeting is focused on particle, high energy and plasma physics. Though much of the fusion news being covered at the meeting was exciting in its own right, the main attraction for me was the particle physics. A subset of particle physics is high energy physics, or HEP for short. There were many notable HEP community members at the meeting and many big wigs to boot, but perhaps the largest wig of them all was Dr. Makoto Kobayashi, the 2008 Nobel laureate in physics for his work on spontaneous symmetry breaking. An easy way of explaining symmetry breaking is like a pencil standing on its point. The slightest nudge from anything is going to make the pencil fall over, thus breaking its symmetry by the direction it falls compared to all the other directions it could have fallen.

He also has had a tremendous impact in the study of CP-violation: a way of "mirroring" particles as anti-particles to analyze how a physical situation changes. His 1973 paper, "CP Violation in the Renormalizable Theory of Weak Interaction," was the 3rd most cited high energy physics paper of all time in 2007.

Kobayashi's work is very key to understanding the universe as we know it. Most of the universe is made of matter as opposed to anti-matter today, but early in the universe's history the numbers were much closer. In fact, there was only a difference in 1 part per billion between the two! In the end, matter survived, but, I asked Dr. Kobayashi, could symmetry breaking have anything to do with this initial imbalance? ``The difference between the particle and the anti-particle,'' said Kobayashi, ``must be caused by CP violation. But we have not yet understood the concrete mechanism of CP violation's interaction, so this is a present subject to attack.''

Dr. Makoto Kobayashi gave a talk on his Nobel Prize-winning work at the April meeting of the American Physical Society.

When asked about whether or not the LHC could help attack that subject, Kobayashi said ``it may have some implication into the matter dominance issue,'' given the LHC has more of a chance at observing CP violation than ever before. Soon the LHC may prove useful in answering the question as to why the universe is dominated by what we call matter instead of what we call anti-matter.

## Shedding Light on Dark Matter

One of my passions is the world of dark matter and this meeting proved to be prolific in its bounty of dark matter-related people, stories and even debates.

One of the talks I was scheduled to go to was a fast-paced seminar on dark matter searches. There were 8 talkers, each given about 10 minutes to present their research to a room so jam-packed with physicists that there was standing room only left for those coming in only minutes before the talks started. These talks were largely focused on the Fermi telescope's first results, future results and how they pertain to dark matter, but there were also talks given about methods to detect dark matter from ground-based observatories like the Very Energetic Radiation Imaging Telescope Array System (VERITAS). In fact, one talk covered how to measure a magnetic moment of a dark matter particle, should it even have one! For someone who thought they were ensconced in the world of dark matter research, these quick talks opened my eyes into just how vast this field of scientific research was.

After the lightning round of talks, I went to a more subdued session on cosmic ray electrons, another result from the new Fermi telescope. Arriving after the first talk, I didn't get a sense of tension that was going to erupt later in the session. One talk towards the end of the session pointed towards a cosmic ray electron spectrum given by the Fermi data versus that given by the Advanced Thin Ionization Calorimeter (ATIC). ATIC showed a very pronounced bump in the data from what we would expect and that this would correlate well with a particular dark matter candidate. However, the Fermi data, which was much more robust, showed that this bump was significantly less pronounced than what ATIC saw. It was still above the baseline and therefore could still point to dark matter, but with Fermi's new instruments, a big discrepancy was found. Almost immediately the room began to cascade into a kerfuffle from one side to the other with many upset about the data. Eventually the session had to close, but the debate kept roaring on for long after until people were forced to vacate the room. There are very few debates in the science world that are accurately reported in the media, but this definitely would have made the cut as far as implication and speculation are concerned.

Another big debate realm in the world of particle astrophysics is the controversies between dark matter versus that of Modified Newtonian Dynamics, or MOND. Because this conference was going to be hosting many experts in the world of dark matter research, I wanted to hear their opinions on MOND: how valid was it, where was it going and was dark matter truly on the ropes?

MOND seeks to explain away dark matter by saying that Newton's law of gravitation, normally a function that goes as $r^{-2}$, should, at the scale of galaxies, go instead as $r^{-1}$.

One of the posters at the APS caught my attention, since it was on the topic of MOND. The woman presenting the poster said she thought there were a lot of problems with the theory surrounding dark matter and that MOND could be used to explain away a large portion of the need for such ``crazy,'' as she put it, models on the universe. Knowing that there were two dark matter juggernauts at the meeting, I posed the questions to them.

Dr. Lawrence Krauss, one of my physics-world heroes, is very busy at Arizona State University, being the Director of the Origins Institute as well as Foundation Professor of the School of Earth and Space Exploration. His book *Quintessence: The Mystery of the Missing Mass in the Universe*, got me hooked into the world of dark matter, which is what I partly study in my research now.

I asked Lawrence Krauss about what he the state of MOND was. "I wouldn't buy stock in it," he said, "It's not dead, well, perhaps Modified Newtonian Dynamics is, but people have refined the theory. One of the examples is something called TeVeS, which is a relativistic version because Newtonian mechanics is kind of old fashioned. I think that from the point of view of trying to explain away dark matter, I would have to say it's not good times for MOND."

Krauss went on to say that adding new particles to particle physics was "trivial" in comparison to reformulating how gravity was supposed to behave for arbitrary reasons.

## The State of Science Journalism

The public awareness of science was a topic that was well scrutinized at a meeting that would normally be only about fusion and particles. The scientific community is more and more aware every year of the decline in interest and knowledge about science, especially so in many parts of the United States.

Krauss gave a talk on science and society at the April APS meeting and cited recent results from a National Science Foundation study which stated that "Only 53% of adults know how long it takes for the Earth to revolve around the Sun," among other saddening percentages. I asked Krauss if science journalists, who are well qualified to do their job, are getting the message of scientific understanding out to the general public. "No," he stated flatly, "I mean, it's a difficult task and there are inherent problems. First of all, one should realize that most science journalists are not well qualified for their job: most science journalists are not scientists, which is ok. In a way it's good, because if they can distill it, they should be able to understand it at the level of the public. They're well qualified to the extent that they might be journalists, but there are two problems: one is that journalism at its very basis has got a fundamental tension with respect to science, namely, journalists are always taught that there are two sides to every story. But in science, one side is usually wrong. The other part of the problem is actually editors. And, again, they often serve as a roadblock: the science journalists will think something is interesting and the editors won't think it is of interest and don't put it on. It's a very daunting task and I actually don't think many good science journalists necessarily think that they are the ones to teach the public. Their job isn't to teach the public, it's to inform the public of the news. I think that scientists have to take that task to hand. One of the things I'm doing at my new Origins Initiative at Arizona State University is to educate journalists. The more educated journalists are, the better job they'll do conveying it."

This conference had many graduate students, but few undergraduates. There are many regional meetings of the American Physical Society to which undergrads may have easier access to than national meetings half a country away, but these regional meetings lack the volume and panache of the national-level meetings.

The experience of reporting on the APS has really inspired me to seeking a master's program in science journalism after my undergraduate education. Many at the conference referenced how important it is for young scientists to get involved in their fields. Some stressed the importance of needing younger, skeptically-minded scientific journalists in the field as well.

Of course, science journalism may not be every physicist's cup of tea. So I asked Dan Hooper, associate scientist at Fermi National Accelerator in Batavia, Illinois and assistant professor at the University of Chicago, about how students, just beginning their college career in physics, could get involved in some of the stuff talked about at the APS meeting: things ranging all the way from nuclear fusion to dark matter research. "Well, it depends where you are," he said, "If at the university you happen to be at, there are labs or professors who happen to be working on this topic approach them and say, 'I am interested in this, is there any chance you have use for an eager and enthusiastic undergrad?' I work at Fermilab and we have a lot of summer students who come in and do these summer research experience programs. It's a great way to get involved. If you tell people, 'this is the stuff I'm interested in,' there's a pretty good chance you'll be able to work on that. The other thing is: don't make up your mind too early about what kind of research you want to do, because today's hot topic could be, five years from now, old news. I know people who five years ago who desperately and enthusiastically pursued String Theory and it's not an easy place to get a job anymore, there's not as much activity as there used to be. So maybe they would have been better off waiting and seeing how things developed before they made that choice."

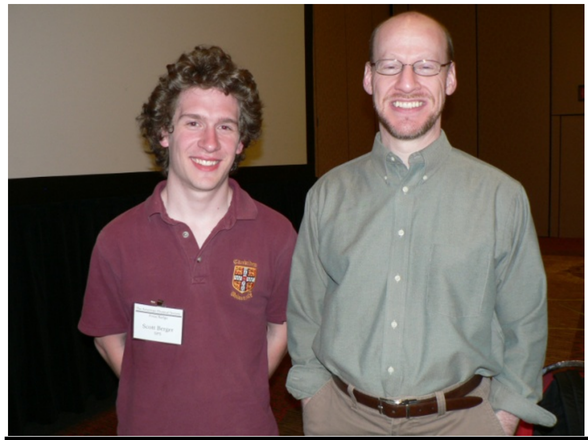
## Homeward Bound

The meeting came into its full perspective at the end of my journey. Before I landed back in Seattle, the woman sitting next to me asked why I was in Denver. I told her about the APS and she asked me ``what exactly does a physicist do?'' It's a valid question to ask, but a very hard one to answer. I leafed through the APS Bulletin that had all the meetings, talks and colloquia in it and selected the ones that I thought exemplified physics and physicists. I told her about the Large Synoptic Survey Telescope (LSST), the planned successor to the Sloan Digital Sky Survey and how it would literally change the way we see the cosmos. We talked about ITER and the promise of nuclear fusion as a viable source of energy in the future. I also told her about Richard Muller's talk on examining the terrorist threat. I referenced her to Muller's recent book, *Physics for Future Presidents* as a fantastic way of learning about physics from a non-scientist perspective.

"I envy you," she said, "you're just beginning your journey. You have so many opportunities, are so young and so many great things to accomplish. I wish you the best of luck." That meant a lot to me for many reasons. The compliment was not only personal but I felt it could be applied to all those beginning their careers in physics, wherever those careers may take them. The young physicists today are the envy of the old. We are all beginning our journeys. We all have so many opportunities and have many great things to accomplish. Best of luck to us all!


## Acknowledgements

This couldn't have been possible without help from Kendra Rand and James Riordon. I also want to thank Jennifer Siegal-Gaskins, Michael Kuhlen, Nadia Ramlagan, Dr. Hooper, Dr. Curt Callan, Dr. Kobayashi, Dr. Krauss and Dr. Phil Plait.

The author with Dr. Phil Plait (right), blogger for Discover Magazine. His latest book, "Death From the Skies!" details the ways in which the universe is extremely inhospitable for life. Plait gave a public talk at the APS about both his book and how some movies use lousy science for entertainment, or, as Plait calls it, "bad astronomy."