FACES OF MASS SPECTROMETRY / Facundo Fernández

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Setting the Bar Higher

Meeting virtually with Facundo Fernández feels surprisingly like an in-person event. We start off talking about the commonalties we share with regard to life during the pandemic, his cordiality and presence transcending the computer screen. Immediately, it is apparent that Facundo is a seasoned communicator who understands the importance of social connection.

Many of us are already familiar with Facundo because of his role as Associate Editor of the Journal of the American Society for Mass Spectrometry. We soon learn that scientific journals have been impactful throughout Facundo's career. He explains that his intense interest in mass spectrometry was triggered when he read journal articles about the field while working toward his PhD in Argentina.

Facundo was born and raised amid the hustle and bustle of big city life in Buenos Aires, which he describes as a "Latin New York." After finishing his doctoral work, Facundo set his sights on opportunities in the United States that would allow him to access the mass spectrometers he had read so much about in journals. He was soon on his way to San Francisco, where the next chapter of his career began to unfold.

Now a professor in the School of Chemistry and Biochemistry at Georgia Institute of Technology, Facundo's diversified areas of research range from exploration of cancer and other chronic diseases, to the study of traumatic brain injuries, to helping solve issues that astronauts encounter while in Earth's orbit.

Facundo's expertise in ambient sampling has led to large-scale collaborative projects, such as with the CDC to identify the sale and distribution of counterfeit medicines. Resolving sweeping problems requires partnerships, and Facundo stresses that he collaborates with other scientists who maintain a level of excellence. He seeks the most motivated of scientists, who are zealous enough to reach new heights through research.

In juxtaposition to his serene demeanor, Facundo is a scientist with a bit of a wild streak. He has a newfound interest in off-roading and a longtime interest in rock climbing. With two children and a wife accompanying him on his adventures, there are some great memories in the making!

How did you get your start in mass spectrometry?

I did my PhD in Argentina -- I'm from Buenos Aires. My PhD was not in mass spectrometry, but I was craving to play with these complex, expensive toys, and I kept reading about them in journals. Back in the late 1990s, mass spectrometry was exploding. So, when I finished my PhD, I definitely wanted to do mass spectrometry work. I started looking for postdoc opportunities in the United States. I emailed a lot of people, and many of those emails went unanswered. But one person replied. That was my first postdoc advisor. His name is Dick Zare from Stanford. He said, "If you want to apply for fellowships, I'll take you in." So, I completed a bunch of applications --he helped me--and I got funding to fly to do a postdoc at Stanford. They took me to the lab, the same day after a 12-hour flight, and I was doing experiments on a homebuilt mass spectrometer. It was a wonderful experience, and Dick Zare was a super inspirational guy. Then I did a second postdoc with Vicki Wysocki, who's the former president of the ASMS and a great mentor. She has a lot of people working with her who are wonderful, such as Arpad Somogyi, and that pushed my path into the field. Then I started my independent career at Georgia Tech.

At what point did you transition to focus on ambient sampling?

That was when I was interviewing at Georgia Tech, which is in Atlanta, and we also have the CDC in Atlanta. As part of the interview, they asked me if I wanted to give a talk for the CDC. After my presentation, a scientist from the audience came up to me and said, "We're working on this really interesting problem. We know that in many developing countries, there

Facundo Fernández climbing The Prow in Yosemite's Washington Column during his years as a postdoctoral fellow at Stanford.

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are fake medicines in circulation. We know they're fake because they don't have the active ingredient that they should have. But we have also learned they have other active ingredients, and we don't know what they are. I wonder if you could help us figure that out." This was Michael Green from the CDC. He introduced me to another person from Oxford University named Paul Newton. The three of us started working together on this topic of fake medicines. At the same time, a group of people developed "ambient mass spectrometry," which is basically a set of mass spectrometry tools used for analysis of samples without any sample prep. That was perfect for this problem of fake medicines, because we had thousands of samples. But we did not want to be doing a lot of in-depth analyses; we just needed to do a quick pass/fail screening. And we started applying it to counterfeit drugs. So, those two things converged in the early years of my career.

What kinds of networking opportunities have you used to connect with others in the mass spectrometry field?

One of the main networking tools is our annual conference. The ASMS conference is an opportunity to take the pulse of the field and find out what's going on, what people are doing, and what ideas are floating around. Over the years, it has also become a great opportunity to see friends. Since the pandemic, I've really missed attending that conference in person. These are not just people that I work with; they're people with whom I can come up with ideas that may inspire collaboration. The other tool that I love is Twitter. In the mass spectrometry community, it is a good place to exchange ideas, ask questions, and discuss articles very quickly. I like the format of Tweets, because they're very short and concise. Twitter is great in that sense. It connects you with who's doing what and where.

What are some of the mass spectrometry techniques that your group has been using for space exploration?

There are many places for mass spectrometry in space exploration, such as in astrobiology and origins of life research. We did work with NASA for some time. A concrete problem is, when you have astronauts in the space station, the air and water do not come in or out, so you need to purify what you are breathing and drinking. They have lots of sensors to make sure that the astronauts are safe in this way. NASA challenged me with the idea of how to develop better sensors. They had multiple sensors, but we determined that if different inlets could be developed for the same sensor, maybe that would simplify the system a lot and be much more affordable. That is where ambient mass spectrometry comes in, because it is a technology for how to introduce a sample into a mass spectrometry "sensor." They made us think really hard about how to sample air and water and put everything into a miniature mass spectrometer. I did my PhD work in atomic spectrometry. So, we adapted that a little bit to ambient mass spectrometry, and NASA loved it. We came up with some prototypes, and hopefully one day we will get something in space.

How has your work in pharmaceuticals and mass spectrometry contributed to our understanding of disease?

In the past few years, almost all of my work has been related to some sort of disease. It started when a colleague of mine wanted to measure metabolites in patients with ovarian cancer and wanted my help. I said, "We don't really do that right now, but you're making me think this may be something that we should be doing." We started very small, looking at women with ovarian cancer—some in

the early stages and some in the late stages--and comparing them against controls using mass spectrometry. You could tell, even in the early-stage patients, that there was some sort of signature in serum in their blood that was indicative of a process related to cancer. That was an eye-opener. The same methods are applicable to other diseases, such as cystic fibrosis. I actually got a chance to meet with some cystic fibrosis patients. Once you meet with them, you want to do whatever you can to help them. It is not just about diagnosing cystic fibrosis, but it is about really trying to improve the prognosis over time to see if they can live a better life. These patients get sicker and sicker progressively over the years. The clinicians wanted to see if we could detect anything before they got sick. We analyzed their breath by mass spectrometry, and were able to tell when somebody was about to get sick down the road. The life expectancy for patients has gone from 20 to 40 or even 50+ years. So, while it is still a terrible disease, it is not what it used to be.

How has your work in mass spectrometry been used to study traumatic brain injuries?

We've recently been doing this work with a specialist in the field at Georgia Tech, Michelle LaPlaca. Most people are trying to look at biomarkers of traumatic brain injury or are focused on proteins that are in the brain. If you have an injury in the brain, some of those proteins may leak to your blood, and you can detect them. But those tools are not perfect. We've been focused mostly on small molecules that could leak more easily in less severe injuries. The weight of the brain is 40% lipids, and our hypothesis is that many of those lipids, when you have a brain injury, could migrate to your blood. A blood test would show that the lipid profile in your blood is changing. We're trying to understand whether it changes over time in a way that we can understand or predict. The preliminary results are really interesting; for sure, there's a change in the lipid profile. What's not as clear is the origin of those lipids. We're basically throwing everything at this problem--we're using all the more advanced mass spectrometry techniques that we know. We're doing metabolomics, imaging mass spectrometry, and ion mobility, for example. I am hopeful that before I retire, some of these things will make it into a clinic. And instead of having maybe 20 different assays, they're going to be doing just one with a mass spectrometer that is going to measure thousands of molecules. That will take a lot of research, but that is my dream.

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What are some of your interests outside the lab?

My passion all my life has been rock climbing. When I moved to Atlanta, I started picking up other hobbies because climbing was not so easy here. One of the main other things that I like to do is paddling. I have a couple of kayaks and I travel a lot. Around the start of the pandemic, I also picked up archery. It is something that I've been curious about for at least 30 years. I bought a bow, and we have an archery range. It is almost like meditation. The other thing I've been doing with the family recently, because of the pandemic, is going off-roading with my kids and wife. I do not know what I'm doing, but they love it; we're all just trying to stay sane and safe at the same time!