FACES OF MASS SPECTROMETRY / Ingela Lanekoff

Anne Brenner and Hayes Simpson are science writers at Technica Editorial

July 2021

Taking Modular Imaging to the Next Level

The early years of Ingela Lanekoff's career were marked by a caref ul balance between work and home, as she was the mother of two young children at the time. Her introduction to mass spectrometry did not happen by chance, but rather was a planned part of her Ph.D. work. Motherhood and a career in industry inf luenced her to find a passion and purpose before returning for a Ph.D., which was focused on mass spectrometry. Ingela's creative and curious mind continued to take her in unforeseen directions, spurring inventive work as a postdoc and in the years of research and teaching that followed.

Professorship was a natural progression for Ingela, who enjoys seeing her students grow and progress. Motivating young people is admittedly one of the best parts of her job, and she hopes to be an inspiration to women and men launching careers in science. As a tenured Associate Professor in analytical chemistry in the Department of Chemistry - BMC at Uppsala University in Sweden, Professor Lanekoff mentors postdoctoral, doctoral, master, and bachelor level students from around the world.

The Lanekoff group has done a lot of work toward ref ining and discovering techniques that streamline the gathering and analysis of data for the detection, characterization, and quantification of small molecules in biological tissue sections. Quantifying imbalances in small molecules and the changes in molecular composition provides important insights into the underlying causes of human disorders and diseases.

Ambient ionization methods have been an underpinning of Ingela's work on imaging of small molecules that factor in the progression of diseases. She specializes in the use and development of nanospray desorption electrospray ionization mass spectrometry imaging (nano-DESI) technology for imaging of various tissue sections, such as the kidney, implantation sites, and brain. Nano-DESI is a liquid extraction technique for mass spectrometry imaging that saves scientists the step of sample preparation and having to place samples in a mass spectrometer's vacuum. It also allows for chemical dopants and internal standards to be included into the solvent, making the capture of molecular images of molecules quantitative and versatile.

Ingela's penchant for practical applications carries over to her home life as well. During the pandemic, she picked up the new hobbies of amigurumi and growing greens hydroponically, an interesting pastime that also keeps fresh greens at home year-round.

How did you get your start in mass spectrometry?

My work with mass spectrometry started with my Ph.D. After earning my master's degree, I worked in as an analytical chemist in industry for several years while starting a family, but I actually never worked with mass spectrometry during this time. When I started my Ph.D. I first worked with older instrumentation from MicroMass, a triple quadupole and a QTOF for doing liquid chromatography–mass spectrometry. Later, during my Ph.D. work, I moved on to using a TOF SIMS instrument and since my postdoctoral appointment I am mainly working on Orbitrap-based mass spectrometers.

When did your focus shift toward lipid imaging?

I actually did my Master's thesis on lipids using liquid chromatography in a lipid-oriented lab, and later I also worked as a research assistant in a lipid lab doing electrophysiology. So, for me, it was great to start my Ph.D. with a focus on lipid analysis. My Ph.D. work started with fluorescence microscopy imaging of lipid vesicles and cells and lipid analysis of sediments using liquid chromatography–mass spectrometry analysis. But then, in the middle of my Ph.D. work, I started doing SIMS (secondary ion mass spectrometry) on lipids in single cells. Even though I had done fluorescent imaging of lipids in cells previously, this was the start of lipid mass spectrometry imaging for me.

Lanekoff team members playing beach volleyball. From left to right: Victoria Eriksson, Cátia Marques, Petpailin Wiangnak, Varun Sharma, Leonidas Mavroudakis, Ingela Lanekoff, Klaus Welters, Tarja Wiegel, Anastasia Golubova, Johan Lillja.

When did your work shift to liquid extraction techniques and ambient ionization?

For my postdoc, I wanted to switch to something different within the field of imaging mass spectrometry. I saw an ad about developing a new mass spectrometry imaging technique for ambient ionization, and I thought it sounded very interesting. So, I made that switch for my postdoc and started developing nano-DESI for mass spectrometry imaging. Also, I introduced the concept of using internal standards in the solvent for quantitative imaging. During my independent career I have continued with the developments and applications of nano-DESI because I like the sensitivity, versatility, and unexplored areas of the technique. I've also introduced other molecules or additives into the solvent to tailor the analysis. It is fun because it is very flexible, and you can be very creative.

How long have you been performing tissue imaging using nano-DESI? What are its benefits?

I have performed tissue imaging using nano-DESI since its infancy and the start of my postdoc in 2011. Since then, I have worked on developing and using it as an imaging technique for mapping molecular distributions in thin tissue sections. It has involved some engineering, but also chemistry and mass spectrometry. One benefit of the technique is the separation of the events of desorption and ionization, which allows the inclusion of internal standards and other dopants into the solvent. This is important because if the events of desorption and ionization occur simultaneously, the standards and dopants would be ionized before the analytes. For example, the inclusion of internal standards can eliminate matrix effects during ionization since they will experience the same environment as the analytes. Another benefit is the sensitivity, partly because the ionization occurs so close to the inlet of the mass spectrometer and partly because the addition of dopants, such as silver, can increase the ionization efficiency of low abundant molecules such as prostaglandins. It is also very nice that no sample preparation is needed and that the sample is analyzed in ambient conditions and does not have to be placed in a vacuum. What I really like about nano-DESI is the versatility; you can change your solvent, and you can change what you put in it.

> *"What I really like about nano-DESI is the versatility; you can change your solvent, and you can change what you put in it."*

What do you enjoy about being a professor and teacher?

I came to Sweden in 2014, and in Sweden, there are very few academic positions announced. The way to get into academia is to fund yourself. So, I started funding myself to work as a researcher in academia through various funding agencies in 2014. I got my first official teaching position as an assistant professor in 2018, which got me started as part of the curriculum teaching faculty. Since then I have been promoted to associate professor. I always get super excited about new data, but I think mentoring students is the best part of my job, because I feel I can contribute so much. I

> *I get to help and see young people progress and become not only better scientists but also, in many ways, better people.*

really enjoy seeing them grow, progress, come up with their own ideas, and start learning how to drive projects. I have been fortunate to be able to select the best Ph.D. and Master's students from all around the world, including from Greece, Portugal, Russia, Fiji, and Sweden. Meanwhile, teaching undergraduate students is rewarding in its own way. They might know nothing about imaging mass spectrometry on Monday, but by Friday, they're arguing about different techniques. I really like it that way, because I get to help and see young people progress and become not only better scientists but also, in many ways, better people.

How has teaching analytical chemistry helped you grow as a scientist?

When putting new teaching material together I find myself re-experiencing it and I also find myself looking into areas of analytical chemistry that are not my main research focus. This provides me with a broader view of analytical chemistry, and I can get inspiration from unexpected sources. That helps me grow as a scientist, because I look into different corners and leave my own bubble. Also, I value students' questions even if they are sometimes hard to answer.

What other departments, universities, or institutions do you collaborate with?

At Uppsala University I collaborate both within and outside my department. I also collaborate with other universities within Sweden, Europe, and the United States. We recently started a new diabetes center here in Uppsala and I am part of the recently started EpiLipidNet COST Action, so I am excited about new and upcoming collaborations as well.

What are your interests outside the lab?

I'm spending a lot of time with my family, and I enjoy learning and socializing. I play musical instruments, sing, and read sometimes, but not serious books, just to relax and get into different environments. With so much more time at home over the past year, I've started with amigurumi, which is crocheting small animals, and cultivating plants hydroponically. Right now, I'm experimenting with cultivating tomatoes, peppers, broccoli, and chili in addition to lettuce. The price of buying these at a store is probably much lower, but the salads are very nice to always have fresh at home.

What accomplishment fills you with pride so far this year?

This year, I've really seen my group and group members' progress. We have a lot of exciting projects ongoing in various stages, and there is a lot of drive and positive attitude. I am proud of us all for managing our tasks in these difficult times and keeping it all together in a positive way.