CONVERSATIONS WITH SCIENTISTS

Michael L. Larsen: Untangling the World's Mysteries

September 2014

"...be an active thinker. Nobody ever tells you how to do original science. One day, you just have to start doing it. Yes—you'll make mistakes and take approaches that look foolish later, but that's how you find stuff out."

Courtesy of Michael Larsen

Michael Larsen is an assistant professor in the department of physics and astronomy at the College of Charleston in South Carolina. He earned his bachelor's degree in physics from Michigan Technological University in Houghton in 2001, and he completed his Ph.D. in atmospheric physics at the same university in 2006. As a graduate student, he was a fellow at the National Science and Engineering division of the U.S. Defense Department. Upon completion of his doctorate, Larsen worked for a year as a postdoctoral fellow at the National Research Council in Adelphi, Maryland. Prior to joining the Charleston faculty in 2010, Larson was an assistant professor in the physics department at the University of Nebraska at Kearney for three years and a consultant for the Army Research Laboratory in Adelphi.

Larsen's physics training is in atmospheric microphysics which includes the study of rain, clouds, aerosols, and radiative transfer. Currently, his research is focused on "understanding how spatial and temporal structures in rainfall vary over scales smaller than resolved by a typical radar pixel."

Below are Michael Larsen's October 4, 2014 responses to questions posed to him by Today's Science. *Some of the questions deal with how he became interested in science and began his career in physics while others address particular issues raised by the research discussed in Raindrops Are Falling . . . Faster and Faster.*

Q. When did you realize you wanted to become a scientist?

A. Pretty early on. When I was in elementary or middle school, I would pick up books that popularized physical science — talking about the people who started unraveling the quantum mechanics mysteries in the early 1900s. I didn't follow everything, but I was kind of awestruck by the fact that you could make a career out of trying to untangle the mysteries of the world around us. It felt like a very meaningful thing to do with your life.

Q. How did you choose your field?

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Raindrops Are Falling . . . Faster and Faster

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A. Most of those books that I mentioned earlier really romanticized different elements of quantum physics, so for a very long time I thought I'd do that — try to follow in the steps of [Albert] Einstein, [Niels] Bohr, [Max] Planck and the rest of the well-known names and make my own mark. When I started taking classes in quantum mechanics in college, however, I realized that I really loved the less abstract areas of physics even more. I found classical mechanics fascinating and eventually realized I wanted to study something that was accessible, but not understood as well as you'd expect. I knew it would be something in the realm of physics, but I really didn't know what.

Eventually, I took a class with Alex Kostinski; he would eventually become my Ph.D. advisor (and he's a coauthor on the super-terminal drops paper). Alex seemed to play with ideas in a way that was a bit different than most of my professors; I liked his lectures and how he seemed to look at the world. Ultimately, I really wanted to work with him and, at the time, he was mostly working on problems in various areas of atmospheric microphysics.

Over time, I really began to love the field — and I was fortunate to have a bunch of really great professors teach me the basics in this area (in addition to Alex Kostinski, I received a lot of guidance and insight from Raymond Shaw and Will Cantrell).

I'm not sure if I'll stay in atmospheric microphysics forever (I may have things to say in other areas of physics), but, for now, I still have more to say, and I still think I can contribute more to this community than if I started over in a different area.

Q. Are there particular scientists, whether you know them in person or not, that you find inspiring?

A. Absolutely. I named three of them above. There are many more — both current and from the past. Some of them are famous enough that most people know about them — but some really don't get the press/attention they deserve. If you go back, there was some amazing work with tremendous insight done by some people in the 20th century that just doesn't get that much attention outside of the circles of scientists — people like Lev Landau, Irving Langmuir or G(eoffrey) I(ngram) Taylor. I'm not as much of a science historian as I'd like to be, but I know there are dozens of others.

I have to admit, I don't read biographies as much anymore — so I can't really speak to the personal lives of the scientists whose work I'm enamored with. What I find inspiring is the clearly demonstrated clarity of thought that is evident when reading their writings.

Q. What do you think is the biggest misconception about your profession?

A. A lot depends on what you mean by profession. There are stereotypes about scientists all over the place, sure — but I think that most people understand those stereotypes are more caricatures than anything else.

I guess the misconception that frustrates me the most is about people who are professors. There seems to be (at least in some parts of the country) an impression that professors don't work very hard — they teach a few classes a week, and spend the rest of their time pontificating or going home early. Nothing could be further from the truth.

I work, on average, at least 70 hours a week — sometimes way more. Sure, we only spend 10-15 hours a week in the classroom, but I spend at least 2-3 hours preparing for every hour in class, plus writing original homework assignments with answer keys, grading, giving individual students help during office hours, providing service to the community and the college (serving on committees, academic advising, reviewing manuscripts and grant applications, consulting for local people who need scientific insight, and dealing with administrative responsibilities and duties) and doing other things that I can't even think of right now. This gets us to about 50-60 hours already — and I haven't even started talking about doing research, mentoring undergraduate research projects, writing papers, applying for research grants, purchasing equipment, or trying to stay current on the literature in the field.

We work hard. Very hard. All the time. But we do it because it is totally worth it to live a life of the mind. My job has the biggest perk in the world — I'm paid to think about and study things that I find interesting. That's so unbelievably awesome, I feel a bit guilty that I get to do it and not everyone else does.

Q. You are careful to say in your study that the objective was to verify that super-terminal raindrops are a real phenomenon, not to discover the explanation for how they occurred. But are you looking into that? Also, if a Las Vegas oddsmaker asked what odds he should give for different explanations, what would you say?

A. We are looking into that; there's a lot of possibilities out there as to what the ultimate cause would be. We scientist types tend not to speculate, however, until enough evidence is in to reach conclusions.

David Q. Cavagnaro/Getty Images

"...there's a lot of possibilities out there as to what the ultimate cause [of super-terminal raindrops] would be.

I am the gambling type, but not on science. I stick to games where I already know and understand all the rules.

Q. Are there any phenomena that seemed curious or inexplicable in terms of precipitation physics that now can be explained with the realization that small super-terminal raindrops are fairly common?

A. Maybe. I hate to equivocate, but I'd really like more results out there from other investigators to figure out how prevalent this effect is before I start assigning the phenomena relevance that may not be there.

Q. Would hail or any other precipitation phenomena possibly also be due for a correction along the lines of what you are investigating for raindrops?

A. Possibly — depending ultimately on the mechanism that causes it. Hail has a lot of other complications related to its geometry, and — since I study stuff in South Carolina — that's probably a study someone else will have to try to conduct.

Q. Are there any atmospheric conditions that would make this effect more or less pronounced — e.g., would it be less common when there is less wind?

A. Possibly — and this is a question a lot of us have been asking. However, we've only had the instrument array up that we used to detect this since late December. We weren't even able to compare summer vs. winter storms in the paper, because we didn't have any summer data yet. It is a great question, but so far we just don't know.

Q. Aside from super-terminal raindrops, what are some of the other unresolved questions in atmosphere physics that you are interested in?

A. Anything in the atmosphere smaller than a breadbox and involving a physical process. Right now, my focus is on understanding how spatial and temporal structures in rainfall vary over scales smaller than resolved by a typical radar pixel. Normally, weather radar reveals a single measurement of returned power for an area of nominally 1 km x 1 km, and only returns this measurement once every 4 or 5 minutes. Everyday experience certainly suggests that variability within these areas and time scales can be substantial. We're trying to understand that variability and how to best describe it statistically.

Q. Where do you spend most of your workday? Who are the people you work with?

A. I'm mostly in my office. When I'm not there, I'm working with students in my lab, or I'm in the classroom lecturing. When I'm not in any of those places, I'm either in meetings or — when I'm lucky — out at the field site getting data and maintaining the site.

The people I work with closest on a day-to-day basis are my students. I am currently a research mentor for 5 different undergraduate students (working on 5 different projects related to the one big theme of rain microphysics).

Q. What do you find most rewarding about your job? What do you find most challenging about your job?

A. The most rewarding thing is when you learn something about the universe that's really new. I'm still pretty early in my career, but there have already been a dozen moments or so when I've seen data that has given me chills. You realize suddenly what you're seeing, and then you get really excited and try to put the pieces together. It sounds a bit hokey, but in those moments you feel really alive. When you think back, you realize that — if I didn't look into that, then nobody would know this thing about the universe.

Of course, this really awesome, rewarding, inspiring thing doesn't happen that often. Maybe it does to other folks, but most of the time you're just chasing it.

The most challenging thing about my job is the work-life balance. Like I mentioned previously, I work a lot of hours. Balancing the responsibilities of being a good teacher, scholar, citizen, and boyfriend to my (very patient and understanding) girlfriend is difficult, and I often worry that I am unable to develop the balance that I should in my life.

Q. What has been the most exciting development in your field in the last 20 years? What do you think will be the most exciting development in your field in the next 20 years?

A. That's really hard for me to say. I work in an area that's pretty interdisciplinary. Although I teach in a physics department, I call myself an atmospheric microphysicist. I do research on and study things like rain, clouds, aerosols, and radiative transfer. That pulls from so many different communities (physics, astronomy, earth science, geology, hydrology, meteorology, atmospheric science, etc.) that I can't really speak to an exciting development in this broad area in a coherent way. All of these areas have had huge findings in the last 20 years — but I don't know if I have enough breadth and understanding regarding how it fits together to really know what the biggest idea really was (or will be).

Q. How does the research in your field affect our daily lives?

A. Rain is pretty important, and it has been important to humans throughout human history — or at the very least since we started agriculture. In addition to the direct impact it has on pretty much all the biological organisms on this planet, it is a remarkably efficient means of energy transfer (through latent and sensible heats) and a very effective erosional agent. An average square meter on the surface of the Earth receives many millions of raindrops per year, and both droughts and flooding can be devastating to all organisms. We use radars as a tool to help us figure out what's going on regarding rainfall all over the world, but radars don't always get the whole picture when trying to figure out how rain is distributed over smaller areas. We think that, because of the types of studies we're doing, we might be able to make improvements to how rain accumulations are reported and interpreted. This can improve agricultural strategies, and maybe even give us insight into the processes associated with creating rain in the first place that may yield improvements in geoengineering via, for example, more effective cloud-seeding techniques.

What we're doing is a bit behind the surface, and the benefits of finding this stuff out aren't obvious yet — but we think there's value to be gained in understanding these processes better.

Q. For young people interested in pursuing a career in science, what are some helpful things to do in school? What are some helpful things to do outside of school?

A. From a physicist's perspective, the number one piece of advice I can give youths interested in a career in science is "take as many math classes as you can." The language of physics is mathematics; when we use words to explain ideas, we are often trying to take something that we can state very precisely and carefully with mathematics and approximate it with the much clumsier tool of human language. By being fluent in the language of physics (math), you are setting the framework to develop a much stronger skill set to address the scientific ideas you will be facing later.

Outside of school (or even in school), the other piece of advice I have is to be an active thinker. Nobody ever tells you how to do original science. One day, you just have to start doing it. Yes — you'll make mistakes and take approaches that look foolish later, but that's how you find stuff out.

You're part of a world that's a tapestry of principles and ideas that literally live all around you. Poke the world with a stick and see what happens. Then poke it twice as hard and see what's different. Try to figure out why, and test your theory by poking it one more time a different way.

“Michael L. Larsen: Untangling the World's Mysteries.” *Today's Science.* Infobase Learning, Sept. 2014. Web. 14 Oct. 2014. <http://tsof.infobaselearning.com/recordurl.aspx?wid=10835&ID=31282>.

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