Donna Strickland in her laser laboratory on the day the Nobel Prize was announced.

"Do what you love and you will do your best"

Donna Strickland needed a high-intensity laser pulse for her PhD thesis studies and, therefore, she developed the chirped pulse amplification.

Kerstin Sonnabend

The Nobel Prize in Physics 2018 was awarded "for groundbreaking inventions in the field of laser physics". Arthur Ashkin shared one half "for the optical tweezers and their application to biological systems". The other half went jointly to Gérard Mourou and Donna Strickland "for their method of generating high-intensity, ultrashort optical pulses". Donna Strickland is the third woman to win a Nobel Prize in Physics. She was working on her PhD thesis in the group of Gérard Mourou when she performed the awarded research and she was the first author of the decisive paper.

Chirped pulse amplification was not the topic of your PhD thesis. Why did you work on it anyway?

I was the only person in the group that was working on a high-intensity laser project. I was supposed to measure the ninth harmonic of a YAG laser impinging on a nickel plasma. Therefore, I needed a short laser pulse with sufficient energy but pulse compression did not work.

Why not?

There was a number of reasons – one of them being self-focussing. Because the self-focussing length changes with the power not all of the pulse can focus to the same point in space. Gérard Mourou, my supervisor at the time, came up with the idea of the so-called chirped pulse amplification to overcome the problem. We scrapped what I was working on before and started with the new technique.

Was it a completely new approach?

The technique was known from radar technology – and it was sort of all evolving at that time. It was already shown that the best pulse compression results were possible with stretched pulses.

Were there any detours?

Laser pulses can be stretched using different structures. Oscar E. Martinez suggested different methods to receive the required negative group-velocity dispersion in 1987. I used a special fibre which was donated to our group: 2,5 kilometres in a spool. To get both ends, I had to un-

spool it and, unfortunately, it broke roughly in the middle. In the end, I was able to use 1,4 kilometres to stretch the laser pulse.

Did it work right away?

Yes, the pulse was stretched to 300 picoseconds. That was enough for our purpose although an ideal value would have been around one nanosecond.

What was your aim?

We wanted to show that the amplification did not destroy the chirp. That is mandatory if you want to compress the signal after the amplification to its original length. You only get the desired high-intensity ultra-short pulse if you are able to perform this last step.

How did you show that?

I had to determine the characteristics of the signal like its pulse length and its frequency for each step. And that worked out: The chirp was not destroyed by doing the amplification even past saturation.

However, CPA did not become your PhD project?

I was convinced that it was a good project but it would not be enough for a thesis. For a thesis, you have to perform a scientific study. But I did not study chirped pulse amplification, I just realised it. My scientific study using CPA was about multi-photon ionisation – that was my thesis work.

Did you recognise the breakthrough then?

We knew that we had found a way to get the most intense light. Thus, it would be possible to study the interaction of high-intensity light and atoms in a way like nobody could have done before. But, at that moment, we didn't know that it would work for eye surgery or any of the other applications. We just wanted to use it to change our understanding of how high-intensity lasers interact with matter.

Were you involved in any of the further developments or applications?

No, I chose not to work on chirped pulse amplification as a post-doc. Since then, I have mostly worked on basic non-linear optics.

You changed your focus of research after this important achievement?

Well, I still used CPA for my studies but I did not want to be part of the race to build the biggest and most intense lasers or to produce the shortest laser pulses.

Why not?

I like to work on small projects which I can do on my own or with one graduate student. Improving high-intensity lasers to break the record is a tremendous team effort – and I am not into these big projects.

How big is your group?

It is a small group – just a couple of graduate students and some under-grads.

Are you still working in the lab once in a while?

Yes, I always tried to – but it became more difficult since October 2nd.

Do you remember the moment when you learned about winning the Nobel prize?

It was around five o'clock in the morning. My husband, Douglas Dykaar, answered the phone. We were both worried in case something had happened to one of our children. They asked him whether Professor Strickland was available and said: „Please stay on the line for an important call from Sweden." During the next minutes I thought about it and said to my husband: "This has to be the Nobel prize. What else could it be on this day and from Sweden?"

But you were not sure until the official declaration?

No, I wasn't. I did the work more than thirty years ago and was completely surprised. It is an amazing kind of feeling – and I just thought: Oh my God!

You were awarded together with your supervisor Gérard Mourou…

… because I realised his idea. If Gérard would have won the Nobel Prize by himself I wouldn't have been surprised – that would have been the usual way. I guess we were both awarded because it was only the two of us to author the paper.

Besides spending less time in the lab what has changed for you?

Donna Strickland during her Nobel Lecture at the Aula Magna of Stockholm University.
(Bildquelle: picture alliance / TT NYHETSBYRÅN)

picture alliance / AP Photo

Donna Strickland receives the Nobel diploma and the Nobel medal from Carl XVI. Gustaf, the King of Sweden.

I had dinner with the King of Sweden – and I met the Prime Minister of Canada Justin Trudeau. In addition, I was invited to the Fortune Global Forum where presidents and CEOs of world leading companies listened to me. That's not usual for me.

Why?

I did the work more than 30 years ago and it didn't come to the attention of the general public. But now, after winning the Nobel prize, it seems that there's a stamp on me. And all of a sudden, everybody wants to talk to me. My life has changed completely.

Donna Strickland – CV in a nutshell

University of Waterloo

1977 – 1981 McMaster University, Hamilton, Canada
1981 B.Eng. in engineering physics
1989 Ph.D. from University of Rochester, Rochester, USA
1988 – 1991 research associate, National Research Council of Canada, Ottawa, Canada
1991 – 1992 physicist, Lawrence Livermore National Laboratory, USA
1992 – 1997 technical staff, Princeton University, USA
1997 assistant professor, University of Waterloo, Canada
2002 associate professor, University of Waterloo, Canada
2013 president of The Optical Society of America
2018 Nobel Prize in Physics, full professor, University of Waterloo, Canada

Do you see yourself as a role model for young female scientists?

A number of women, all the way down to elementary school-aged girls, contacted me and said that I am an inspiration. So, I guess there is something to that. However, during the years, I worked with more men than women in my group. For myself, it did not matter whether my supervisors were male or female – I just wanted to do the physics I was interested in.

Can you name any mentor who supported you and your career in a special way?

I did not have a special person who followed me through my career or served as a mentor. I would rather say I learned a lot from all my supervisors in the different stages of my career.

How did you get your present position at the University of Waterloo?

As a post-doc I worked at Canada's National Research Council with Paul Corkum who was one of the leading scientists for ultrafast lasers. That was the job I was eager to do. When the contract ended it was hard to find a new job. I was getting married and my husband, also a physicist, worked at the Bell Laboratories at New Jersey. I took the position of a physicist at Lawrence Livermore National Laboratory near San Francisco. But I didn't stay long because I wanted to live closer to my husband. Therefore, I became a member of the technical staff at Princeton University. At that point, we were both looking for other positions. When I got the position as an assistant professor at the University of Waterloo my husband followed me and took an industry job. Five years later, I became associate professor.

And you were still an associate professor before you won the Nobel Prize?

Yes, because I did not bother to apply for the full professorship. I have had tenure for years – that was the important step. Being a tenured associate professor, I had the same rights and duties as a full professor. To become a full professor I would have had to do some paperwork. Now, it worked out anyway.

Do you have any collaborators outside Canada and the United States?

I was supposed to go to China during the first week of December, but I had to cancel that trip because I had to go to Sweden for Nobel Week. So far, I have not collaborated with any European institute. My research does not rely on huge collaborations.

Being the third woman ever to win the Nobel Prize, you are in the same line as Marie Curie and Maria Goeppert-Mayer. What do you think about that?

It is an overwhelming experience and I feel humbled because my situation is not at all comparable to theirs.

In what sense?

Marie Curie is an outstanding scientist. She did amazing research and won two Nobel Prizes in Physics and Chemistry. No one else was honoured that way. On top of that, nobody expected these accomplishments from a woman. It was before female suffrage, before higher education got common for women, before everything.

And Maria Goeppert-Mayer?

I think she was treated like an equal by her fellow scientists but the universities or society as a whole did not see it that way. When she did her research she later won the Nobel Prize for she was not even paid. This is just mind-boggling to me.

Do you see any drawbacks for female scientists today?

Not really. In our part of the world, women have access to higher education and if they want to progress in science there are no obvious barriers. However, the fraction of women in physics in Canada is 15 to 20 percent. Perhaps, there is a need for encouragement by society as a whole.

Are any of your children studying science?

Yes, my daughter just started graduate school this year in the field of astrophysics.

Do you have any advice for graduate students?

To graduate is a lot of hard work. You need to stay positive. Do what you love and you will do your best. To find the perfect job you also need a lot of luck. In our world, you should be open for all opportunities. If you want to do academic research it seems to be mandatory to travel around the world and find your challenge wherever it is. As there are not so many jobs in academic research you might not live where you want to live. But if you take pride in what you are doing you'll do a great job – and that's all you can do.

Ein persönlicher Blick

Am ersten Dienstag im Oktober habe ich nicht schlecht gestaunt, als am späten Vormittag feststand, dass meine frühere Kollegin Donna Strickland den Nobelpreis erhalten wird. Das war unerwartet, weil sie ein stiller Star ist.

Nach dem Bachelor an der McMaster Universität in Hamilton, Ontario, hat sie auf der amerikanischen Seite des Ontariosees in Rochester promoviert. Danach arbeitete sie am National Research Council of Canada, in Berkeley und Princeton. Sie ist 1997 wieder in ihre Heimat zurückgekehrt: Waterloo ist weniger als eine Autostunde von ihrem Geburts- und ihrem Studienort entfernt. In der Zeit von 2006 bis 2011 haben wir im gleichen Department zwar nicht wissenschaftlich, aber administrativ zusammengearbeitet.

Der Fachbereich Physik in Waterloo war lange Zeit relativ klein und hatte unter anderem kein Graduiertenprogramm. Donna hat das Department vor und während seines Aufstiegs Anfang der 2000er-Jahre mit getragen. Kurz danach begann ein großer Aufschwung, gekennzeichnet durch die Gründung eines privaten An-Institutes (Perimeter Institute for Theoretical Physics) und interdisziplinären Initiativen in der Universität (Institute for Quantum Computing) – beides finanziert durch große private Spenden.

Es ist bezeichnend für Donna Strickland, dass sie sich dem nicht angeschlossen hat. Als Laserphysikerin hätte sie sich auch mit den für die Quantentechnologie eher relevanten schwächeren Lasern beschäftigen können. Aber sie wollte lieber ihrem Interesse folgen als der Universitätspolitik. Sie hatte immer eine überschaubare Gruppe, mit der sie kontinuierlich, aber nicht immer hochrangig publiziert hat. Im Mediensturm nach dem Nobelpreis kam manchmal ihr überschaubarer h-Index zur Sprache, der ihr weniger wichtig war.

Mit Donna Strickland ging der Nobelpreis an eine Wissenschaftlerin, welche die Moden und die Optimierung der formalisierten Beurteilung von Wissenschaft weitgehend vermieden hat. Sie macht gute Physik, getrieben durch ihr Interesse. Außerdem ist sie bekannt als herausragende Dozentin auf allen Ebenen. Ihre Vorlesungen zur nichtlinearen Optik finden großen Anklang bei Studierenden aus allen Vertiefungsrichtungen. Viele der Masterstudierenden und Promovierenden, selbst mit den Schwerpunkten Stringtheorie oder Quanteninformation, haben ihre Vorlesungen mit Begeisterung belegt. Viele Studierende, die sich nach dem ersten Studienjahr in der naturwissenschaftlichen Fakultät für die Physik entschieden haben, haben dies wegen einer Vorlesung von Donna Strickland getan. Chris Ferrie – ein Absolvent aus Waterloo und heute etablierter Wissenschaftler in der Quanteninformationstheorie – berichtete von der großartigen Erfahrung, bei ihr die Bachelorarbeit zu machen. Die Geduld seiner Betreuerin war auch dann noch nicht erschöpft, als er einen sehr teuren Kristall beschädigt hatte. Als Folge ihres hohen Ansehens und dem Willen, der Community zu dienen, war Donna Strickland auch Präsidentin der Optical Society of America. Daneben hat sie selbst die undankbarsten Tätigkeiten im Department nicht gescheut.

Bei Kaffee und Donut vor dem Kolloquium sagte sie einmal zu mir: „If anyone from our field will ever get a Nobel, it will be Ferenc Krausz." Sie hätte sich niemals selbst ins Gespräch gebracht. Ich kenne sie eher als zurückhaltende Wissenschaftlerin in ihrer Community in Kanada. Kurz nach der Ankündigung des Nobelpreises wurde in den Medien diskutiert, dass sie noch kein „full professor" war. Solche Dinge haben sie einfach nicht gekümmert – sie wollte nur gute Physik machen. Darin ist sie ausgezeichnet! Neben der hohen Signifikanz, dass sie erst die dritte Physiknobelpreisträgerin überhaupt ist, zeichnet dieser Preis auch die ungeplante, interessengetriebene, evaluationsimmune Physik aus.

Prof. Dr. Frank Wilhelm-Mauch,
Universität des Saarlandes