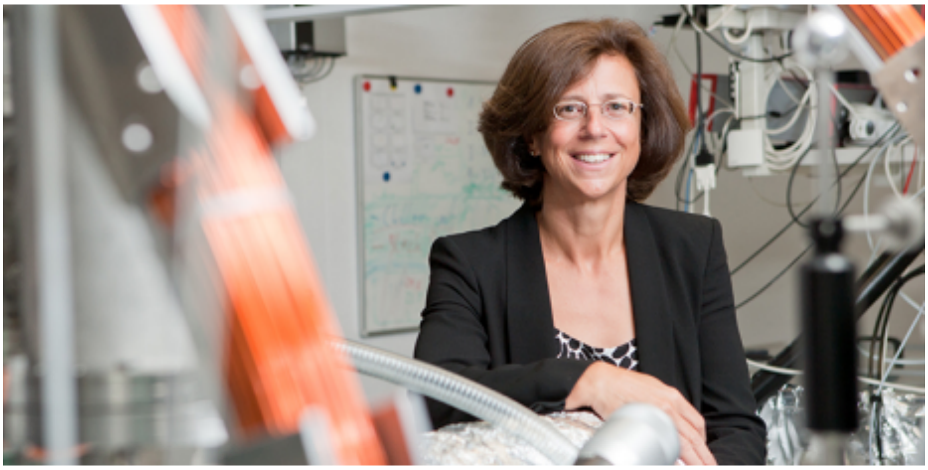
“I see myself as a discoverer”

13.05.2015 | News
By: Barbara Vonarburg

Professor Ursula Keller’s area of expertise is ultrashort laser pulses. Together with her group at ETH, she is currently developing new metrology techniques and novel semiconductor lasers that might well find application in every household. Ursula Keller will be in California on 13 May 2015 to receive the renowned OSA Charles H. Townes Award in recognition of her achievements.



Physicist Ursula Keller will receive a major award for her research focused on ultrashort laser pulses. (Photo: Tom Kawara / ETH Zurich)

ETH News: UNESCO has declared 2015 to be the International Year of Light. Does that make receiving this award all the more exciting for you as a laser physicist?
Ursula Keller: I’m very happy to have won this award now. Laser physics is an extremely important field with many industrial applications, from which Swiss industry also stands to benefit. Everywhere we look, we see materials that have undergone laser processing: in cars, printers, smartphones – even coffee machines. What we never see, for safety reasons, is the laser itself. The UNESCO International Year of Light is a chance to put light and lasers centre stage. We’re also pleased that we were able to convince ETH and the University of Zurich to devote this year’s joint Scientifica event in September to the topic of light.

You’ve already received many honours. Is winning the OSA Charles H. Townes Award still a highlight for you?
Absolutely. This award recognizes two important discoveries that we made here at ETH. One of those was in 1999. What we found out then proved to

Search news

Search the news by:

Enter keyword

Search

Related articles

Tunnelling electrons under the microscope (ETH Life, 15.11.2011)

Further information

Personal web site of Ursula Keller

Web site of The Optical Society

Don't miss the latest news

Sign up for our newsletter

be an essential element of the work that won the 2005 Nobel Prize in Physics, which was awarded to an American and a German. Unfortunately the Nobel laureates in question never cited us properly; they simply left us out of the picture. It really bothered me. And that's why I'm particularly happy to receive this recognition now.

What was it that you found out back then?
It had to do with what are known as frequency combs. These allow you to measure frequencies with absolute accuracy, so you can for instance build extremely precise clocks. Our work was focused on producing ever shorter laser pulses; we even managed to set the world record in this field at ETH. With this kind of pulse, the pulse duration is comparable to the period of oscillation of the light. In this case, the position of the electric field within the pulse becomes important. As far back as the 1980s, people had worked out how to stabilise the pulse rate in these lasers, but the maximum oscillation amplitude of the electric field within the pulse would never occur in the same place. We wanted to stabilise that, too.

And you managed it. Was it thanks to a flash of inspiration, or do you have a particular recipe for success?
We apply the Arnold Schwarzenegger philosophy – one that my students grasp immediately – which states: "If it bleeds, you can kill it!" I expand on this philosophy as follows: "If you see it, you can stabilise it!" We were the first to detect the signal that indicates the electric field's degree of offset within the pulse. As soon as we had this offset signal, we were able to start "pushing buttons" to find out how this signal changes, what causes it to change, and ultimately how to go about stabilising it. Once stabilised, the pulse laser's spectrum looks like a comb averaged over many pulses. The teeth of this comb are like the centimetre or millimetre lines on a ruler, but rather than measuring lengths we use them to measure frequencies. That's why it's called a frequency comb.

So this comb lets you count optical frequencies and thus measure time more accurately than we do now with atomic clocks. What do we need such precise clocks for?
Optical clocks allow us to measure the differences in gravitational effects predicted by Einstein's general theory of relativity. One area where we need to take these into account is in GPS calculations. And being able to test whether natural constants really are constant would be a dream come true. It might be that they are changing over a long time frame, but that's something we've yet to observe.

Did you know at the time that this was award-winning work?
I realised straight away that we were onto something really amazing. The solution to the problem fits on just one line; once you know it, it seems trivial. That's the great thing about our profession. If you're creative and come up with ideas, then you'll uncover new knowledge and find exciting applications for it. I see myself as a discoverer. On top of that, I'm always busy with positive goals. That keeps things incredibly interesting and enriching, and never boring – a unique luxury. To be a professor is a dream job.

You also met with resistance concerning the second piece of work for which you're now being honoured.
That's right. We submitted the paper to the renowned *Nature Photonics* journal, only for it to be promptly rejected on the basis that we were making too many claims. But we've now delivered on everything we "claimed" – and much more besides. In a situation like that, you need to be able to tolerate a degree of frustration, and you must never give up. In the end we

got a different journal to publish the work. And I've come up with a name for my discovery: MIXSEL.

What is a MIXSEL?
It's the next generation of short-pulse lasers, which is much cheaper to produce. The ultrafast lasers we currently have open up lots of applications, but they're solid-state lasers, so they're expensive. The lasers that everyone has at home these days, for instance in their CD player, are semiconductor lasers. These can be mass manufactured. We've presented a concept for a compact pulsed laser that is formed of a vertical stack of multiple semiconductor layers. In the jargon it's known as a "Modelocked Integrated eXternal-cavity Surface Emitting Laser," or MIXSEL for short.

When will the new laser hit the market?
Developing the necessary materials is very demanding, but if we can find a market where the MIXSEL will be a game-changing solution, then we might be able to find an industrial partner. Today's games consoles already contain standard lasers that work like radar to scan the room and the players. A pulsed laser would deliver much higher definition. That would make it possible to measure not just hand movements but even facial expressions. Wherever today's ultrafast lasers are too bulky or too expensive, there might be applications for the MIXSEL – for instance in telecommunications, computer technology or laser displays. If, ten years from now, there's a MIXSEL in every home, then that would be a wonderful retirement gift for me.

About Ursula Keller

Ursula Keller (55) grew up in Zug, studied physics at ETH Zurich and then went into research, primarily in the USA. In 1993 she returned to Switzerland to become a tenured professor at ETH Zurich's Physics Department. She has received many patents for her discoveries. She is married and has two sons. Alongside her work as a scientist, she supports efforts to further encourage and promote women in research.

Scientifica 2015 – Science Days in Zurich

During the **International Year of Light**, Scientifica (5-6 September 2015) will focus on the topic of light, without which there would be no imaging techniques, no films, no speed surfing, no tattoo removals, no knowledge – no life. Researchers at ETH Zurich and the University of Zurich will present their projects in more than 50 exhibition booths and hold numerous short lectures. Shows, talks, science slams and family activities are all part of the attractive programme.

www.scientifica.ch

Research | **Honours and prizes** | **International** | **Careers** | **Physics** | **Ultrafast science**

Leave a comment

We are interested in your comments. Please use our form to send your comment to us:

Comment

No comments yet

Page URL: https://www.ethz.ch/en/news-and-events/eth-news/news/2015/05/auszeichnung-ursula-keller.html
13.05.2015
© 2015 Eidgenössische Technische Hochschule Zürich