Exciting times

Nadya Anscombe talks to Charles Townes, Nobel Prize winner and inventor of the maser, the forerunner to the laser, to find out how the invention of the laser came about and how he struggled to convince people of its importance.

How did the invention of the maser, and then the laser, come about?

I was working at Bell Labs doing spectroscopy with microwaves and wanted to reach shorter wavelengths and higher frequencies. I didn't know how to do it and consulted a lot of people, but no-one knew the answer. I was even appointed chair of a national committee to try and get to shorter wavelengths. After several years we came to the conclusion that we could not do it, and organized what was to be the last meeting to plan our final report. I woke up early in the morning worrying about it. It was a sunny morning and breakfast wasn't ready yet, so I went for a walk and sat on a park bench to contemplate the problem. That was the first time I thought that perhaps atoms or molecules could be used to amplify radiation by exciting them to upper energy states. I was really excited, but I wasn't entirely sure it would work. I didn't even mention it in our last committee meeting because I realized it was a strange idea. When I started trying it, few people thought it would work, and I was even asked by one professor to stop my research. But I continued because I truly believed it would work — and it did. That is when the competition started and other researchers began to show interest. I wanted to know if my maser could go to optical wavelengths and so I consulted my brother-in-law, Arthur Schawlow, who was also working at Bell Labs at the time. When we realized it might be possible, we published a theoretical paper and applied for a patent for what we then called an optical maser. We had a difficult job convincing the patent attorneys at Bell Labs that it was worthwhile applying for a patent. Their attitude was: 'Great idea, but what use is it? Light has never been used for communication.' The first working laser was built in 1960 by Theodore 'Ted' Maiman at the Hughes Research Laboratory using a ruby rod. Getting enough excitation energy into the system was the main challenge. It was Maiman who came up with the idea of using a high-energy flash of light for excitation, and it worked first time. Early lasers included ruby systems, which used a piece of ruby of around half an inch in size, semiconducting systems of a similar size, and gas discharge tubes. These were very exciting times.

TOWNES

"We had a difficult job convincing the patent attorneys at Bell Labs that it was worthwhile applying for a patent. Their attitude was: 'Great idea, but what use is it?'"

Did you realize what impact your invention would have?

My aim was to develop a scientific instrument that I could use in my research, and I was very excited about the fact that we had managed to do it. I did realize that the laser had wider applications such as communications and cutting and welding, but I never envisaged the breadth of applications for which it is used today. The fact that so many Nobel Prize winners use the laser in their work is a measure of the impact the invention had on society, and I am still amazed at the exciting fields in which it is used. For example, I never envisaged the many medical applications a laser could be used for, including eye surgery, minimally invasive surgery and medical imaging. I am also interested to hear about the really big lasers, such as the one at the National Ignition Facility, and when researchers extend the boundaries of the laser, for example going down to wavelengths near the X-ray region of the spectrum. The laser today is so much more than just a scientific instrument.

What are the most important technology milestones over the past 50 years of laser development?

The use of lasers in communications has had a huge impact on society. The speeds and bandwidths available to us are incredible. The amount of power the laser can now produce is also amazing. Focused laser beams provide the greatest concentration of power humans can produce, and this can be used for applications such as fusion and nuclear energy. Furthermore, the lasers ability to perform precise measurements has changed the way we see the world. Measurements of distance, position or frequency can be made very precisely. This accuracy is allowing new kinds of experiments to be made, including measurements of the distance to the Moon, and of the distortion of space by gravity.

Does your current work involve lasers?

Yes it does. My current research at the University of California in Berkeley is in the field of astrophysics — the laser is a very important tool in this field. The laser has been used for astronomy in many ways, such as for improving the imaging of telescopes, and in my case, for performing interferometry on stars. The laser's narrow bandwidth means that I can avoid the gas around a star and measure the size of the star itself, rather than the size of the gas cloud that surrounds it. Ironically, when we invented masers and lasers, we were inventing something that had already existed in space for many years; masers and lasers can be found around stars, but we just didn't look! I still very much enjoy my work, and I am still having fun. Science is fun. But I suppose I must stop soon. I am, after all, turning 95 this year.

INTERVIEW BY NADYA ANSCOMBE

Nadya Anscombe is a freelance science and technology journalist based in the United Kingdom.