

62nd Lindau Nobel Laureates Meeting

PRESS RELEASE

Open to the Unexpected

- *Not without resistance: the long journey from a laboratory note to the Nobel Prize*
- *How important it is to trust one's own experiments*
- *Shechtman: "Experts recognise a discovery immediately"*

Lindau, 6 June 2012. The persistence with which outstanding researchers defend their interpretation of measurement results against the prevailing opinion has often contributed to scientific progress. Dan Shechtman, 2011 Nobel Laureate in Chemistry, is a good example here. He defended his discovery of quasi-periodic crystals for more than ten years before it was recognised. He, as well as 26 other Nobel Laureates and more than 580 young scientists from all over the world will participate in the 62nd Lindau Nobel Laureate Meeting, which will focus on physics. Two further researchers who were awarded the Nobel Prizes because they consistently pursued surprising leads and thus discovered materials with new physical and chemical properties are Sir Harold Kroto and Douglas Osheroff. They will also be present at this year's Lindau Meeting, which takes place from 1 to 6 July.

Perseverance Pays

Dan Shechtman needed a lot of stamina to fight for the recognition of his pioneering discovery. On the morning of 8 April 1982, results of an electron diffraction he was using at Johns Hopkins University to investigate a quickly solidifying aluminium-magnesium alloy showed him a completely unexpected image. Instead of a symmetric crystalline arrangement in three, four or six-fold axes, the diffraction pattern indicated ten-fold axes – an arrangement where the individual atoms no longer had the same distance to all neighbours, which at the time was considered to be absolutely imperative for a crystal. Shechtman's results revealed an aperiodic pattern, similar to the medieval mosaics in the Alhambra Palace in Spain. Shechtman noted down the discovery in his laboratory book with three question marks – but he believed in it, as he now

remembers: “Science is basically experimental and an expert quickly recognizes a discovery when he stumbles upon one.” Further measurements confirmed Shechtman in his discovery, the then unknown quasi-periodic crystal form. However, there was a great host of critics, as the quasi-crystals did not conform to the school of thought at that time. Nevertheless, Shechtman was not distracted, and he and his colleagues tenaciously continued with their research at the Technion in Haifa. “An expert always checks his own results. If his further experiments prove him right, he can stand tall against all criticism that may come from theoreticians,” he says today.

Only when they succeeded in producing larger quantities of quasi-crystals and confirming their pattern by X-ray diffraction were Dan Shechtman and his colleagues able to convince the International Union of Crystallography of the existence of quasi-crystals – ten years after their discovery. And the definition of crystals was altered. Today, owing to their brittle and hard properties, the quasi-crystals are already being used in the production of particularly hard steels, for example.

Exotic Superfluidity

Solids, liquids and gases are the states of matter which we encounter every day. They are linked to physical phenomena such as friction between adjacent particles. A vortex in a liquid which was generated by stirring therefore stops again by itself. Physicists, however, know a further state of matter: superfluidity. Superfluid liquids continue to flow without any friction whatsoever. This exotic state of matter is important for many physics-related research fields – from quantum mechanics through to cosmology. Researchers had known since 1911 that helium 4 had such a superfluid phase close to absolute zero. Helium 4 has an integral spin and is a boson; these are particles that can collectively make the transition into a superfluid state in accordance with Bose-Einstein theory. Helium 3 has half-integer spin and is thus a fermion, and differs significantly from helium 4 in its physical properties at low temperatures. According to the Barden-Cooper-Schrieffer (BCS) theory for the explanation of superconductivity (Nobel Prize for Physics 1972), it was to be expected that helium 3 could also achieve the superfluid state under certain conditions – the formation of a so-called Cooper Pair.

Doctoral student **Douglas Osheroff** confirmed this through his presence of mind one night in April 1972. He investigated the magnetic properties of solid helium 3 only 0.2 degrees above absolute zero at Cornell University in Ithaca. His aim was to record a so-called phase shift by increasing the pressure as a function of time. However, he noticed unexpected jumps in the

measurement curves. “The liquid NMR signal dropped by about a factor of two at the lower temperature transition. I felt that this had to be the result of the formation of ‘Cooper Pairs’ in the liquid,” he remembers. Way after midnight he wrote in his notebook: “2:30 AM have discovered the superfluid phase transition in liquid ^3He tonight.” Several months of careful measurements, which Osheroff carried out with his supervisor David Lee and his faculty colleague Robert Richardson, were required to confirm this discovery. In 1996, the trio was awarded the Nobel Prize for Physics for this feat. In his talk, Osheroff will discuss his view of “How Advances in Science are Made” at the 62nd Lindau Nobel Laureate Meeting.

Fascinating Carbon Spheres

“Always expect the unexpected,” says **Sir Harold Kroto**, who, together with Robert Curl and Richard Smalley, was honoured with the Nobel Prize for Chemistry in 1996 for the discovery of the fullerene. This carbon type, with molecules arranged like honeycombs that form a sphere, was a real sensation, as it represents a completely new form of solid carbon. Until then, the only solid carbon lattices known were hard diamond and soft graphite. The names of the carbon spheres (buckyballs and fullerenes) are reminiscent of the dome constructions of the architect Buckminster Fuller.

During a guest stay at Rice University in Houston in the laboratories of Smalley and Curl, Kroto vaporised graphite with a laser beam in a helium jet in order to detect short carbon chains as they would be expected from measurements in interstellar space. However, a mass spectrometric scan showed the largest peak at a compound which apparently consisted of 60 carbon atoms. Curl, Kroto and Smalley developed the idea of the sphere with 60 carbon atoms. “I had the strong gut feeling that it was so beautiful a solution that it just had to be right,” remembers Harold Kroto. Like Shechtman, he began to verify this assumption or “falsify it himself” in case of any doubt. Soon the results were recognised and fullerenes became the sought-after research object. They are considered to be potential catalysts and lubricants, as well as semiconductors and superconductors. Recently, fullerenes in the solid state, provided cause for excitement: They were detected with the Spitzer infrared telescope in the vicinity of a pair of stars known as XX Ophiuchi.

In his talk “Lost in Translation” at the 62nd Lindau Nobel Laureate Meeting, Sir Harold Kroto will discuss the necessity of communicating scientific language and content. Recognized as an

inspiring science communicator, he has long been a champion of communicating science more strongly via the Internet with such projects as Vega and Geoset.

Communicating scientific content and debates is also a crucial concern of the Lindau Meetings. Their online platform is the Lindau Mediatheque. It comprises audio recordings and videos of the talks of Nobel Laureates from the more than 60 years of history of the Lindau Meetings. With supplementary background information, photos, links to related contents and didactically edited “mini lectures”, the Lindau Mediatheque is a unique resource for researchers, those interested in science, journalists and teachers alike.

Further Information

The programme of the 62nd Lindau Nobel Laureate Meeting, background information regarding the participating Laureates, and abstracts/summaries of their talks are available in the Lindau Mediatheque: www.mediatheque.lindau-nobel.org/#/Meeting?id=284.

Profiles of the Nobel Laureates with background information in the Lindau Mediatheque:

Dan Shechtman (Chemistry, 2011): www.mediatheque.lindau-nobel.org/#/Laureate?id=18263

Douglas Osheroff (Physics, 1996): www.mediatheque.lindau-nobel.org/#/Laureate?id=6907

Sir Harold Kroto (Chemistry, 1996): www.mediatheque.lindau-nobel.org/#/Laureate?id=6862

Official Nobel Prize award reasoning for the Laureates mentioned above:

- Dan Shechtman received the Nobel Prize for Chemistry in 2011 “for the discovery of quasi-crystals”
- Douglas Osheroff was awarded the Nobel Prize for Physics in 1996 together with David M. Lee and Robert C. Richardson “for the discovery of superfluidity in Helium 3”.
- Sir Harold Kroto was awarded the Nobel Prize in Chemistry in 1996 together with Robert F. Curl Jr. and Richard E. Smalley “for the discovery of fullerenes”

The Lindau Nobel Laureate Meetings

27 Nobel Laureates and more than 580 young scientists from 69 countries will participate in the 62nd Lindau Nobel Laureate Meeting (Physics) from 1 to 6 July 2012. The topics of this year’s physics meeting include cosmology, particle physics and the challenges of a sustainable energy supply and climate issues. The Lindau Meetings have been taking place every year since 1951 in Lindau. They are organised by the Council for the Lindau Nobel Laureate Meetings established in

1954 and the Foundation Lindau Nobelprizewinners Meetings at Lake Constance established in 2000. More than 250 Nobel Laureates are members of the Founders Assembly.

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