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50 Years – Research for
A Life Without Cancer

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Nobel Prize winner at the Max Planck Institute for Biophysical Chemistry in Göttingen and the German Cancer Research Center: Nobel Prize in Chemistry awarded to Stefan Hell

For the second time a researcher at the DKFZ has been awarded the highest distinction in science: Professor Stefan Hell, director of the Max-Planck Institute for Biophysical Chemistry in Göttingen and department head at the DKFZ, has been awarded this year´s Nobel Prize in Chemistry for his pioneering work in the field of ultra high resolution fluorescence microscopy. This follows the 2008 Nobel Prize in Medicine for Harald zur Hausen.

“Stefan Hell is an absolutely exceptional scientist,” says Professor Otmar D. Wiestler, Chairman of the Management Board and Scientific Director of the German Cancer Research Center (DKFZ). “We are delighted and very proud to have a second Nobel Prize winner from the DKFZ, following Harald zur Hausen, within just a couple of years.” The highest distinction in science rewards many years of tireless research work during which Stefan Hell achieved a ten-fold increase in the resolution of light microscopy, making it possible for scientists to obtain images of structures ten times smaller than anyone had previously thought possible. “He has taken microscopy to a completely new dimension,” Wiestler says.

“During my PhD thesis work, I already suspected that the matter of light microscopy had not yet been entirely thought through,” Stefan Hell remembers. At that time light microscopy was believed to have reached its limits, at a barrier of 200 nanometers, as defined by Ernst Abbe in his famous diffraction law of 1873: For two dots to be distinguished in the focal plane of the objective, they have to be separated by a distance equal to at least half the wavelength of visible light. It was not until 120 years later, in the early 1990s, that physicist Stefan Hell was able to break this “magic” barrier and to lay the foundation for light microscopy at nanometer resolution, i.e. light nanoscopy.

In 1990, in a first step, Hell invented the 4Pi microscope, in which a sample is illuminated from two directions at the same time. This concept immediately improved resolution by four to seven times. He then went on to develop “stimulated emission depletion” (STED) microscopy, a technique based on the properties of fluorescence dyes that are used for dying proteins or DNA. STED can visualize biological structures that are up to 2000 times thinner than a human hair (achieving a resolution of 20 to 50 nanometers).

“The Nobel Prize makes me very proud and grateful – after all, it is the highest distinction in science,” says Hell, who is Director at the Max-Planck-Institute for Biophysical Chemistry in Göttingen and simultaneously heads the Division of Optical Nanoscopy at the DKFZ. “But most of all it is exhilarating for me to see how the STED microscope has empowered basic research in medicine. Although electron and scanning probe microscopes also permit observations of structures at nanoscales, these techniques require cutting samples into ultra-thin sections. This makes it impossible to use them to study intact or living cells. STED microscopy also delivers nanoscale insights into living cells, without these restrictions.”

At the DKFZ Hell and his co-workers are using ultra-powerful variants of these new techniques for basic biological and medical research. In one project they are studying the distribution of receptor proteins on the surfaces of viruses – molecules that are relevant for infectious processes. Ultra-fast imaging can also visualize physiological processes such as the transport

or release of chemical messengers at the ends of nerve cells. Additionally, through a combination of STED and 4Pi microscopy, the researchers attain improved spatial resolution that makes it possible to obtain information about the smallest details in the interior of living cells, for example the distribution of specific proteins in small cell organelles such as the mitochondria, the power plants of the cells.

Stefan Hell (born in 1962) earned his PhD in physics from the University of Heidelberg in 1990. From 1991 to 1993, he worked at the European Molecular Biology Laboratory (EMBL) in Heidelberg, followed by three and a half years of research positions at the Universities of Turku, Finland, and Oxford, United Kingdom. In 1997, he joined the Max Planck Institute for Biophysical Chemistry in Göttingen as a junior research group leader. Hell was appointed a Max Planck Director and head of the Department of NanoBiophotonics at this institute in 2002. In addition, he has headed the Division of Optical Nanoscopy at the German Cancer Research Center (DKFZ) in Heidelberg since 2003. Hell has been honored with numerous prestigious awards. Most recently, in September 2014, he received the Kavli Prize in Nanoscience, and one year earlier, in September 2013, the Carus Medal from the German National Academy Leopoldina. In 2011, when he won the Meyenburg Award for Cancer Research, the physicist said: “This is something very special, because it shows that our research is being applied on a broader basis – and cancer concerns us all, unfortunately. In this sense, I dearly hope, and I am excited, that in the future we will obtain many insights that will help fight cancer.”

Hell shares the €875,000 Nobel Prize in Chemistry with his American colleagues Eric Betzig from the Howard Hughes Medical Institute in Ashburn, U.S.A., and William E. Moerner of Stanford University, U.S.A.

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