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1998 Hans Sigrist Prize

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Individual fluorescent molecules are now currently imaged with optical microscopes and sensitive detectors. 'Optical spectroscopy of single molecules in physics, chemistry and biology' was the topic of the Hans Sigrist Prize, which I had the honour to receive in 1998. Since that time, my group and myself developed single-molecule investigations further, particularly towards the production of single photons. In 1905, A. Einstein, then in Bern, attributed the photo-electric effect to light grains, later called photons. Individual photons could be detected already in the 1950's with photomultipliers, but the production of individual photons is more difficult. How to produce one and only one photon, on demand ? We have suggested that a single molecule can do that, because it only emits one photon at a time. One just has to prepare the molecule in its emitting state, with certainty. Generous support by the Hans Sigrist Foundation helped us build up the single-photon source described in [1], which demonstrated the feasibility of the idea. The production of single photons has many important potential applications, for example in quantum cryptography, i.e., the communication of a coding key with absolute secrecy against eavesdropping [2].

More recently, we developed a special objective for low-temperature microscopy. Normal objectives are designed for microscopic work in ambient conditions, for example for biology. A single-photon source, however, works best at cryogenic temperatures, which conventional objectives can't withstand. Part of the prize's funding was spent on the design of the objective shown in the attached Figure, enabling better imaging and fluorescence collection at low temperatures and in ultrahigh vacuum.

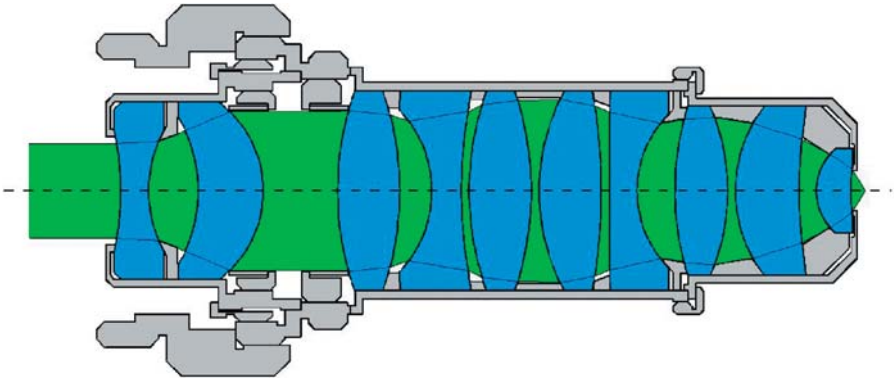
By supplying considerable funding 'with no strings attached', the Foundation

has been instrumental in the latest developments of single-molecule spectroscopy. It is a great pleasure for me to gratefully acknowledge its contribution.

[1] Brunel C. et al., Phys. Rev. Lett. 83 (1999) 2722.
[2] Gisin N. et al., Rev. Mod. Phys. 74 (2002) 145.

The financial support of the Prize helped me fund my various activities and react rapidly and with total flexibility to the unexpected situations popping up in everyday scientific research. Examples are the design of a dedicated scientific instrument that no national institute alone would have funded, or the financial support of a promising young scientist for a post-doctoral stay in the USA.

From a more personal perspective, I am convinced that the Prize played an important part in the negotiations that ended up with my installation as a full professor at Leiden University, in the Netherlands, in 2001.



Optical ray-tracing of the 10-lens objective designed by the company Bernhard Halle Nflg (Berlin, Germany) for low-temperature operation. The objective offers excellent spatial resolution and fluorescence collection in extreme environments.

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