Heinrich Rohrer

(1933–2013)

Co-inventor of the scanning tunnelling microscope.

Heinrich Rohrer, Heini to those who knew him, helped to open the door to nanotechnology. With Gerd Binnig, he produced a device that allowed researchers to image and measure atoms and molecules, and to manipulate them.

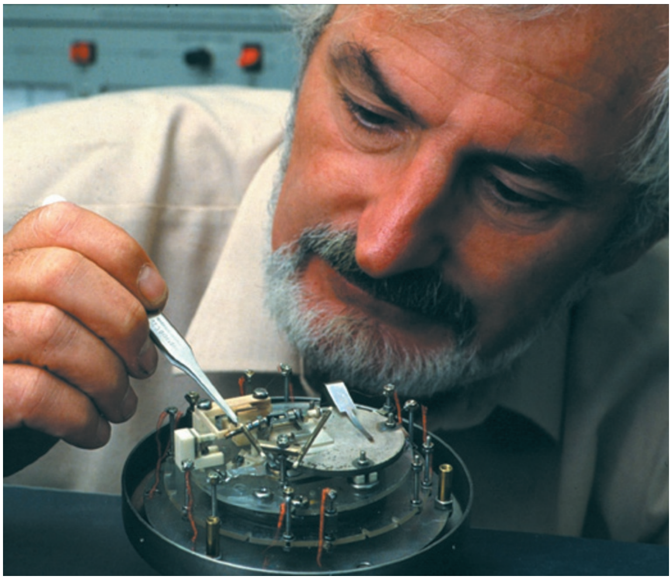
Rohrer, who died on 16 May, three weeks before his 80th birthday, was born in 1933, half an hour after his twin sister. He grew up in the village of Buchs in eastern Switzerland. Rohrer studied physics at the Swiss Federal Institute of Technology (ETH) in Zurich, where he remained to pursue a PhD. It was during his PhD years that he first came into contact with the nanometre scale, through studying the properties of superconductors.

After receiving his PhD in 1960, Rohrer pursued a two-year postdoctoral research fellowship at Rutgers University in New Jersey, working on superconductors and metals. At the end of 1963, he joined the IBM Research Laboratory in Rüschlikon, Switzerland, on the recommendation of various peers including physicist Bruno Lüthi, who had worked alongside Rohrer at the ETH.

Towards the end of the 1960s, Rohrer began working on an antiferromagnet called gadolinium aluminate ($GdAlO_3$) in collaboration with Keith Blazey, another physicist at the IBM lab. Antiferromagnetism is a type of magnetic ordering that vanishes at a certain temperature. The work brought Rohrer into the field of critical phenomena and led to crucial findings about magnetic phase transitions. By this point, the group at the IBM lab had established a world-renowned reputation in critical phenomena, after K. Alex Müller — then head of physical science — had pioneered the field of structural phase transitions.

In the late 1970s, Rohrer's interest shifted towards the complex structure of surface materials. In building ever-faster computers, the semiconductor industry was rapidly approaching the design of chips on the nanoscale. Yet few tools were available to study the structure and properties of materials at this scale. In 1978, Rohrer insisted that the IBM lab hire Gerd Binnig, a young German physicist from Frankfurt University, and the two started to contemplate a new device. By 1981, the pair had designed the world's first scanning tunnelling microscope (STM).

Unlike conventional microscopes, the STM did not use lenses. Instead, a probe sharpened to a single atom at the tip was moved close enough to the surface of a conductive material, such as silicon or gold, for the electron wavefunctions of the atoms in the tip to overlap with those of the atoms in the conductive surface. (Picture two overlapping electron 'clouds'.) When a voltage was applied to the tip, electrons started to 'tunnel', or 'leak', through the vacuum gap, causing a current to flow from the foremost atom of the tip into the surface.



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Moving the tip by the diameter of a single atom changed the current by a factor of a thousand, giving the device its enormous resolution. As the tip was scanned back and forth, it followed the atomic structure of the surface, extending and retracting over dips and bumps. Thus, for the first time, it was possible to get up close and personal with atoms in three dimensions.

Nobody believed that Rohrer and Binnig's experiments demonstrating quantum tunnelling could ever work. A tremendous challenge was bringing the tip only 0.2 nanometres away from the surface (1 nanometre is 1 billionth of a metre). However, a cleverly designed mechanism using the forces of strong magnets did the trick.

Rohrer and Binnig's initial results were eventually verified by other groups and presented at a workshop on the STM in the Austrian Alps in 1985. Devices such as the atomic force microscope (AFM) — a very high resolution type of scanning microscope that measures the atomic forces between the tip of a probe and the surface being scanned — have their roots in this meeting. During the last night of the workshop, the mountains were abuzz with crazy ideas about how such microscopes might be used in applications in all sorts of fields, from fundamental physics and chemistry to information technology, quantum computing and molecular electronics, as well as in the life sciences.

In 1986, Rohrer and Binnig shared half of the Nobel Prize in Physics. The other half of the prize was given to the German physicist Ernst Ruska for inventing the scanning electron microscope, a device that produces images of a sample by scanning it with a focused beam of electrons.

With the emergence of scanning probe microscopes (the STM and the AFM are just two among many types of these), the door to the nanoworld was pushed wide open. Today, such tools are still making a tremendous impact on numerous disciplines.

An extraordinarily charismatic man, Heini went on to promulgate nanoscience and nanotechnology to upcoming generations of researchers. I remember a lecture he gave in South Korea some years ago, which was attended by almost 4,000 high-school and university students. His captivating description of the development of the STM was followed by thunderous applause. In fact, one of the attendees recently told me that it was Heini's talk that inspired him to study physics and nanoscience.

Heini will be deeply missed as a natural leader, a visionary, a stimulating scientist and a wonderful person. He is survived by his wife Rose-Marie Egger, his two daughters Doris Rohrer Hansen and Ellen Rohrer, and two grandchildren. ■

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