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## Curriculum Vitae:     **Andreas J. Heinrich**

Heinrich is a world-leading researcher in the field of quantum measurements on the atomic-scale in solids. He pioneered spin excitation and single-atom spin resonance spectroscopy with scanning tunneling microscopes – methods that have provided high-resolution access to the quantum states of atoms and nanostructures on surfaces. He has a track record of outstanding publications and invited talks and has established a strong network of global collaborations. As a consequence, Heinrich’s work has received extensive media coverage worldwide. Heinrich spent 18 years in IBM Research, which uniquely positioned him to bridge the needs of industrial research and the academic world. This unique environment gave Heinrich extensive experience in presenting to corporate and political leaders, including the president of Israel and the IBM Board of Directors. Heinrich became a distinguished professor of Ewha Womans University in August 2016 and started the Center for Quantum Nanoscience (QNS) of the Institute for Basic Science (IBS) in January 2017. Under his leadership, QNS focuses on exploring the quantum properties of atoms and molecules on clean surfaces and interfaces with a long-term goal of quantum sensing and quantum computation in such systems. Heinrich is a member of the Korean and German Physical Societies as well as a fellow of the American Physical Society and the American Association for the Advancement of Science

### ***Academic Degrees***

1998	PhD Physics, University of Göttingen, Germany
1994	Masters (Diplom), University of Göttingen, Germany

### ***Employment***

2017 - current	Director of Center for Quantum Nanoscience (QNS) of Institute of Basic Science (IBS)
2016 - current	Distinguished Professor at Ewha Womans University
2005 - 2016	Research Staff Member at IBM Almaden
	Group leader on scanning probe microscopy and magnetic nanostructures on surfaces

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2001 - 2004	Researcher / Engineer at IBM Almaden
1998 - 2001	Postdoc at IBM Almaden with Dr. Donald M. Eigler
1994 - 1998	Research Assistant, University of Göttingen (Prof. Rainer G. Ulbrich and Dr. Martin Wenderoth, Supervisors)

## Scientific Impact

### *Spin excitation spectroscopy*

In 2004, Heinrich created the field of atomic scale spectroscopy of individual magnetic atoms on surfaces and helped to grow this topic to international prominence in the following years.

#### Key milestones:

- Design and construction of a novel scanning tunneling microscope for temperatures below 1 Kelvin and high magnetic fields – specifically built to investigate single-atom electron loss spectroscopy on magnetic atoms. This microscope was the first of its kind in the world.
- First to achieve single atom spin-excitation spectroscopy with his STM measurement of the Zeeman splitting of individual atoms on surfaces (*Science* 2004).
- Groundbreaking achievements with spin excitation spectroscopy include the measurement of single atom magnetic anisotropy (*Science* 2007), spin-spin coupling in engineered chains (*Science* 2006), and the Kondo effect (*Nature Physics* 2008).
- Developed nanosecond scanning tunneling microscopy (STM) (*Science* 2010), an improvement in time resolution of 100,000 times.
- Demonstrated atomic-scale magnetic data storage (*Science* 2012 and *Nature* 2017), which led to world-wide coverage in scientific and general media.
- Developed single-atom electron spin resonance in STM (*Science* 2015) which can be used as quantum sensor on clean surfaces to measure neighboring atoms and molecules (*Nature Nanotechnology* 2017).
- Combined spin excitation spectroscopy with ensemble averaging x-ray absorption spectroscopy (*Science* 2014).
- Heinrich has given 10 plenary lecture and over 65 invited talks at major international conferences. He has given about 100 seminar and colloquium talks at universities and international research institutions.

## ***Precise atom manipulation***

In addition to these groundbreaking accomplishments, Heinrich has built on the pioneering achievements of Dr. D.M. Eigler in the area of precise atom manipulation on surfaces by constructing model devices for possible future applications in data storage and computation.

### Key milestones:

- Development of a technique to control the motion of CO molecules on surfaces. Application of such processes to perform arbitrary logic operations via mechanical computations (*Science* 2002).
- Construction of a state-of-the-art low-temperature atomic force microscope in close collaboration with Professor Franz Giessibl (Regensburg) with atomic resolution. This work sparked an increasing interest in low-temperature AFM with atoms and small molecules in the following decade.
- Published a fundamentally new technique for measuring the atomic forces that act on atoms and molecules on surfaces. Applied this technique to measure the force it takes to move atoms and molecules on surfaces (*Science* 2008).
- Construction of complex nanostructures for atomic-scale magnetic data storage (see above, *Science* 2012).
- Creation of the World's smallest movie 'A Boy and His Atom' with about 10,000 precise atom moves (YouTube 2013).

## **Recognition**

### ***Awards and plenary lectures***

2018	100 Excellent National R&D Performance in 2018 and Ministerial Citation from the Ministry of Science and ICT, Republic of Korea
2018	Plenary lecture at the European Magnetic Resonance Meeting (EUROMAR 2018), Nantes, France: 'The Quantum Science of Atoms on Surfaces – Single Spin Electron Spin Resonance'
2018	Foresight Institute 2018 Feynman Prize – Experimental

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For advances in manipulating atoms and small molecules on surfaces and employing them for data storage and computation.

- 2018 Keithley Award for Advances in Measurement Science from the American Physical Society:  
For the design and construction of a series of highly sophisticated scanning probe instruments, including the development of inelastic electron tunneling spectroscopy at the single atom and single spin limit, that provided many breakthroughs in the science of measurement.
- 2017 Awarded directorship of the Center for Quantum Nanoscience as part of the Institute for Basic Science. This award provides significant long-term funding for basic science research.
- 2017 Plenary lecture at the 50th Annual International Meeting of the ESR Spectroscopy Group of the Royal Society of Chemistry, Oxford, United Kingdom:  
'Electron Spin Resonance of single atoms on a surface'
- 2017 Plenary lecture at Korean Physical Society Fall Meeting, Gyeongju, Korea:  
'The Quantum Properties of Magnetic Atoms on Surfaces'
- 2016 Distinguished Fellowship under the Chinese Academy of Science President's International Fellowship Initiative
- 2015 Fellow of the American Association for the Advancement of Science:  
For the development of scanning tunneling microscope methods to study individual magnetic atoms by spin-excitation spectroscopy and nanosecond pump-probe techniques.
- 2015 Plenary lecture at the International Vacuum Science Congress 20 (IVC-20) and ICN+T 2016, Busan, Korea:  
'Electron Spin Resonance of single atoms on a surface'
- 2014 Outstanding Technical Achievement Award, IBM:  
For the creation of the scientific movie 'A Boy and his Atom' and the resulting public engagement with IBM basic science research.
- 2014 Plenary lecture at Dutch Physical Society Meeting, Veldhoven, The Netherlands:  
'A Brief History of Atom Manipulation'.
- 2012 Fellow of the American Physical Society:  
For the development of spin excitation spectroscopy and nanosecond STM.

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- 2012 Plenary lecture at International Conference on Nanoscale Science and Technology (ICNT 2012), Paris, France:  
'Quantum or Classic: An atomic-scale perspective on magnetism on surfaces'.
- 2011 Best of IBM Award (top 100 annual contributors out of 430,000 employees):  
For Atomic Scale Manipulation and Chemistry on Surfaces.
- 2011 Corporate Award, IBM:  
For Atomic Scale Manipulation and Chemistry on Surfaces.
- 2011 Plenary lecture at German Physical Society Meeting, Dresden, Germany:  
'Probing the energetics and dynamics of individual atomic spins on surfaces'.
- 2010 Outstanding Technical Achievement Award, IBM:  
For the development of a technique for measuring atomic forces during the manipulation of atoms on surfaces.
- 2010 Plenary lecture at International Vacuum Congress (IVC 18), Beijing, China:  
'Nanosecond STM and quantum tunneling of magnetization'.
- 2009 Zhong-Guan Cun Forum at Institute of Physics, Chinese Academy of Sciences:  
'An atomic-scale look at magnetic nanostructures on surfaces'.
- 2007 Outstanding Innovation Award, IBM:  
For the development of a scanning tunneling microscope for the investigation and atomic-scale construction of magnetic nanostructures.
- 2006 Plenary lecture at California Section of the American Physical Society, Long Beach, CA, USA:  
'Magnetism Revisited on the Atomic Scale'.
- 2003 Research Division Award, IBM:  
For the development of molecule cascades, a novel concept for information processing on the atomic scale.
- 2005 Plenary lecture at International Conference on Scanning Probe Microscopy and Related Techniques (SPM'13), Sapporo, Japan:  
'Inelastic STM spectroscopy at Low Temperatures'.
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- 2005 Plenary lecture at 32<sup>nd</sup> Annual Meeting of Canadian Microscopy Society, Hamilton, Canada:  
'Scanning Tunneling Microscopy'.
- 2003 Plenary lecture at International Conference on Scanning Probe Microscopy and Related Techniques (SPM'12), Eindhoven, The Netherlands:  
'Molecule Cascades: Concepts and Applications'.
- 2003 Plenary lecture at Spring Meeting of German Physical Society, Dresden, Germany:  
'The STM as a Hand in the Nanoworld'.
- 1998 Feodor Lynen scholarship, the Alexander von Humboldt-Foundation, Germany:  
Funded postdoctoral research at IBM.

### ***List of Organized Workshops and Conferences***

- 2019 IBS Conference on Quantum Nanoscience, Seoul, Korea
- 2019 Quantum Spins at the Nanoscale – Recent Theoretical Advances, Seoul, Korea
- 2018 Workshop on Advanced Scanning Probe Microscopy(ASPM II) 2017, Busan, Korea
- 2017 Workshop on Advanced Scanning Probe Microscopy(ASPM I) 2017, Gyeonggi-Do, Korea
- 2016 Workshop on Experimental Physics, Seoul, Korea
- 2016 Theory Workshop on Solid State Physics, Seoul, Korea
- 2009 Winter Conference at the Aspen Center for Physics 'Unifying themes in condensed matter', Aspen, CO, USA

### ***Organizing committees of national and international conferences***

- 2019 - present International Organizing Committee of the 9th International Symposium on Surface Science(ISSS-9) by the Japan Society of Vacuum and Surface Science (JVSS), Takamatsu, Japan
- 2018 Organizing Committee of the Second Spins on Surfaces(SoS II) Workshop, San Sebastian, Spain

### ***Scientific Advisory Boards***

- 2012 - present    Scientific Advisory Board of Max Planck Institute for Solid State Research, Stuttgart, Germany.
- 2014 - 2016     Scientific Advisory Board of Center for Low-dimensional electronic materials (CALDES) of Institute of Basic Science (IBS), Pohang, Republic of Korea.

### ***Membership of Scientific Societies***

- 2017 - present    Membership of the Korean Physical Society
- 1993 - present    Membership of the German Physical Society
- 1999 - present    Membership of the American Physical Society
- 2001 - present    Membership of the American Association for the Advancement of Science (AAAS)